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 R1, the sum of the differences in capacity from the largest mould; R2, the sum of the squares of the above differences; R3, the sum of the squares of the differences from the mean mould capacity; and similarly L1, L2 and L3 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.

Diagram 1 COPY OF A DOWNTIME ANALYSIS SHEET

Machine	Out-put	Running Time	Down-time	Mech & Elec	Linings & PVC	Mould Clean	Mould Changes
PL 1	1881	1440	245	135		20	
PL 2	1262	1440	490	42	190	10	
PL 3	1816	1440	288	88	109	30	
PL 4	1142	1440	720	645		10	
PS 1	2007	1440	374	70	95	15	
C 1	1581	1165	22	105	66		25
C 2	2256	1440	244	80	20		20
C 3	376	260	59		10		

DATE: 13/9/74

Table 1 Typical Input Data for one week on one machine

Machine	Moulds	Prd^n	Cycle	Downtime	Hours	Man hours	Shift Indicator
4	959 1148 1159 1230 1313	428	261	130	8	20	1
		524	259	42	8	20	0
		502	259	50	8	20	0
		482	259	81	8	16	0
		518	258	45	8	20	0
		510	256	67	8	20	0
		504	257	120	8	20	0
		523	258	35	8	20	0
		495	258	64	8	20	0
		287	244	264	8	16	0
		366	248	115	7	14	0
		572	246	10	8	20	0
		508	243	102	8	20	0
		375	240	171	8	20	0
		580	238	20	8	20	0

Table 2 Selected correlations for the second data set on large protective machines

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

* 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 3 Distribution of the first set of data

		Machine No.				
		1	2	3	4	All
Size Range						
Child's:	Shifts	34	152	-	-	186
	Mean output	481	561	-	-	546
Juvenile's:	Shifts	-	-	139	-	139
	Mean output	-	-	591	-	591
Women's:	Shifts	162	4	-	177	343
	Mean output	483	398	-	544	513
All:	Shifts	196	156	139	177	668
	Mean output	483	557	591	544	537

Table 4 Distribution of the second set of data

		Machine No.				
		1	2	3	4	All
Size Range						
Child's:	Weeks	2	3	-	-	5
	Mean output	587	592			590
Juvenile's:	Weeks	5	-	15	-	20
	Mean output	494		557		541
Women's:	Weeks	6	-	-	13	19
	Mean output	497			517	511
All:	Weeks	13	3	15	13	44
	Mean output per shift	517	554	557	517	534

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.

Size range	Juvenile's					Women's								
Size	9	10	11	12	13	1	2	3	4	5	6	7	8	9
Weekly demand	200	300	500	650	520	510	490	340	330	280	250	250	200	180
Initial stock														
Problem 1	1050	1450	1750	2530	1950	2180	1500	1450	1700	1110	775	1125	1150	850
Problem 2	1628	1921	1653	357	707	1300	2469	3088	2229	2363	269	1655	261	1096
Initial machine loading														
Problem 2	X			X	X		X		X					

Machine empty for Problem 1

Notes The production rate from each mould in use is 1000 pairs per week.

In problem 2 the demand in the final week of the schedule is 3.2 times the normal weekly demand. This is to build up the final balanced stocks. There is no such condition in problem 1 which represents a continuing schedule.

APPENDIX 3 I M F SCHEDULING SYSTEM

CONTROLLER'S MANUAL

SECTION	CONTENTS
1.	Purpose of the System.
2.	Controlling the Scheduling System.
3.	Gathering the Data.
4.	Completing the Cards.
5.	Running the Scheduling System on the Computer.
6.	Use of the diagnostic printouts.
7.	Detecting errors in the FORTRAN programs.

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 should be made in the following week.

The schedules are also used to determine future raw materials requirements (using the ICL 'PROMPT' 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 sizeroll 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 where 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-COMMIT 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.

SEQUENCE OF EVENTS (contd)

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.

SECTION 3

GATHERING THE DATA

Mostof the data is gathered by the Controller himself or provided by three other people - the Planning Manager, the Senior Planner IMF 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 IMF

The controller determines the stockdate 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.

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

Card Type	Purpose	One card for each
DESC	Description	List no./size range
SZRL	Sizerolls	"
STKS	Stocks	"
PROD	Production before schedule	"
MATS	Material availability	"
REQS	Requirements	List no.
MCLD	Machine loading	Size
MLDS	Mould availability	Mould type
FORC	Forces mould into particular machine	"
MCDA	Machine Data - Production rate and scheduling parameters	Man. Group
RAWS	Expediting costs by week	"
CHOV	Overrides chart card	Man.Group/Machine No.
CHRT	Charts manufacturing group schedule	Mach.Type/Machine No.
WEEK	Working days in week	One only
SYNC	Synchronises dates	"
CAL	Calendar card	"

DATES

All cards have a date attached. This is merely informative on DESC, SZRL, MLDS, MCDA, MCLD, 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 STKS 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:-

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

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.

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

Notes: If the true 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 DMF 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.

Cols.	Content	Correct Value
1- 4	Card Type	MLDS
5-10	Creation date	Current date
11-13	Machine type	603, 606, 609 or 704
14	Manufacturing group	1 to 5
15-16	First valid week *	Generally blank
18-21	List number	Blank
22	Size range	C, J, W or M
23	Type of mould used	B, D, or space
28	No. of moulds for first series in range	Up to 3
Every 5th column		
63	No. of moulds for eight size in range	
64-69	Total number of moulds	
70-80	Not used	

* 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 sizeroll.

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 CRO8 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 STOCKS 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.

Cols.	Content	Correct Value
1- 4	Card Type	STKS
5-10	Stocks date*	See note. As on SYNO card
11-13	Machine type	Leave blank
14	Manufacturing group	" "
15-16	Reference week	" "
18-21	List number	
22	Size range	C, J, W or M
23	Type of mould used	Leave blank
24-28	Net stocks for first size in range	
5 cols.at time		
59-63	Net stock for eighth size in range	
64-69	Total stock for size range	
70-75	Cumulative released orders	
76-80	Not used	

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 CR08. If net stocks are negative, place minus sign in the first column of the field.

THE PRODUCTION

Purpose - There is a delay between collecting the information and implementing the new schedule. This allows for data preparation and processing, and for ordering materials. In this period the old schedule will be retained; the production card states the expected production between the stock date and the start of the new schedule.

Source - The DF planner will provide this information. It should generally come from the previous schedule. If the stocks date is the end of a week, a complete number of weeks production will be input.

Frequency - New Production Cards are needed for each schedule.

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.

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

THE MACHINE LOADING

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.

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

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 sizeroll.

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.

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

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

Cols.	Content	Correct value
1- 4	Card type	SYNC
5-10	Schedule start date	A Monday
11-16	Schedule finish date	
17-22	Stocks date	As on STKS and PROD cards.
23-80	Not used	

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 IM50 and not in IM10 and IM20.

Completing the CAL Card

Cols.	Content	Correct value
1- 3	Card type	CAL
4- 9	Schedule starting date	As SYNC card
10-15	Schedule finish date	" " "
16-21	Excluded date	Not normally used
22-27	Excluded date	"
...		
76-77	"PROMPT" week for schedule start	
78-79	Weeks in current 'Prompt' year	52 assumed if blank
80	Pay Indicator	▽ if weekly schedule 1 if daily schedule

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 CHART CARDS

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

Cols.	Content	Correct value
1- 4	Card Type	WEEK
5-10	Start date of manufacturing group schedule	A Monday
11-20	Unused	Blank
21-80	Working days in week	0 to 7
1- 4	Card Type	CHRT
5-10	Start date of manufacturing group schedule	As WEEK card
11-13	Machine type	603, 606, 609 or 704
14	Machine Number	1 to 5
15-20	Unused	Blank
21-80	Manufacturing group loaded	0 to 5

Notes:

Columns 21 to 80 refer respectively to the first to sixtieth week of the manufacturing group schedule. Thus colum 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.

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

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.

Cols.	Content	Correct value
1- 4	Card Type	MCDA
5-10	Current date	
11	Part	1
12-14	Machine Type	603, 606, 609 or 704
15	Manufacturing Group	1 to 5
16-17	Starting week	Normally blank
18-19	End week	" "
20-23	Average production per full week	Prs. of bests
24-27	Weekly production on Machine 1	
28-31	" " " " 2	
32-35	" " " " 3	
36-39	" " " " 4	
40-43	" " " " 5	
44	Machine to take smallest sizes	
⋮	Other machines in order	
48	⋮	
49-51	Typical large size for Machine 1	Eg. C09, M11.
	⋮	Normally blank
3 cols.at time	⋮	
61-63	" " " " " 5	
64-69	Desired minimum freestock	Normally blank
70-79	Not used	
80	Day Indicator	D for daily W for weekly

Cols.	Content	Correct value
1- 4	Card Type	MCDA
5-10	Current date	
11	Part	2
12-14	Machine Type	603, 606, 609 or 704
15	Manufacturing Group	1 to 5
16-17	Starting week	Normally blank
18-20	Expediting cost	£ per week's supply
21-23	Set-up Cost	£
24-26	Colour change cost	£
27-29	Size Scatter Cost	£.nnn per size differenc
30-31	Maximum spread of sizes	Often zero indicating unlimited
32-33	Mould change limit	
34-37	Weighting factor	Thousandths
38-41	Fraction saleable	"
42-45	Indicator	Ø or ± 1

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. 603 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, EM30 scales this figure down by 10% so no adjustment to the MCDA 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 FREESTOCK

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).

SCHEDULING PARAMETERS (contd)

Parameters - 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 .400; 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 it 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, FORC, 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, FORC 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.

OPTIONAL 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 artifical 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 thesizes, 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.

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

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 MCDA 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.

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

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.

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

Cols.	Content	Correct value
1- 4	Card Type	FORC
5-10	Current date	
11-13	Machine type	
14	Manufacturing group	1 to 5
15-16	Relevant Week	Relative to schedule start date
18-21	List number	Leave blank
22	Size range	C, J, W or M
23	Type of mould used	B, D or space
28	Machine for first size in range	Space or 0 to 5
Every fifth column		
63	Machine for eighth size in range	
64-69	Total of entries	
70-80	Not used	

SIMPLE EXAMPLE

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 (MLDS) 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.

DATA NEEDED (contd)

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.

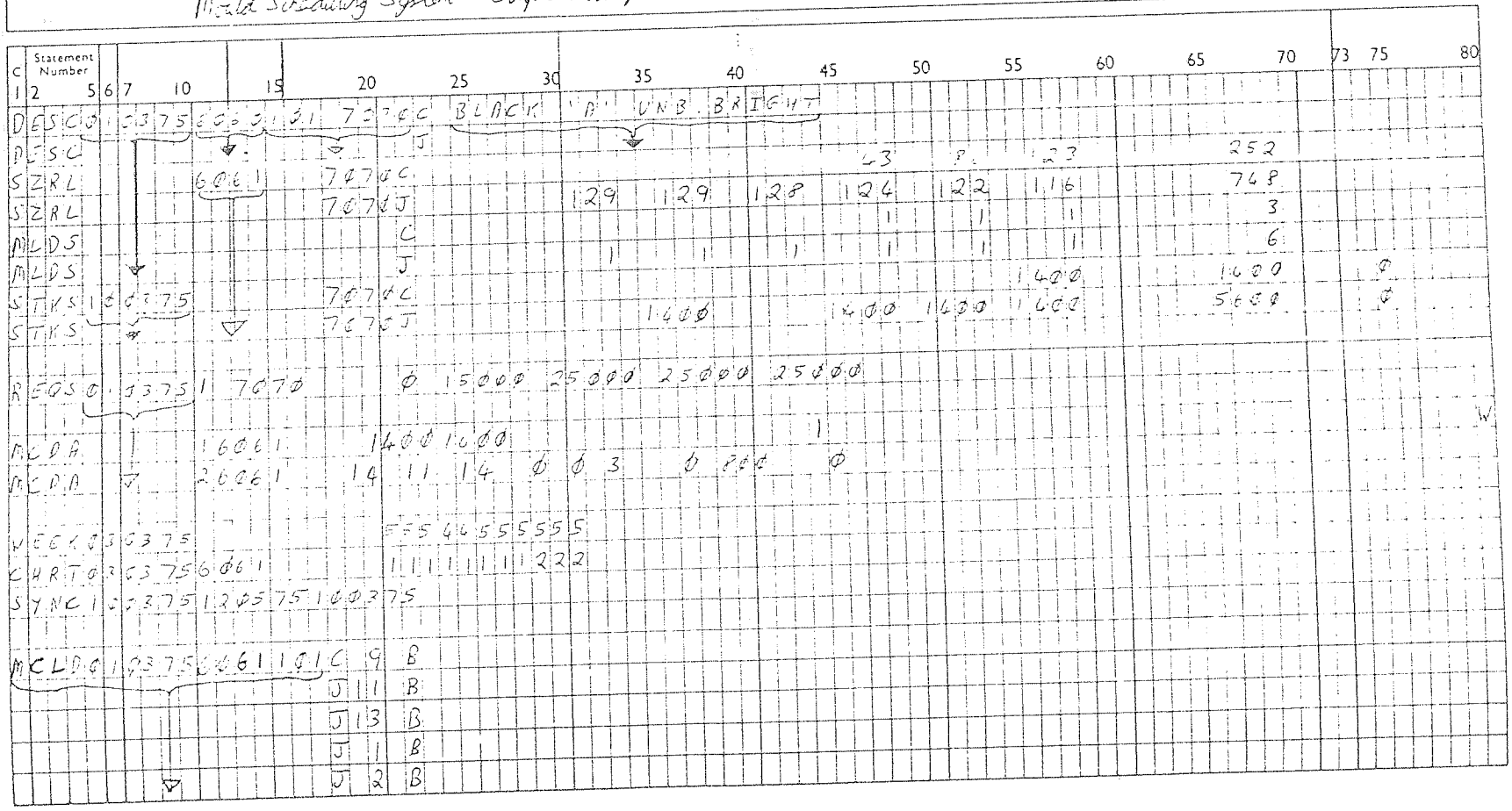
The Week card (WEEK) specifies the number of working days in each week. This is five days a week except over Easter, when it is four.

The Chart card (CHRT) specifies the manufacturing group to be made on the first 606 machine. Group number 1 is to be made for 8 weeks and then Group 2 (Snotops).

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).

Mould Scheduling System – Simple Example



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 (IM10 and IM20) (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, MCDA 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 EM10.

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, EM10 will be run with the setting ON2.

Checking the Printouts

Two printouts are issued; one from EM10, and one from EM20. 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 MCDA cards very carefully to see that they have been correctly coded. Scan earlier MCDA 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 MCLD 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 sizerolls 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 EMF SCHEDULING RUN

The second scheduling run proceeds right through the system unless halted by errors, and finishes by printing out schedules for the EMF.

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 EM50.

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 EM10 pack for use in the EM50 run.

When EM20 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 EM40 if there are errors in either EM30 or EM40, in which case, the message HALTED EE appears on the console. Otherwise, the system proceeds to EM50 and prints the schedules.

EXAMINING THE SCHEDULES AND DIAGNOSTIC PRINTOUTS

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 EM30 or EM40. Check missing weeks against CHNT cards.
2. Examine the control totals to see if any records were rejected. There is a control total in EM30 at the end of each machine type and in EM40 at the end of the run.
3. Skip through the EM40 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 EM30 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 EM40 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).

EM10 ERROR CODES

Error Code	Condition	Card Type Reference
001	Unrecognised Card Code	
005	Day invalid	DESC CHRT CHOV FORC MATS MCDA MCLD MLDS PROD RAWS REQS STKS SYN SZRL WEEK
006	Date non-numeric	DESC etc.
010	Month invalid	DESC CHRT CHOV FORC MATS MCDA MCLD MLDS PROD RAWS REQS STKS SYNC SZRL WEEK
015	Year below 74	DESC CHRT CHOV FORC MATS MCDA MCLD MLDS PROD RAWS REQS STKS SYNC SZRL WEEK
020	Machine Type not 603, 606, 609 or 704	DESC CHRT CHOV FORC MCDA MCLD MLDS RAWS
025	Manufacturing Group not between 1 and 5	DESC CHRT CHOV FORC MCDA MCLD MLDS RAWS
027	Internal Product Number not 1 to 9	DESC
030	List Number not numeric	DESC
033	Every occurrence of list number must have same internal product number	DESC
035	Size range must be C, J, W or M	DESC FORC MCLD MLDS
038	B or D marker must be B, D or ▽	FORC MLDS DESC
040	Colour invalid. Spaces also accepted on CHOV.	DESC CHOV
047	More than 200 DESC cards	DESC
048	DESC Card out of sequence	DESC
050	Machine No. Not 1 to 5. Space acceptable	CHRT CHOV FORC MCDA MCLD
055	Week between 1 and 60. Spaces acceptable	CHOV FORC MATS MCDA MCLD MLDS PROD RAWS SZRL
056	Week must be zero or spaces	STKS
060	Finish week greater than or equal to start week, except when blank.	CHOV MCDA
065	Number of Moulds exceeds 5	CHOV
070	Number of shifts outside Range 0 to 19	CHOV
087	Incorrect total	FORC MATS MCDS PROD STKS SZRL
090	List number not in DESC table	MATS PROD REQS STKS SZRL
095	Position (Pairs available) not numeric	MATS

E110 ERROR CODES

Error Code	Condition	Card Type Reference
105	Part number not 1 or 2	MCDA
115	Average Production outside 500 to 3000	MCDA
120	Weekly prodn. outside 500 to 3000. Spaces acceptable.	MCDA
122	Largestsize range = spaces, C,J,W,M	MCDA
124	Largest size = spaces, 1 to 13	MCDA
125	Desired Freestock = numeric	MCDA
130	Day/Week indicator = D, W	MCDA
135	Expediting cost, numeric not blank	MCDA
140	Set up cost, numeric not zero	MCDA
145	Colour change cost, numeric not blank	MCDA
150	Size scatter cost, numeric not blank	MCDA
155	Max. spread, numeric not blank	MCDA
160	Weighting factor 0 to 1000	MCDA
165	Mould change limit, numeric not zero	MCDA
168	Fraction saleable, 0 to 1000	MCDA
170	Size = 1 to 13	MCLD
185	B or D Moulds = BV, VB, BB, BD DB, DV, VD, DD	MCLD
190	Position (No. of Mlds) = spaces, Ø 1 or 2.	MLDS
195	Position (Pairs produced) numeric	PROD STKS SZRL
200	Part = 1 to 8	RAWS
205	Week 1 less than Week 2, Week 2 less than Week 3 etc	RAWS
210	Alteration Cost = numeric not blank	RAWS
215	Part = 1, 2, 3	REQS
207	Stock date must not be later than start date.	SYNC
220	Numeric, blank entries at end of card only. Priority allocation may be blank.	REQS
230	Cumulative releases numeric	STKS
250	Start date must be Monday	WEEK
260	No. of days not above 7 (Space = 5)	WEEK
700	Warning: If equal to or greater than Ø less than 5	CHOV
705	Warning: If list no. and man.grp. disagree.	MATS PROD STKS SZRL
730	Warning: If available stock > 10,000	MATS

IM20 ERROR CODES

Error Code	Condition	Card Type Reference
400	SYNC Card Invalid	All cards
402	WEEK Card Invalid	CHRT
405	Incomplete set of parts for one record	MCDA MLDS STKS REQS RAWS
410	Start or end weeks outside schedule	MCDA MLDS FORC MCLD MATS SZRL PROD
420	Week nos. on RAWS card decreasing	RAWS
430	Creation date not within one month of schedule start date.	MATS MCLD
427	More than 5 moulds loaded in a machine.	MCLD
440	Sturt date over two months older than SYNC schedule start date.	CHRT CHOV RAWS
445	Start date younger than schedule start date.	CHRT CHOV REQS
450	Stock date does not equal SYNC stock date	STKS PROD
475	Total sizeroll not between 990 and 1010	SZRL

IM20 WARNING CODES

Warning Code	Condition for Warning	Card Type
800	Creation date more than six months old	MCDA MLDS FORC SZRL
805	Creation date over one month before schedule start date with non blank start or end weeks.	MCDA
807	Fewer than 5 moulds loaded in a machine	MCLD
810	Costs on RAWS card not decreasing	RAWS
815	Number of machines for CHRT AND MCLD differ	CHRT MCLD
822	Production per machine-week above 12,500 pairs	PROD
824	Production per machine-week below 4,000 pairs	PROD
830	Incomplete set of output records (one per list no.)	REQS
835	" " " " " " " " "	SZRL
840	" " " " " " " " "	STKS
845	" " " " " (one per man.group)	MLDS
850	" " " " " " " " "	MCDA

MACHINE AND MANUFACTURING GROUP TABLE

(REFERENCE ONLY)

MACHINE TYPE	MAN. GROUP	DESCRIPTION (REFERENCE ONLY)
609	1	Bright and Dull Wellingtons
609	2	Splashabouts
609	3	Fashion Wellingtons
609	4	Men's Industrial (PVC)
609	5	Women's Industrial (PVC)
603	1	Toddlers
603	2	Golf Shoes
704	1	Standard Sports Shoes
704	2	Red Flash
704	3	Hockey Boots
704	4	Marks and Spencer

11. TABLES

SIZE TABLE

SIZE RANGE GROUP	SIZE RANGE	SIZE	BRIGHT/ DULL	INTERNAL SIZE
1	C	4	-	1
1	C	5	-	2
1	C	6	-	3
1	C	7	-	4
1	C	8	-	5
1	C	9	-	6
1	J	10	B/D	7/8
1	J	11		9/10
1	J	12		11/12
1	J	13		13/14
1/2	J/W	1		15/16
1/2	J/W	2		17/18
2	W	3		19/20
2	W	4		21/22
2	W	5		23/24
2	W	6		25/26
2	W	7		27/28
2	W	8		29/30
2	H	6		31
3	H	7	-	32
3	H	8	-	33
3	H	9	-	34
3	H	10	-	35
3	H	11	-	36
3	H	12	-	37

COLOUR TABLE

COLOUR	COLOUR CODE
BLACK	1
BROWN	2
RED	3
GREEN	4
BLUE	5
YELLOW	6
WHITE	7

SECTION 6

USE OF THE PRINTER OUTPUT

Each of the five programs in the scheduling system produces some output. The outputs from programs EM10 and EM20 are used to check the validity of the data. The outputs from EM30 and EM40 are mostly diagnostic information but provide a stock projection for each brand. The output from EM50 is the set of schedules for each machine.

EM10 Output

EM10 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.

EM20 Output

EM20 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.

EM30 Output

EM30 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 saleable 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)

DM40 Output

DM40 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.

DM50 Output

DM50 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 EMF Scheduling System.

In EM20 total stocks at manufacturing group level are projected.

In EM30 planned saleable stocks by brand are projected.

The stock projection in EM30 is more detailed than that in EM20 and is probably more useful.

The EM20 Stock Projection

Example

Week	PROD	REQS	STOCK	
00	56000	80926	33691	
04	98800	81322	16213	
08	91000	141168	- 33955	STOCKOUT
...	...	...	...	

Interpretation

STOCK Week 00 - The expected stock at the schedule start date
04 - " " " after 4 weeks
08 - " " " after 8 weeks

PROD Week 00 - The expected production from stock date to schedule start date
04 - do. do. in the first 4 weeks of the schedule
08 - do. do. in weeks 5-8 " " "

REQS Week 00 - The expected requirements from stock date to schedule start date
04 - do. do. in the first 4 weeks of the schedule
08 - 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 BTC Stock Projection

Example

LIST NO	STOCK	UNBAL'D STOCK	TOTAL REQTS. OVER SCHEDULE	PROJECTED SALEABLE STOCKS 1 MTH	2MTH	3MTH
1234	44089	12095	60384	11130	8791	10424
			REQTS	23792	33654	40710
5678	17979	15812	32197	4636	4331	3814
			REQTS	11396	15555	17999
...						

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 sizeroll. (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.

EM30 Output

The EM30 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.nnn of requirements in month n.

1. eg. 0.632 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.nnn 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 EM40). A negative value indicates the current stocks are sufficient to meet demand over the schedule.

Freestock Analysis

Example

	SIZE	COLOUR	RANGE	TOTAL
MINIMUM	41650	8500	5000	55150
SURPLUS	14274	2775	2415	19464

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

M430 will determine scheduling requirements where it has both machine details from MCDA cards, and the manufacturing group is scheduled for that period.

If there is either no MCDA 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.

M40 Output (printed by manufacturing group)

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-explanatory.

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 layouts 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 TREND 1

INITIAL PRIORITY

00.00 00.00 - 281.93 - 105.45 79.69 etc.

FINAL PRIORITY

00.00 00.00 -281.93 - 105.45 -58.05 etc.

CUT-OFF PRIORITY -2.72

MOULDS 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 TREND 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 38 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 MCDA Parameters

Introduction

The earlier section on completing the MCDA 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

CIRCUMSTANCE	ACTION
Spread of sizes frequently too wide	Reduce maximum size spread
Wide spread of sizes would be acceptable	Increase maximum size spread, or set it to zero.
Safety stocks too low:	
a) stocks generally low	Increase mould change limits.
b) stocks generally high	Increase fraction saleable.
Too many mould changes generally In single week	Reduce mould change limit adjust manually.
Overproduction of one size range and underproduction of another	Increase weighting factor or calculate appropriate desired largest sizes and set factor to zero.
One mould keeps switching machines unnecessarily	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.

COSTS

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 W5 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 childs 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 .300 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.

SECTION 7

DETECTING ERRORS IN THE FORTRAN PROGRAMS

Program EM30 may fail because of an execution error; EM40 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 EM30 fails with an Execution error, the output tape is incomplete and EM40 will halt Execution Error 107 on failing to read.

For other execution errors refer to the FORTRAN manual.

Note: EM30 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 nnn n IN WEEK nn DUE TO
INTERNAL ERROR nnn " followed on the next page by the final stocks.

Error No.	Meaning
1	Program or data error
2	Too many moulds assigned
11	Error in filling machines
20	Error in deciding brand
100	Too few moulds assigned to fill available places

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.

Spring Internal Error 100

This error is given when, after assigning all allowable moulds with priority above - 500, there are still mould places left.

This may occur because there are insufficient moulds, e.g. incorrect MLDS 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 MCLD 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.

September 1975

APPENDIX 4 HANDBOOK ON MACHINE LOADING

FOR THE INJECTION MOULDED FOOTWEAR DEPARTMENT

Contents

INTRODUCTION

This handbook describes an efficient method for planning the machine loading of the I.M.F. 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.

PART ONE - THE MODEL

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

$$\text{Storage cost} = V.I.St$$

$$\text{Shortage cost} = P.\int_{Bal}^{\infty} (Bal-d)\ \frac{1}{\sqrt{2\pi}\ \&}\ \exp\ (-d^2/2\&^2)dd$$

$$\text{approximated by } \cdot 16^{Bal/\&} \times \cdot 4P\& \quad \text{if } Bal \geq 0$$

$$\text{or} \quad \cdot 16^{-Bal/\&} \times \cdot 4P\& + P.|Bal| \quad \text{if } Bal < 0$$

$$\text{Production cost} = SU \text{ on a set-up}$$

$$\text{and } K/PFr \text{ during production}$$

$$\text{Expediting costs} = E.q^{*}$$

$$\text{where } St = Bal + PFr + InFr + UFr$$

1.4 Notation

Symbol	Meaning
St	Total stock
Bal	Expected balanced stock
PFr	Effective part of planned free stock
InFr	Ineffective freestock
UFr	Unplanned freestock

q^*	Quantity expedited
V	Value of stock
I	Interest rate
P	Penalty cost per unit short per week
K	Production constant
SU	Set-up cost
E	Expediting cost
&	Standard deviation of sales
d	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', &. 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 :

$$\text{Shortfall} = \cdot 16^{\text{Bal}/\&} \times \cdot 4\& \quad \text{if expected balanced stock is positive}$$

$$= \text{Bal.} + \cdot 16^{|\text{Bal}|/\&} \times \cdot 4\& \quad \text{if expected balanced stock is negative.}$$

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

mould 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.

PART TWO - INITIAL DATA PROCESSING

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 ½p. 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 ½.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 :-

$$Ncolour.(Numsize + Dup)-5.(Ncolour-1)$$

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/(&.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 ½&; 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 :-

Probability demand exceeds the critical stock = $100/P.MEF^2$

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-½ 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 ½& is 400. The freestock should take its minimum value if the expected balanced stock is negative so that the probability of a stockout exceeds ½. For positive balanced stocks, the probability of a stockout is below ½ 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

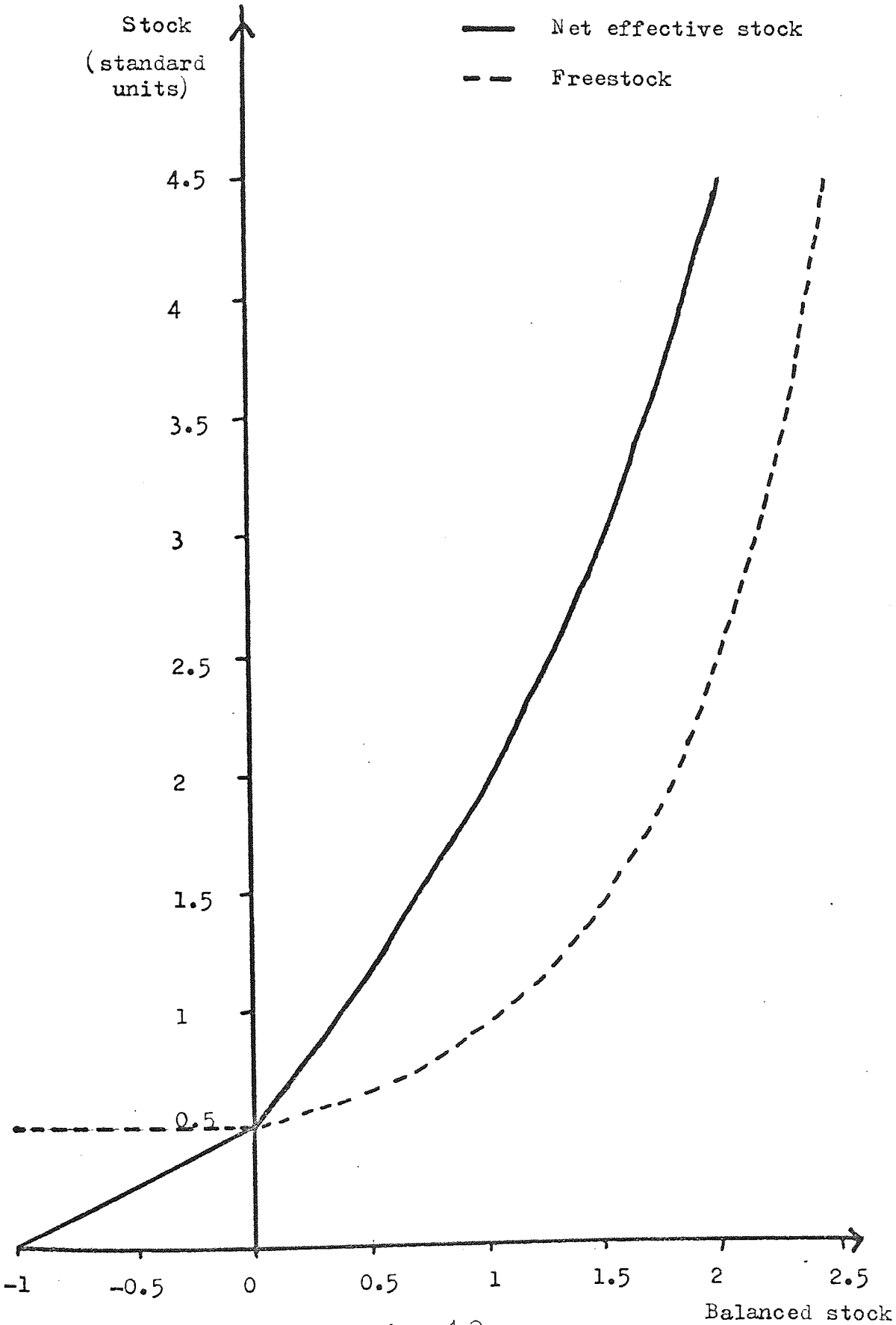


Diagram 2

THE MARGINAL VALUE OF STOCK AS A FUNCTION OF NET EFFECTIVE STOCK

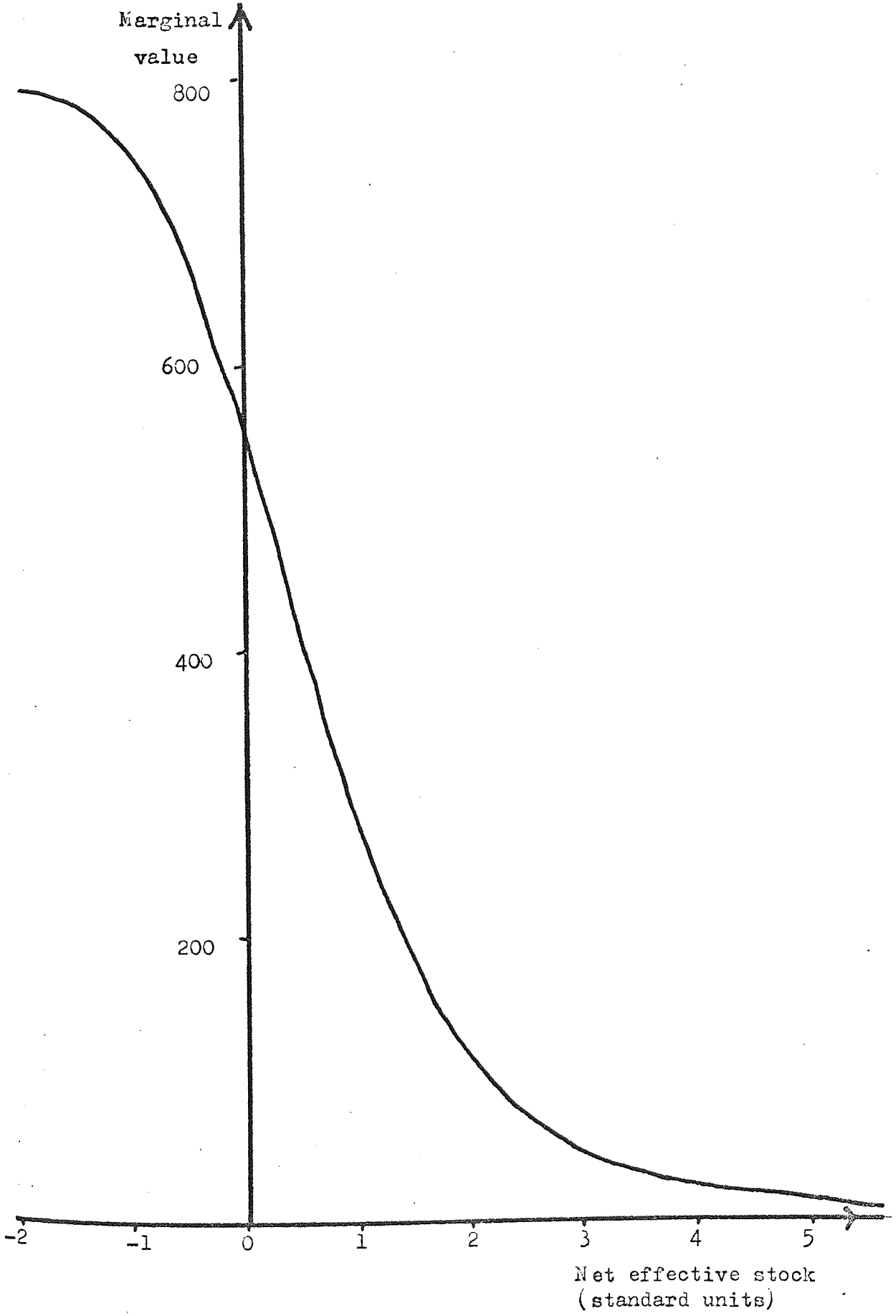
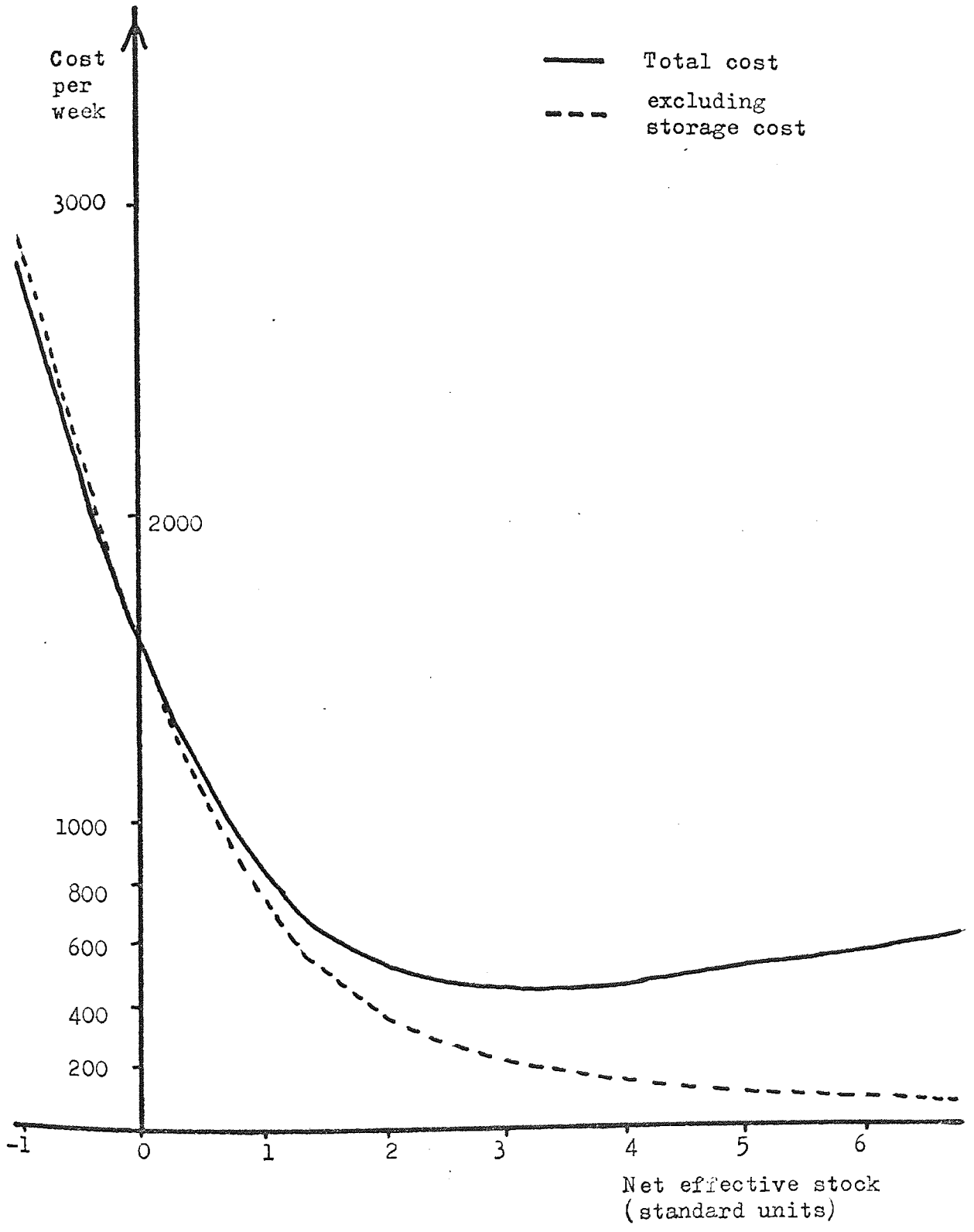


Diagram 3

THE OPTIMAL TOTAL COST AS A FUNCTION OF NET STOCK



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=½.

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, &.

P, which equals the ratio of the penalty cost to the implicit marginal value of stock

and 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=SU.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 intercepting the graph at that stock level. Calculate the area, A, above the graph but below this line, and the length of the line, L,

Diagram 4

THE OPTIMAL EFFECTIVE STOCK AS A FUNCTION OF RELATIVE PENALTY COST

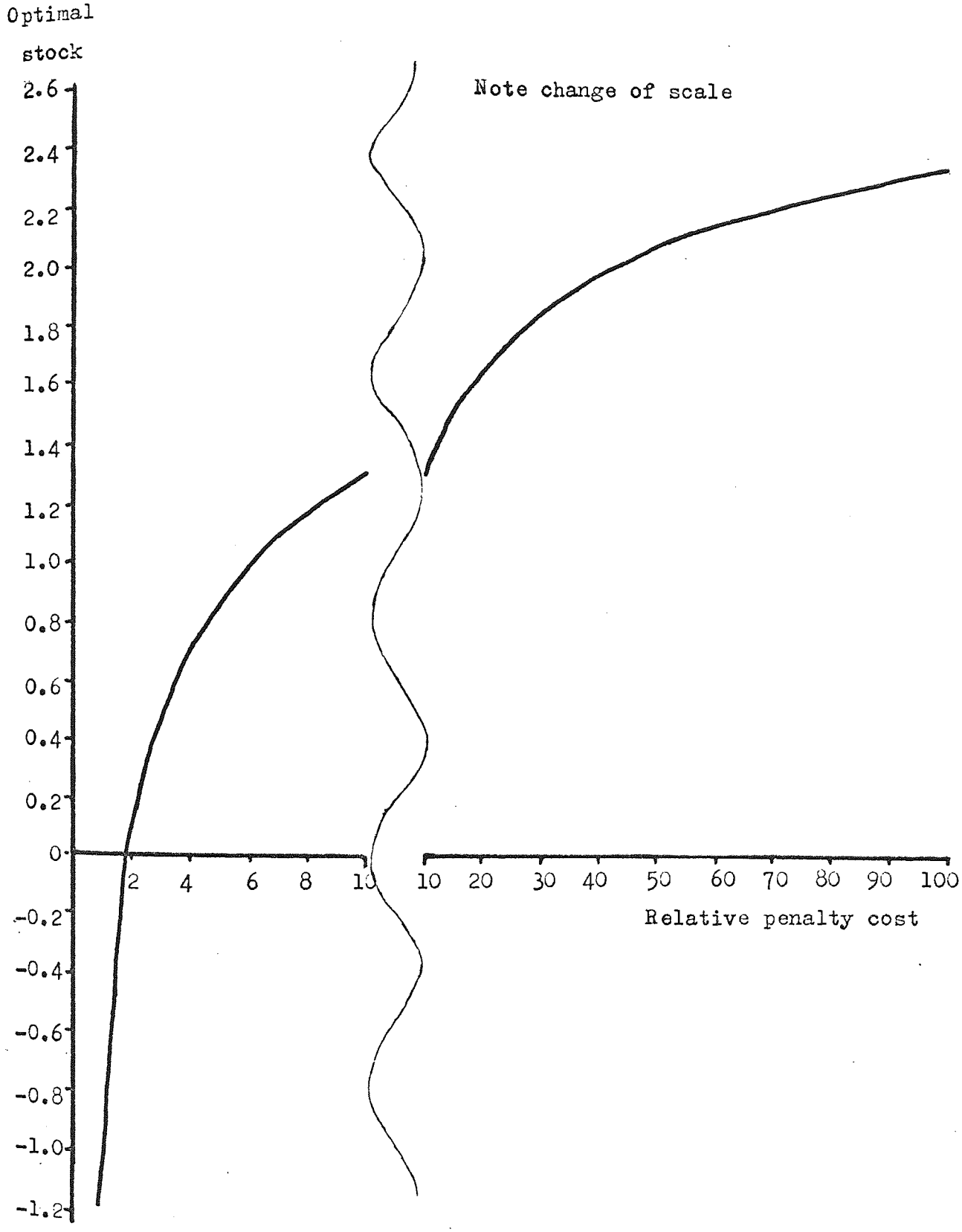


Diagram 5

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

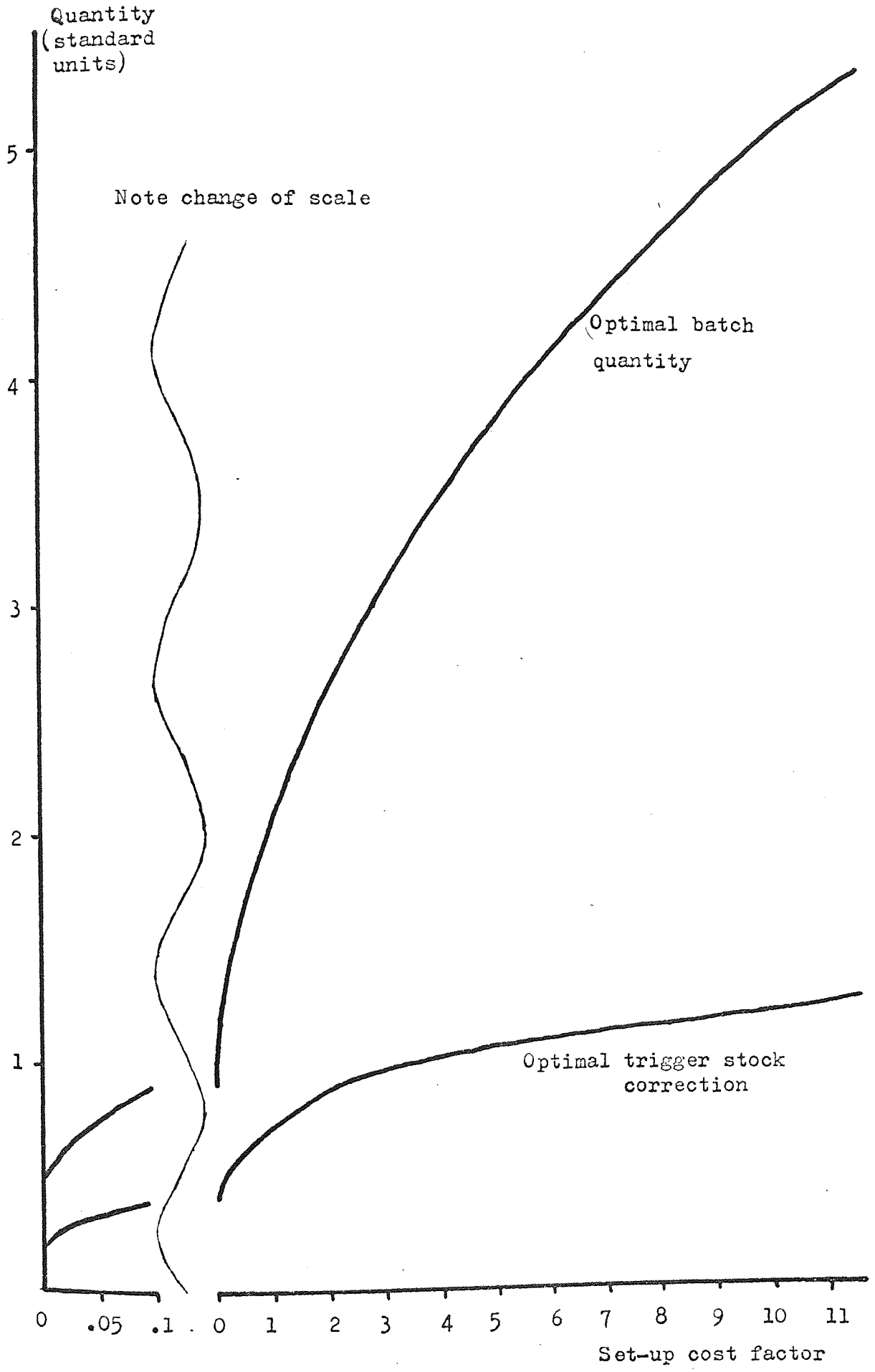
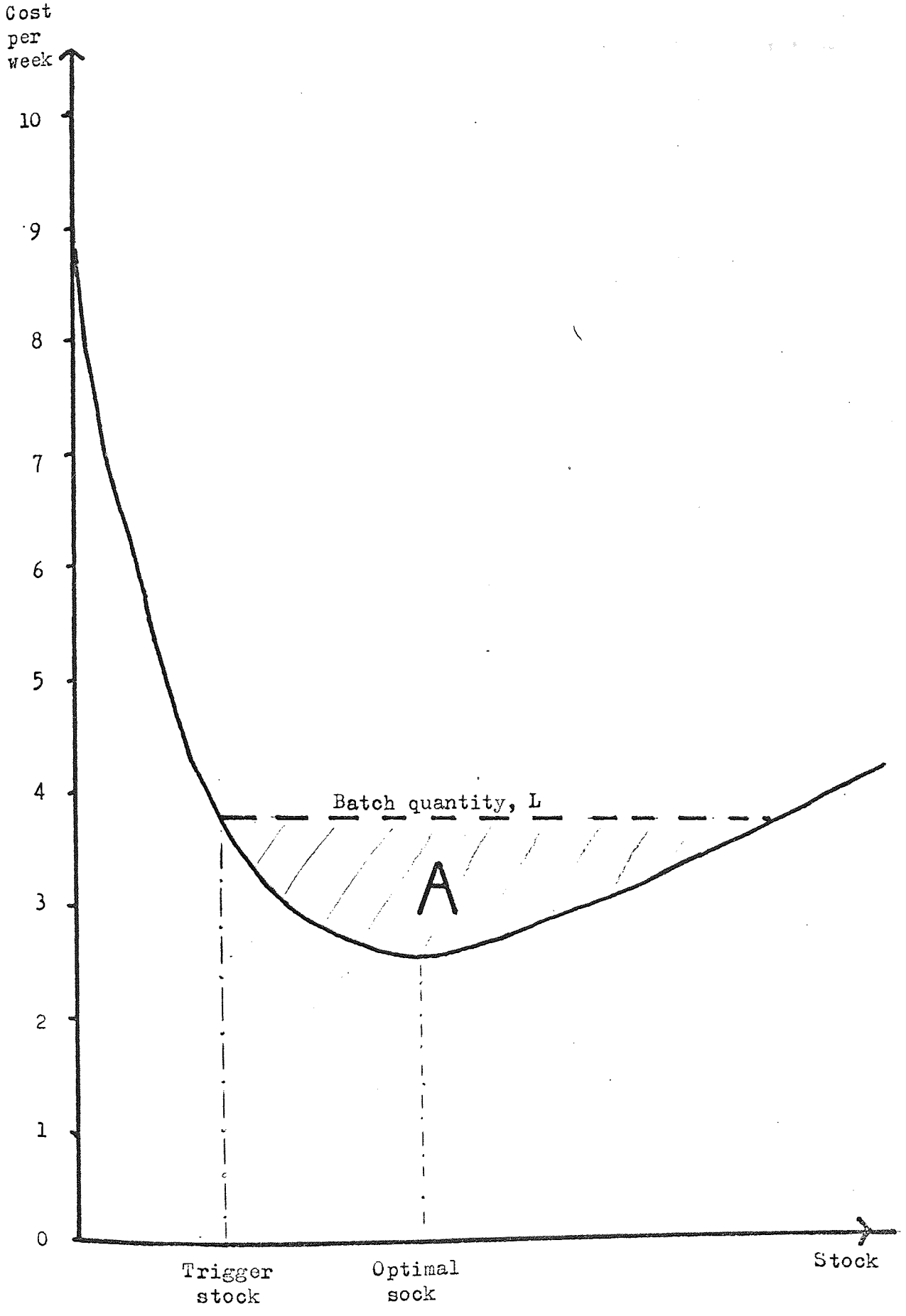


Diagram 6

EXAMPLE OF THE GRAPHICAL DERIVATION OF THE OPTIMAL BATCH QUANTITY AND TRIGGER 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.

PART THREE - CLASSIFYING THE PROJECTED STATES

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)

	April	May	June	July	Aug	Sept	Oct	Nov
Initial stock	181	173	194	254	262	191	151	140
Planned prod^{n}	62	93	118	91	39	117	100	103
Expected sales	60	82	58	83	110	157	111	64
Final stock	183	194	254	262	191	151	140	179
Min. oper. stock	130	141	129	141	155	178	156	132
Residual stock	53	53	125	121	36	-27	-16	47
'Standard error' of forecasts	15	25	30	33	40	47	52	55
Ratio	3.5	2.1	4.1	3.6	0.9	-0.6	-0.3	0.9
Classification	Satis-factory	Satis-factory	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'.

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 Maching 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.

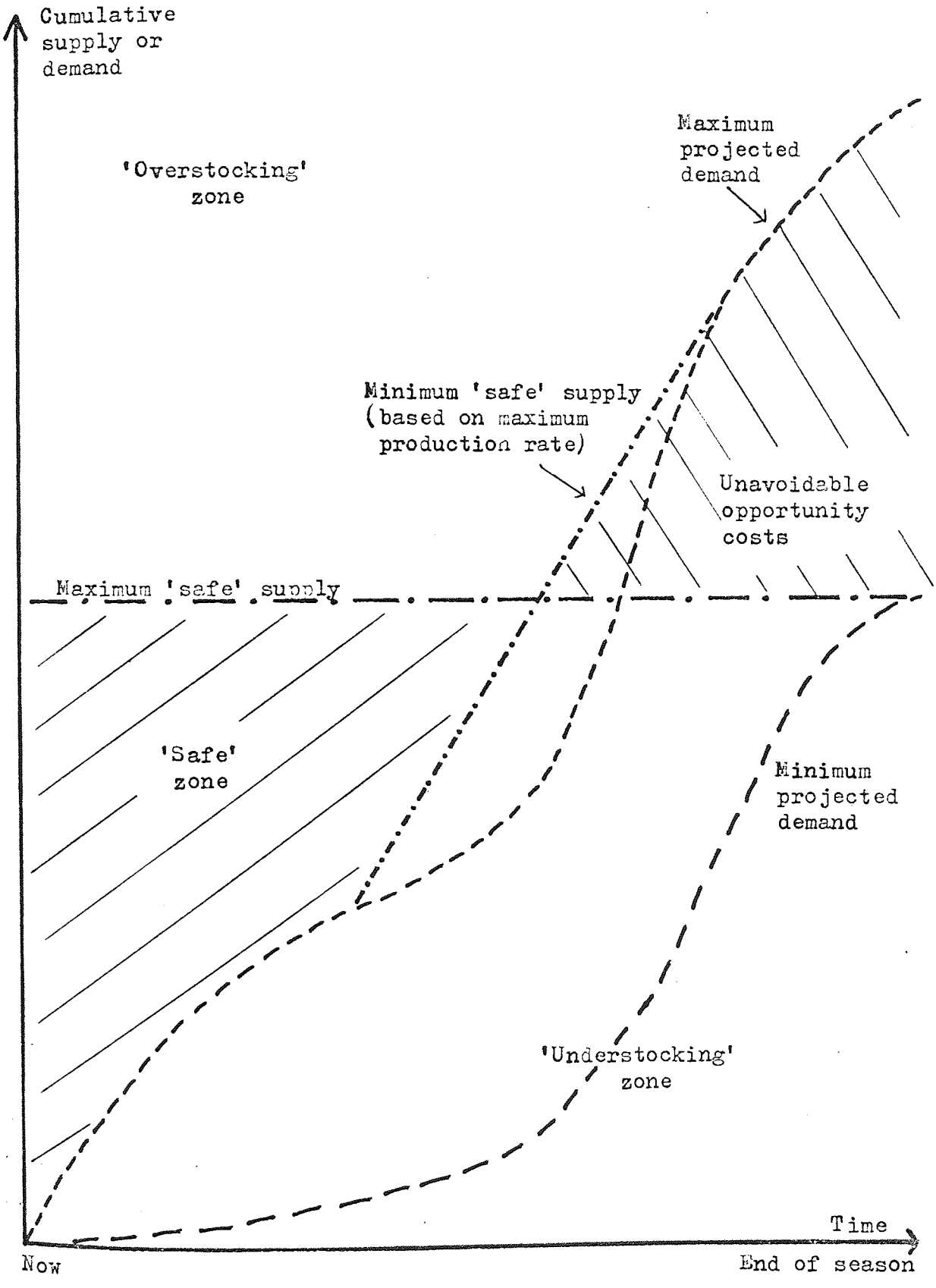
4.5.1 Explanation of opportunity costs

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.

Diagram 7

HOW OPPORTUNITY COSTS VARY WITH PROJECTED SUPPLY AND TIME OF SEASON



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 over-stocked, 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.

PART FIVE - SUMMARY

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, &.

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 & in the balanced stocks, hence & 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.

APPENDIX 5 MONTHLY SALES (ADJUSTED) FOR SELECTED PRODUCTS

Product A

	Year							
	1	2	3	4	5	6	7	8
January	43	27	52	37	49	67	48	47
February	52	40	47	34	51	63	51	49
March	42	41	45	34	42	71	66	53
April	33	27	35	28	29	44	32	35
May	31	35	37	56	31	41	43	26
June	47	43	43	13	31	49	36	33
July	40	37	50	32	34	42	39	35
August	49	46	42	35	51	59	40	31
September	89	73	83	68	84	74	75	57
October	66	80	70	62	79	79	59	53
November	79	55	75	69	63	59	58	65
December	107	106	65	61	50	84	72	62
Total	678	610	644	529	594	722	619	546

Product B

	Year							
	1	2	2	4	5	6	7	8
January	39	20	62	37	40	53	37	57
February	52	25	42	19	18	55	22	22
March	30	21	52	20	8	45	29	16
April	8	20	32	9	4	12	16	5
May	12	27	8	22	12	15	21	6
June	25	48	45	58	60	42	20	19
July	44	49	63	58	67	64	62	61
August	66	98	72	58	106	82	116	100
September	99	100	117	88	134	132	186	111
October	95	46	45	75	119	98	91	80
November	79	38	70	71	97	75	93	90
December	100	82	85	62	42	114	106	94
Total	649	574	693	577	707	787	799	661

Product C

	Year							
	1	2	3	4	5	6	7	8
January	33	12	35	41	32	20	21	22
February	42	20	25	32	17	14	15	20
March	31	13	23	27	4	30	20	25
April	7	11	23	10	2	6	13	7
May	7	19	14	14	6	10	11	6
June	15	33	19	38	13	17	6	12
July	26	29	48	39	26	24	23	27
August	43	65	38	39	47	36	45	36
September	65	67	63	72	61	63	74	64
October	48	53	16	32	54	50	36	35
November	57	55	39	38	49	30	31	44
December	71	127	35	42	25	49	49	53
Total	445	504	378	424	336	349	344	351

Product D

	Year							
	1	2	3	4	5	6	7	8
January	38	26	16	47	29	65	37	37
February	60	46	70	49	56	43	69	75
March	76	60	90	57	68	63	89	82
April	56	43	35	49	60	44	55	75
May	64	63	70	58	73	67	81	83
June	46	45	40	35	60	75	68	64
July	29	26	26	34	21	65	59	60
August	28	12	25	39	34	41	46	46
September	37	27	35	53	27	71	59	65
October	23	23	18	28	27	61	62	45
November	12	19	17	23	35	25	49	24
December	19	12	28	24	42	34	25	23
Total	488	402	470	496	533	654	699	679

APPENDIX 6 CALCULATION OF PERFORMANCE MEASURES

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 sizeroll 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 sizeroll 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 equalling 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

```
      MASTER IN30                                                          100
      LOGICAL BALANCEUP,FIRSTLOOP,DAILY,SHORTTERM                          120
      INTEGER STOCK,SIZEROLL,SIZE                                          140
      INTEGER PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME,WEEK,STARTWEEK        150
      INTEGER WEEKSOFF,ENDWEEK,BRAND,PRODN,DAY                             160
      DIMENSION MODA(40),STOCK(40,10),ICLEAR(445)                          210
      COMMON/ARRAYS/ MANGRPSCHED(60,5),MCBSCHED(60,5),NSHIFTSCHED(60,5)    230
     1    , KOLOURSCHED(60,5),LISTNO(10),KOLOUR(10)                       2301
     2    , NUMRELEASES(10),ESTOCK(10),KK,MACHPRODN(5),MACHINUSE(5)       2302
     P    , MAXDESIRESIZE(5),KKK(20),NUMSIZE,NUMVARIETIES                 2302P
     Q    , MINSIZE,MAXSIZE,ESTMACH(5),NUMREQ(10,25)                      2300
     3    , SIZEROLL(40,10),KOSTEXPEDITE(40),MEASURE(40)                  2303
     4    , GENERAL(40),MACHINES(10),INITSTK(10),NTHCOLOUR(5)             2304
     5    , NTHSTART(5),NOOFSHIFTS(10)                                    2305
     6    , INITIALREQ(10),FINALREQ(10),TOTALREQ(10),TXETREQ(10)          2306
     7    , COVER(10),PROPORTION(10),PROPCOL(10)                          2307
     8    , TCUMREQ(20),RELATIVEFREE(15),SMOOTHEDREQ(15)                  2308
     9    , IREQSIZE(40),NSHIFTS(10),KUMPRODN(5)                          2309
     A    , TCUMPRODN(15),UNBALANCED(10),UNRAT(10)                        2310
      COMMON/VARS/ NCTYPE,MANGRP,BRAND,ENDWEEK,PRODN                       250
     1    , PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME                        2501
     2    , INPUTNOW,INPUTRECS,BALANCEUP,DAILY,FIRSTLOOP                  2502
     3    , LASTWEEKOFPLAN,STARTWEEK,WEEK,WEEKSOFF                        2503
     4    , MONTH,MONTHSTART,LASTMONTH,MONTHOLD                           2504
     5    , MACH,NMACH,MACHTOUSE,KOLOR,KOLORTOMAKE                        2505
     6    , NBRAND,NCOLOUR,NSHIFT,NSHIFTSET,NSHIFTTOT                     2506
     7    , MINEREF,INITSTOCKTOTAL,KUMRELEASED,IDUM,IFLAG,NUM             2507
      COMMON/REALS/ ONE,THOUSAND,ONEMILLION,DUMMY                          270
     1    , FREE,FREESZ,AVERAGEFREE,FRACTION                              2701
     2    , TCUMREQTS,TOTALPROD,WEEKLY                                    2702
      EQUIVALENCE (ICLEAR(1),MEASURE(1))                                   520
      EQUIVALENCE (KK,MODA(1)),(STOCK(1,1),KOSTEXPEDITE(1))                530
 9001 FORMAT(1H1,29X,24HSCHEDULE FOR MAN. GROUP ,I3,11H  FOR WEEKS,        550
     1    I3,3H TO,I3/// 40X,19HGROSS OPENING STOCK,I7 //                 5501
     2    40X,18HTOTAL PRODUCTION,F11.0//  40X,19HSUFFICIENT TO COVER,     5502
     3    F7.3 / 40X,18HOF REQTS IN MONTH ,I2  //  )                       5503
 9004 FORMAT( //// 41X,24H**  STOCK PROJECTION  **  ///                    560
     1    11X,40HLIST     STOCK     UNBAL'D      TOTAL REQTS,              5601
     2    8X,25HPROJECTED SALEABLE STOCKS/  12X,2HNO,15X,                 5602
     3    23HSTOCK      OVER SCHEDULE,4X,7(I4,4H MTH)  )                  5603
 9005 FORMAT( // 11X,37H** NOTE **   RESCHEDULE ONLY TO MONTH,I3     )      565
 9006 FORMAT(////  41X,24H** FREESTOCK ANALYSIS ** ///                      570
     1    45X,26HSIZE  COLOUR   RANGE   TOTAL //                          5701
     2    34X, 7HMINIMUM,4I6// 34X,7HSURPLUS,3I8,F9.0 / )                 5702
 9008 FORMAT(1H1,40X,24H**  OVERALL SUPPLIES  ** )                         575
 9009 FORMAT(1H*, 87X,22HPRODUCTION  COMMENCING/ 59X,                      580
     1    25H** SHORT-TERM SCHEDULE **  )                                 5801
 9010 FORMAT(// 115,2F10.0,I14,I15 )                                       585
 9011 FORMAT(//// 41X,24H* REQUIREMENTS BY SIZE * // 4(15X,10I8/) /)       590
 9012 FORMAT(1H1)                                                          595
      WRITE(30,9012)                                                       610
      INPUTRECS=-1                                                         612
   20 PLANNINGWEEK=60                                                      616
      IF (INPUTRECS) 100,100,0                                             620
      WRITE(30,9008)                                                       630
      WRITE(30,9004) LASTMONTH                                             635
```

```
      DO 70 BRAND=1,NBRAND                                                  440
      IF (LISTNO(BRAND) ) 70,70,0                                           445
      WRITE(30,9010) LISTNO(BRAND),FSTOCK(BRAND),UNBALANCED(BRAND),         450
     1    KUMREQ(BRAND,LASTMONTH),KUMRELEASES(BRAND)                       4501
   70 CONTINUE                                                              460
C                                                                           500
C        READ IN 'SCHD' RECORDS FOR NEW MACHINE TYPE IF NECESSARY           502
C        AND THEN A 'MCDA' RECORD FOR SOME MANUFACTURING GROUP              505
C                                                                           508
  100 CALL INOUT(5,20,2).                                                   520
      IF (MCTYPE) 9900,0,0                                                  530
  110 LASTWEEKOFPLAN=ENDWEEK                                                550
  112 BALANCEUP=.FALSE.                                                     550
      NMACH,STARTWEEK,NSHIFTTOT,NSHIFTSET=0                                 560
      WEEK=PLANNINGWEEK                                                     565
      CALL CLEAR(JCLEAR,445)                                                570
  120 MACH=0                                                                610
      MONTH=(WEEK+3)/4                                                      615
      DO 150 MC=1,5                                                         625
      IF (MANGRPSCHED(WEEK,MC)- MANGRP) 150,0,150                           630
      MACH=MACH+1                                                           635
      NSHIFT  = NSHIFTSCHED(WEEK,MC)                                        640
      KUMPRODN(MC)=KUMPRODN(MC) +(MLDSCHED(WEEK,MC)*NSHIFT                  645
     1    * MACHPRODN(MC)) / PLANNINGUNIT                                  6451
      NSHIFTTOT=NSHIFTTOT + NSHIFT                                          650
      KOLOR=KOLOURSCHED(WEEK,MC)                                            655
      IF (KOLOR) 150,150,0                                                  660
      NEWSHIFTS(KOLOR) = NEWSHIFTS(KOLOR) + NSHIFT                          670
      NSHIFTSET=NSHIFTSET + NSHIFT                                          675
  150 CONTINUE                                                              695
      IF (MACH) 210,210,0                                                   710
      WEEKSOFF=0                                                            715
      IF (STARTWEEK) 0,0,230                                                730
      STARTWEEK=WEEK                                                        735
      MONTHSTART=MONTH                                                      740
      IDUM=STARTWEEK+21                                                     745
      IF (LASTWEEKOFPLAN.GT.IDUM) LASTWEEKOFPLAN=IDUM                       750
      GO TO 230                                                             780
C        NO PRODUCTION THIS WEEK                                            800
C        SEE IF THERE IS A FOUR-WEEK GAP-IF SO STOP SCHEDULE HERE           802
  210 IF (STARTWEEK) 250,250,0                                              810
      WEEKSOFF=WEEKSOFF+1                                                   815
      IF (WEEKSOFF-4) 230,0,0                                               825
      BALANCEUP=.TRUE.                                                      830
      GO TO 280                                                             850
C        EVALUATE TOTAL PRODUCTION BY 'MONTH'                               900
  230 IF ( WEEK.NE.MONTH*4.AND.WEEK.LT.LASTWEEKOFPLAN) GO TO 250            910
      NMACH=0                                                               920
      DO 240 NUM=1,5                                                        925
      MC   =1STMACH(NUM)                                                    928
      IF (MC) 240,240,0                                                     930
      IF (KUMPRODN(MC)) 0,240,0                                             935
      NMACH=NMACH+1                                                         938
      MACHINUSE(NMACH)=MC                                                   940
C        MACHINUSE IS A MACHINE USED IN THIS SCHEDULE                       942
      TCUMPRODN(MONTH)=TCUMPRODN(MONTH) + KUMPRODN(MC)                      945
```

```
  240 CONTINUE                                                          950
  250 WEEK=WEEK+1                                                       965
      IF (WEEK-LASTWEEKOFPLAN) 120,120,0                                970
      IF (STARTWEEK) 20,20,0                                            980
C                                                                      1000
C        NOW START PROCESSING                                          1002
C                                                                      1005
C        CHECK TO SEE IF THERE IS A FOUR-WEEK GAP AFTER THE END        1007
C        IF SO THE FINAL STOCKS WILL HAVE TO BE BALANCED UP            1008
      BALANCEUP= WEEKSOFF.GT.0                                         1010
      DO 270 IDUM=1,4-WEEKSOFF                                         1020
      WEEK=LASTWEEKOFPLAN+IDUM                                         1025
      DO 270 MC=1,5                                                    1030
C        WE NEED NOT BALANCE UP IF THIS MAN.GRP IS MADE ON             1035
C        ANY MACHINE IN THE SUBSEQUENT 4 WEEKS.                        1040
  270 BALANCEUP=BALANCEUP.AND.MANGRPSCHED(WEEK,MC).NE.MANGRP           1050
  280 IF (BALANCEUP) LASTWEEKOFPLAN=WEEK-4                             1055
      LASTMONTH= (LASTWEEKOFPLAN+3)/4                                  1060
      TOTALPROD=TOUMPRODN(LASTMONTH)                                   1065
      MACHTOUSE=MACHINUSE(1)                                           1070
      PLANNINGTIME=STARTWEEK                                           1075
      IF (DAILY) PLANNINGTIME= 7*STARTWEEK-6                           1080
C        READ IN STOCKS,SIZEROLLS AND REQUIREMENTS                     1085
C        EXCEPT-NO STOCKS IF WEEK ABOVE 1,AND OTHER INFORMATION NOT    1088
C        EXPECTED                                                      1090
      CALL INOUT(30,45,8)                                              1110
      IF (.NOT.FIRSTLOOP) GO TO 510                                    1125
      NBRAND=BRAND                                                     1130
C        CALCULATE STOCK INFORMATION FOR EACH BRAND                    1150
      NBRANDSIZES=0                                                    1155
      DO 380 BRAND=1,NBRAND                                            1210
      BALANCED,BALBAR1= TSTOCK(BRAND)                                  1220
      DO 350 SIZE=1,40                                                 1250
      SZRL= SIZEROLL(SIZE,BRAND)/THOUSAND                              1270
      IF (SZRL) 350,350,0                                              1275
      NBRANDSIZES=NBRANDSIZES+1                                        1280
      KSTOCK= STOCK(SIZE,BRAND)                                        1285
      IREQSIZE(SIZE)= IREQSIZE(SIZE) - KSTOCK                          1290
C        CALCULATE THE BALANCED STOCKS OF EACH BRAND                   1300
      SALEABLE= KSTOCK/SZRL                                            1310
      IF (SALEABLE-BALANCED) 0,340,340                                 1315
      DUMMY=BALANCED                                                   1330
      BALANCED=SALEABLE                                                1335
      SALEABLE=DUMMY                                                   1340
  340 IF (SALEABLE.LT.BALBAR1.AND.SZRL.GT.30.) BALBAR1=SALEABLE        1360
  350 CONTINUE                                                         1370
      UNBALANCED(BRAND)= TSTOCK(BRAND) - BALANCED                      1410
      UNBAR1(BRAND)    = TSTOCK(BRAND) - BALBAR1                       1420
C        STORE THE UNBALANCED STOCKS FOR EACH BRAND                    1425
C        AND THE UNBALANCED(BAR ONE SIZE)                              1430
      TSTOCK(BRAND)= TSTOCK(BRAND) + KUMRELEASES(BRAND)                1440
C        OUTPUT STOCKS RECORD  FOR THIS BRAND                          1450
      CALL OUTPUT(STOCK(1,BRAND),3)                                    1460
  380 CONTINUE                                                         1480
      CALL CLEAR(STOCK,400)                                            1510
C        THIS RECORDS THAT THE STOCKS HAVE BEEN PROCESSED AND          1525
```

```
C          THE STOCKS ARE OVERWRITTEN                                    1530
C          ADD UP INITIAL STOCK                                          1600
  510 KUMRELEASED,INITSTOCKTOTAL=0                                       1610
      DO 520 BRAND=1,NBRAND                                              1620
      KUMRELEASED=KUMRELEASED + KUMRELEASES(BRAND)                       1625
  520 INITSTOCKTOTAL=INITSTOCKTOTAL + TSTOCK(BRAND)                      1630
      TCUMREQTS= TOTALPROD + INITSTOCKTOTAL                              1640
C                    OPTIONAL CHECK CAN GO HERE                         1650
C          CHECK FOR PRODUCTS ONLY REQUIRED IN LATER MONTHS              1655
C          NOW FIND THE MONTH AND FRACTION SUCH THAT THE REQUIREMENTS     1700
C          ARE MET UP TO THIS MONTH AND'FRACTION' OF THAT MONTH.          1702
C          CUMREQ(BRAND,MONTH) IS THE TOTAL REQUIREMENTS                  1704
C          TO THE END OF EACH   4 WEEK PERIOD.                            1707
      DO 560 MONTH=1,20                                                  1740
      DO 560 BRAND=1,NBRAND                                              1750
  560 TCUMREQ(MONTH)= TCUMREQ(MONTH) + KUMREQ(BRAND,MONTH)               1760
C          NEED TWO PERIODS FOR CALCULATION BELOW                         1772
C          CHECK TO SEE IF REQTS TILL MONTH EXCEED TOTAL                  1800
C          IF THE REQUIREMENTS ARE SUFFICIENT, FRACTION IS THE PART       1803
C               OF THE REQTS FOR 'MONTH' WHICH COULD BE MET.              1804
C          IF REQTS INSUFFICIENT, FRACTION IS THE RATIO OF 'TCUMREQTS'     1806
C               TO THE INPUT REQTS, FRACTION THEN EXCEEDS 1.              1807
      MONTH=1                                                            1810
      MONTHOLD=MONTH                                                     1812
      MONTH=MONTH+1                                                      1814
      IF (TCUMREQ(MONTH)- TCUMREQTS) 0,580,580                           1815
      IF (TCUMREQ(MONTH)-TCUMREQ(MONTHOLD) ) 0,0,570                     1825
      FRACTION= TCUMREQTS/TCUMREQ(MONTH)                                 1830
      DUMMY=0.                                                           1835
      GO TO 590                                                          1840
  580 FRACTION= (TCUMREQTS - TCUMREQ(MONTHOLD) )/                        1850
     1          (TCUMREQ(MONTH) - TCUMREQ(MONTHOLD) )                   18501
      DUMMY=ONE - FRACTION                                               1855
  590 DO 600 BRAND=1,NBRAND                                              1857
      KOLOR=KOLOUR(BRAND)                                                1865
      IF (KOLOR) 600,600,0                                               1867
C          OUTPUT SIZEROLL RECORDS                                        1875
      CALL OUTPUT(SIZEROLL(1,BRAND),4)                                   1880
C          SET UP TOTAL REQUIREMENTS FOR EACH BRAND                       1878
      TOTALREQ(BRAND)=FRACTION*KUMREQ(BRAND,MONTH) +                     1890
     1                DUMMY*KUMREQ(BRAND,MONTHOLD)                      18901
C          DETERMINE THE PROPORTION OF THE REQUIREMENTS                   1900
C          FOR EACH COLOUR AND FOR EACH BRAND                             1902
      INITSTK(KOLOR)=INITSTK(KOLOR) + TSTOCK(BRAND)-KUMRELEASES(BRAND)   1930
      PROPORTION(BRAND)=(TOTALREQ(BRAND)-KUMRELEASES(BRAND) ) /          1935
     1                  (TCUMREQTS-KUMRELEASED)                          19351
      PROPCOL(KOLOR)= PROPCOL(KOLOR) + PROPORTION(BRAND)                 1940
      IF (PROPCOL(KOLOR).LT.0.0011) PROPCOL(KOLOR)=0.0011                1945
  600 CONTINUE                                                           1950
      NUMVARIETIES=NBRANDSIZES                                           1955
      MCDA(36)=NBRAND                                                    1957
C          FIND OUT THE NUMBER OF COLOURS                                 1960
      NCOLOUR=0                                                          1965
      DO 630 KOLOR=1,8                                                   1970
  630 IF (PROPCOL(KOLOR).NE.0) NCOLOUR=NCOLOUR+1                         1975
      MCDA(35)=NCOLOUR                                                   1980
```

```
C        OUTPUT GENERAL INFORMATION ON MAN.GROUP                                1988
C      WRITE(30,9001) MCTYPE,MANGRP,STARTWEEK,LASTWEEKOFPLAN                    1990
     1    , INITSTOCKTOTAL,TOTALPROD,FRACTION,MONTH                             19901
                                                                                2000
C        CALCULATE THE REQUIREMENTS OF EACH SIZE                                2005
C        MAINLY FOR'FORC' RECORDS,BUT ALSO FOR INFORMATION                      2008
C        IDUM CONTAINS 'MAXDESIRESIZE' FOR THE SMALL SIZE MACHINE               2009
C                                                                               2010
      IDUM=MAXDESIRESIZE(ISIMACH(1))                                            2018
C        READ IN ANY FORCE RECORD                                               2020
      CALL INOUT(50,50,0)                                                       2030
      IF (.NOT.FIRSTLOOP.AND.IDUM.GT.0) GO TO 810                               2050
C        FURTHER CALCULATION REQUIRED FOR TOP SIZES AND NUMSIZE                 2055
      MINSIZE,NUMSIZE=0                                                         2060
      DO 640 BRAND=1,NBRAND                                                     2062
C        WORK OUT NET REQTS OF EACH BRAND                                       2064
C        ON FIRST LOOP THE INITIAL STOCKS OF EACH SIZE ARE KNOWN                2066
C        ON SUBSEQUENT LOOPS THESE ARE ASSUMED BALANCED                         2070
      DUMMY=KUMRELEASES(BRAND)                                                  2075
      IF (.NOT.FIRSTLOOP) DUMMY=TSTOCK(BRAND)                                   2080
  640 TNETREQ(BRAND)=(TOTALREQ(BRAND)-DUMMY)/THOUSAND                           2110
      DO 680 SIZE=1,40                                                          2120
      DO 660 BRAND=1,NBRAND                                                     2140
  660 IREQSIZE(SIZE)=IREQSIZE(SIZE)+TNETREQ(BRAND)*SIZEROLL(SIZE,BRAND)         2150
      IF (IREQSIZE(SIZE)) 0,680,0                                               2160
      NUMSIZE=NUMSIZE+1                                                         2165
      MAXSIZE=SIZE                                                              2170
      IF (MINSIZE.EQ.0) MINSIZE=SIZE                                            2190
  680 CONTINUE                                                                  2195
      WRITE(30,9011) IREQSIZE                                                   2302
C        DO NOT NEED TO SET'MAXDESIRESIZE'IF ALREADY SET                        2310
      IF (IDUM) 0,0,810                                                         2315
      IF (NMACH-1) 810,790,0                                                    2330
      DO 730 SIZE=MINSIZE,MAXSIZE                                               2335
C        'MEASURE' CONTAINS THE 'FORC' RECORD,IF ANY                            2345
      IF (MEASURE(SIZE)) 730,730,0                                              2350
      MC= MEASURE(SIZE)                                                         2360
      KUMPRODN(MC)  =KUMPRODN(MC)  - IREQSIZE(SIZE)                             2370
  730 CONTINUE                                                                  2410
      NUM=1                                                                     2415
      MACH=MACHINUSE(NUM)                                                       2420
      DO 750 SIZE=MINSIZE,MAXSIZE                                               2425
      IF (MACH) 750,750,0                                                       2430
      IF (MEASURE(SIZE)) 0,0,750                                                2440
      IFLAG,KUMPRODN(MACH)= KUMPRODN(MACH)      -IREQSIZE(SIZE)                 2450
      IF (IFLAG)  0,0,750                                                       2455
C        SEE THE TOP SIZE FOR ANY MACHINE BY SEARCHING THROUGH TILL             2458
C        THE CUM.REQTS EXCEED THE PRODN FOR THAT AND EARLIER MACHINES           2460
      MAXDESIRESIZE(MACH)=SIZE                                                  2465
      NUM=NUM+1                                                                 2470
      MACH=MACHINUSE(NUM)                                                       2475
      IF (MACH.NE.0) KUMPRODN(MACH)= KUMPRODN(MACH) + IFLAG                     2490
  750 CONTINUE                                                                  2503
C        WITHOUT ROUNDING ERRORS FOR LAST MACH SHOULD END WITH MAXSIZE          2510
      IF (MACH.NE.0) MAXDESIRESIZE(MACH)=MAXSIZE                                2515
      GO TO 810
```

```
C       WITH ONLY ONE MACHINE SET TOP SIZE AS 2/3 MAXSIZE                    2550
  790 MAXDESIRESIZE(MACHINUSE(1))=(MINSIZE*MAXSIZE+MAXSIZE)/3                2550
  810 FIRSTLOOP=.FALSE.                                                      2710
C         CALCULATE THE MINUMUM AND AVAILABLE FREESTOCK                    2802
C                                                                          2803
C         IF MAX. SPREAD IS LOW ,THEN IN ANY WEEK SOME FRACTION            2806
C         OF THE SIZES CANNOT BE MADE                                      2807
      FRACTION= ONE - (NMACH*MCDA(25))/FLOAT(MAXSIZE-MINSIZE)              2810
      IF (FRACTION)  820,830,0                                             2815
      IF (ONE - FRACTION) 820,820,830                                      2820
  820 FRACTION= 0.                                                         2825
C         CALCULATE MINUMUM FREESTOCK                                      2840
C         IF THE MINUMUM DESIRED FREESTOCK IS ZERO,SET IT                  2842
  830 MINFREESZ=(NBRANDSIZES-NUMSIZE+5*NMACH)*PRODN/2                      2845
      MINFREECL=0                                                          2849
      IF (NCOLOUR.GT.1) MINFREECL=5*NMACH*PRODN/2                          2850
      MINFREERG=FRACTION*NMACH*PRODN*5                                     2855
C         THESE ARE THE MINUMUM STOCKS NECESSARY TO SUSTAIN                2857
C         STOCKS OF ALL SIZES AND COLOURS                                  2858
      MINFREE= MINFREESZ+MINFREECL+MINFREERG                               2860
      IF (MCDA(17).EQ.0) MCDA(17)=MINFREE                                  2865
C         DETERMINE SPLIT OF ANY EXTRA FREESTOCK                           2902
C         MOST OF THIS GOES TO INCREASING THE BATCHSIZE                    2903
C         BUT SOME INCREASES THE COLOUR AND RANGE EFFECTS                  2906
C         THE RATIO IS NUMSIZE:RATIOCL:RATIORG                             2908
      RATIOCL=SQRT(20.*MCDA(23)*(NCOLOUR-1)/MCDA(22))                      2910
      RATIORG=FRACTION*FRACTION*NMACH*22.5                                 2920
C         22.5=(LAP/FREE)*SIZES IN MC * HALF (FOR AVERAGE)                 2922
C         FREESZ CONVERTS THE FRESTOCK IN PAIRS TO THE PART                2927
C         USED TO INCREASE BATCHSIZES,AND DECREASE MOULD CHANGES           2928
      FREESZ  = ONE    /((NUMSIZE+RATIOCL+RATIORG)* PRODN)                 2930
C                                                                          3000
C                       DETERMINE REQUIREMENTS                             3002
C                                                                          3009
      SHORTTERM= DAILY.OR.LASTWEEKOFPLAN.LE.STARTWEEK+3                    3012
C         WRITE 'STOCK PROJECTION' HEADING                                 3018
      WRITE(30,9004) (IDUM,IDUM=MONTHSTART,LASTMONTH)                      3020
      IF (SHORTTERM) WRITE(30,9009)                                        3025
C         DECIDE WHETHER THIS IS A SHORT OR A LONG RUN AND                 3050
C         CALL APPROPRIATE SUBROUTINE                                      3053
      JENERAL(1)=STARTWEEK-1                                               3070
      JENERAL(2)=LASTWEEKOFPLAN - JENERAL(1)                               3075
      IF (SHORTTERM) GO TO 890                                             3090
      CALL LONGTERMREQTS                                                   3110
      IF (LASTWEEKOFPLAN-4*LASTMONTH) 940,940,0                            3120
      WRITE(30,9005) LASTMONTH                                             3130
      LASTWEEKOFPLAN=4*LASTMONTH                                           3140
C         RESCHEDULE FOR SHORTER PERIOD TO ATTEMPT TO AVOID STOCKOUT       3143
      GO TO 112                                                            3150
  890 CALL SHORTTERMREQTS                                                  3210
C         FILL UP OTHER PARTS OF 'BSIC' RECORD                             3500
  940 JENERAL(10)=AVERAGEFREE*THOUSAND                                     3510
C         AVERAGEFREE WAS MEASURED IN WEEK'S PRODN/SIZE                    3515
C         NOW MEASURE IT IN PAIRS                                          3520
C         SIZE EFFECT IN IDUM, RANGE IN IFLAG                              3523
      IDUM=AVERAGEFREE*(NUMSIZE*PRODN)                                     3530
```

```
      KOLOURADV,JENERAL(9)= AVERAGEFREE*RATIOCL*PRODN                    3540
      IFLAG=AVERAGEFREE*RATIORG*PRODN                                    3550
      AVERAGEFREE= AVERAGEFREE/FREESZ                                    3560
      JENERAL(11)= MINFREE + AVERAGEFREE                                 3565
      WRITE(30,9006) MINFREESZ,MINFREECL,MINFREERG,MINFREE,              3570
     1    IDUM,KOLOURADV,IFLAG,AVERAGEFREE                              35701
C        WRITE OUT A 'MCDA' RECORD                                       3600
      BRAND=0                                                            3610
      CALL OUTPUT(MCDA,2)                                                3620
C        WRITE OUT A'BSIC'  RECORD                                       3650
      JENERAL(6)=NMACH                                                   3670
      CALL OUTPUT(JENERAL,1)                                             3680
C                                                                        3700
C        OUTPUT 'RECS' RECORDS                                           3702
C        STORE FRACTION OF TOTAL REQTS MET BY SCHEDULE END               3708
      FRACTION=( JENERAL(40-JENERAL(3) ) / FLOAT(JENERAL(40) ))          3710
      CALL CLEAR(JENERAL,40)                                             3715
      DO 970 BRAND=1,NBRAND                                              3720
      IF (LISTNO(BRAND)) 970,970,0                                       3725
      JENERAL(1)=LISTNO(BRAND)                                           3730
      JENERAL(2),KOLOR= KOLOUR(BRAND)                                    3735
      JENERAL(3)=ENITIALREQ(BRAND) - KUMRELEASES(BRAND)                  3740
      JENERAL(4)= FINALREQ(BRAND) - ENITIALREQ(BRAND)                    3750
      JENERAL(5)=PROPCOL(KOLOR) *THOUSAND                                3760
      KUMRELEASES(BRAND)=ENITIALREQ(BRAND)+ JENERAL(4)*FRACTION          3770
      CALL OUTPUT(JENERAL,5)                                             3790
  970 CONTINUE                                                           3795
C        PROCESS'MLDS' AND 'RAWS' RECORDS                                3800
      CALL INOUT(55,55,4)                                                3810
      CALL INOUT(60,60,8)                                                3820
C                                                                        4000
C                    START 'WEEKLY' PART OF SCHEDULE                     4002
C                                                                        4003
C        THIS PROCEEDS ONE UNIT AT A TIME, WRITES OUT ANY OUTPUT RECORDS 4005
C        CREATING NEW 'WKLY' RECORDS WHEN CHANGES OCCUR                  4007
C        IT ALSO UPDATES THE TOTAL STOCKS                                4008
      IF (PLANNINGWEEK.NE.1) MEASURE(17)=1                               4010
C        FOR CONTINUING RUNS CHECK MACHINE LOADING                       4011
      IF (PLANNINGWEEK.NE.STARTWEEK) MEASURE(17)=-1                      4013
C        IF THERE ARE SOME WEEKS BEFORE THE START, CLEAR THE MACHINES    4014
      DAY=0                                                              4015
      NSHIFTSET=0                                                        4020
      NUM=1                                                              4025
C        PLANNINGTIME IS INITIALLY SET AS STARTWEEK (OR 7*STARTWEEK-6)   4030
      PLANNINGWEEK=STARTWEEK                                             4035
 1210 MACHTHISWEEK,MACHASSIGN=0                                          4050
      MONTH=(PLANNINGWEEK+3)/4                                           4055
      CALL CLEAR(JENERAL,40)                                             4080
      DO 1300 MACH=1,5                                                   4110
      MC=MANGRPSCHED(PLANNINGWEEK,MACH)                                  4115
      IF (MC) 0,0,1220                                                   4120
C        WITH NO MANUFACTURING GROUP TO BE MADE THE CURRENT MOULDS       4125
C        NEED NOT BE CLEARED.                                            4127
C        RESET PLACES  WITH AN IMPOSSIBLE COLOUR                         4129
      JENERAL(MACH)=MEASURE(MACH)                                        4130
      JENERAL(10+MACH)=-10                                               4135
```

```
      GO TO 1300                                                          4140
C        FINISHED IF NOT CORRECT MANUFACTURING GROUP                      4150
 1220 IF (MC-MANGRP) 1300,0,1300                                          4155
      MACHTHISWEEK=MACHTHISWEEK+1                                         4160
      JENERAL(MACH)=  MLDSCHED(PLANNINGWEEK,MACH)                         4165
C        IF A  LONG  RUN GET REMAINING INFORMATION FROM'SCHED'DETAILS     4200
      NSHIFT=NSHIFTSCHED(PLANNINGWEEK,MACH)                               4210
      IF (DAILY) GO TO 1240                                               4220
      IF (SHORTTERM) GO TO 1250                                           4225
      KOLOR=KOLOURSCHED(PLANNINGWEEK,MACH)                                4230
      IF (NCOLOUR.EQ.1) KOLOR=KOLOUR(NBRAND)                              4235
      IF (KOLOR) 1230,1230,0                                              4240
      MACHINES(KOLOR)=MACHINES(KOLOR)+1                                   4245
      GO TO 1270                                                          4250
 1230 KOLOR=10                                                            4260
      MACHASSIGN=MACHASSIGN+1                                             4265
C        IF THE COLOUR CANNOT BE IMMEDIATELY DETERMINED                   4268
C        SET IT TO 10 AND CHOOSE IT LATER                                 4270
      GO TO 1270                                                          4280
C        FIND COLOUR FOR SHORT RUNS                                       4300
C        FIND PRODUCTION FOR THE NEXT DAY (SUBTRACT TOTAL ALREADY USED)   4303
 1240 NSHIFT=NSHIFT- 3*DAY                                                4310
      IF (NSHIFT) 1300,1300,0                                             4320
      IF (NSHIFT.GT.PLANNINGUNIT) NSHIFT=PLANNINGUNIT                     4325
 1250 IF (NSHIFTSET+3.GE.NTHSTART(NUM+1) ) NUM=NUM+1                      4350
      KOLOR=NTHCOLOUR(NUM)                                                4355
 1270 JENERAL(MACH+10)=KOLOR                                              4370
      JENERAL(MACH+5)=MACHPRODN(MACH)* NSHIFT/PLANNINGUNIT                4375
      NSHIFTSET=NSHIFTSET+NSHIFT                                          4380
 1300 CONTINUE                                                            4390
C                                                                         4500
C                    COLOUR DETERMINATION                                 4502
C        WITH ONLY ONE MACHINE IN USE,COLOUR TO MAKE IS 'KOLOR'           4515
      MEASURE(10)=KOLOR                                                   4520
      IF (MACHASSIGN) 1710,1710,0                                         4540
C        ASSIGN ANY MACHINES NOT YET FIXED (IF ANY)                       4545
      IF (NMACH.EQ.1) GO TO 1710                                          4550
C        WITH ONLY ONE MACHINE DECIDE COLOUR IN IM40                      4560
C        WITH SHORT RUNS COLOUR HAS ALREADY BEEN DECIDED                  4565
C        DETERMINE COLOURS FOR UNASSIGNED MACHINES                        4600
      MACHASSIGN=0                                                        4610
      DO 1340 KOLOR=1,8                                                   4620
      DUMMY= PROPCOL(KOLOR)*MACHTHISWEEK                                  4625
      MACH= DUMMY                                                         4630
      IF (MACH.LT.MACHINES(KOLOR)) MACH=MACHINES(KOLOR)                   4635
C        MACH REPRESENTS THE MINIMUM NO.OF MACHINES FOR THAT COLOUR       4638
      DUMMY=DUMMY-MACH                                                    4645
C        DUMMY IS THE FRACTION OF EXTRA MACHINES NEEDED                   4648
      MACHINES(KOLOR)=MACH                                                4650
      IF (DUMMY) 0,0,1320                                                 4660
      COVER(KOLOR)= ONEMILLION                                            4670
      GO TO 1340                                                          4680
 1320 COVER(KOLOR)= MACHTHISWEEK*(INITSTK(KOLOR)+5*MACH*PRODN)/DUMMY      4710
     1                + MACH*KOLOURADV                                     47101
C        WE ADD COLOURADV FOR EACH EXTRA MACHINE NEEDED                   4713
C        AND THEN SUBTRACT IT FOR ALL MACHINES OF THAT COLOUR             4716
```

```
C          LAST WEEK. THIS DISCOURAGES UNNECESSARY COLOUR CHANGES          4719
C          WHILE NOT BIASING IN FAVOUR OF COLOURS NEEDING MANY MACHINES    4722
C          THUS COVER IS A CORRECTED STOCK COVER                           4725
           DO 1330 MC=11,15                                                4740
 1330      IF (MEASURE(MC).EQ.KOLOR) COVER(KOLOR)=COVER(KOLOR)-KOLOURADV   4745
 1340      MACHASSIGN= MACHASSIGN + MACH                                   4750
           GO TO 1410                                                      4755
 1360      DUMMY=ONEMILLION                                                4760
           DO 1370 KOLOR=1,8                                               4765
C             FIND THE COLOUR WITH LOWEST COVER                            4768
           IF (COVER(KOLOR).GE.DUMMY) GO TO 1370                           4770
           KOLORTOMAKE=KOLOR                                               4775
           DUMMY=COVER(KOLOR)                                              4778
 1370      CONTINUE                                                        4780
           MACHINES(KOLORTOMAKE)=MACHINES(KOLORTOMAKE)+1                   4785
           COVER(KOLORTOMAKE) = ONEMILLION                                 4790
           MACHASSIGN=MACHASSIGN+1                                         4795
 1410      IF (MACHASSIGN-MACHTHISWEEK) 1360,0,0                           4810
C             NOW FIND THE MACHINES TO BE ASSIGNED                         4815
C             FIRST REMOVE THOSE ALREADY FIXED                             4820
           DO 1420 MC=11,15                                                4825
           KOLOR= JENERAL(MC)                                              4830
           IF (KOLOR) 1420,1420,0                                          4835
           MACHINES(KOLOR)=MACHINES(KOLOR)-1                               4840
 1420      CONTINUE                                                        4845
C             ASSIGN SAME COLOUR AS LAST WEEK (IF STILL NEEDED)            4850
           DO 1440 MC=11,15                                                4855
           IF (JENERAL(MC).NE.10) GO TO 1440                               4857
           KOLOR= MEASURE(MC)                                              4860
           IF (KOLOR) 1440,1440,0                                          4865
           IF (MACHINES(KOLOR)) 1440,1440,0                                4870
           JENERAL(MC)=KOLOR                                               4875
           MACHINES(KOLOR)=MACHINES(KOLOR)-1                               4880
 1440      CONTINUE                                                        4890
C             THIS HAS ASSIGNED ALL MACHINES WHERE THAT COLOUR WAS MADE    4900
C             LAST WEEK.                                                   4902
C                       BECAUSE NO 3 704 IS BETTER FOR CHANGING OUT OF     4903
C             BLACK, THIS MACHINE WILL BE LEFT FREE(WHERE THERE IS A CHOICE) 4904
C             ASSIGN REMAINING MCS - LOWEST COLOUR TO LOWEST MACHINE       4910
           MC=11                                                           4915
           DO 1490 KOLOR=1,8                                               4920
 1450      IF (MACHINES(KOLOR)) 1490,1490,0                                4925
 1460      IF (JENERAL(MC).EQ.10) GO TO 1470                               4930
           MC=MC+1                                                         4935
           IF (MC-15) 1460,1460,1490                                       4940
 1470      JENERAL(MC)=KOLOR                                               4960
           MACHINES(KOLOR)=MACHINES(KOLOR)-1                               4965
           GO TO 1450                                                      4970
 1490      CONTINUE                                                        4975
C                    ** SPECIAL CONDITION FOR STANDARD SPORTS **           4980
C             NUMBER 3 704 IS NORMALLY SINGLE INJECTION BUT CAN BE DOUBLE  4982
 1710      IF (MCTYPE*MANGRP.NE.704) GO TO 1720                            4990
           IF (JENERAL(13).EQ.1) JENERAL(3)=JENERAL(3)*9/10                4995
C             CHECK TO SEE IF THERE ARE ALTERATIONS FROM LAST WEEK         5006
C             IF SO WRITE OUT A NEW RECORD                                 5007
 1720      IFLAG=0                                                         5020
```

```
      DO 1730 IDUM=1,15                                                    5025
      IF (JENERAL(IDUM).EQ.MEASURE(IDUM)) GO TO 1730                       5030
      MEASURE(IDUM)= JENERAL(IDUM)                                         5035
      IFLAG=10                                                             5040
      IF (IDUM.LE.5.AND.MEASURE(IDUM).EQ.0) MEASURE(17)=1                  5045
C        THIS INDICATES A MACHINE WHICH HAD MOULDS IN MUST BE EMPTIED      5048
 1730 CONTINUE                                                             5055
      IDUM=MEASURE(39)                                                     5060
      IF (PLANNINGWEEK.LE.40) MEASURE(39)=KOSTEXPEDITE(PLANNINGWEEK)       5065
      IF (IDUM.NE.MEASURE(39)) IFLAG=1                                     5070
      IDUM=MEASURE(40)                                                     5075
C        CALCULATE THE RELATIVE FREESTOCK                                  5077
      MEASURE(40)= RELATIVEFREE(MONTH)                                     5080
      IF (SHORTTERM) MEASURE(40)= RELATIVEFREE(NUM)                        5082
      IF (IDUM.NE.MEASURE(40)) IFLAG=1                                     5085
      IF (IFLAG.NE.0) CALL OUTPUT(MEASURE,15)                              5095
      MEASURE(17)=0                                                        5099
C        PROGRESS STOCKS OF EACH COLOUR AND BRAND                          5300
      PROPCOL(10)=ONE                                                      5310
      DO 1960 MC=1,5                                                       5320
      KOLOR= MEASURE(10+MC)                                                5325
      IF (KOLOR) 1960,1960,0                                               5330
      IDUM= MEASURE(MC)*MEASURE(5+MC)                                      5335
C        IDUM IS THE PRODUCTION OF'KOLOR'                                  5340
      INITSTK(KOLOR)=INITSTK(KOLOR)+IDUM                                   5345
      DUMMY=IDUM/PROPCOL(KOLOR)                                            5350
      DO 1940 BRAND=1,NBRAND                                               5360
      IF (KOLOR.NE.10.AND.KOLOR.NE.KOLOUR(BRAND)) GO TO 1940               5365
      SALEABLE= DUMMY*PROPORTION(BRAND)                                    5370
      TSTOCK(BRAND)= TSTOCK(BRAND) + SALEABLE                              5375
      UNBALANCED(BRAND)=UNBAR1(BRAND)                                      5380
      UNBAR1(BRAND)=    UNBAR1(BRAND) - SALEABLE                           5385
 1940 CONTINUE                                                             5390
 1960 CONTINUE                                                             5395
C        READ ACROSS ANY RECORDS FOR THIS WEEK                             5402
      CALL INOUT(50,85,4)                                                  5410
C        ADVANCE TO NEXT DAY OR WEEK                                       5500
      IF (.NOT.DAILY) GO TO 2020                                           5510
      DAY=DAY+1                                                            5515
      IF (DAY-7) 2030,0,0                                                  5520
      DAY=0                                                                5525
 2020 PLANNINGWEEK=PLANNINGWEEK+1                                          5565
 2030 PLANNINGTIME=PLANNINGTIME+1                                          5575
      IF (PLANNINGWEEK-LASTWEEKOFPLAN) 1210,1210,0                         5585
C        CHECK UP ON FINAL VALUES OF UNBALANCED STOCKS                     5600
      DUMMY=MINFREE + AVERAGEFREE*RELATIVEFREE(LASTMONTH)/THOUSAND         5615
      DO 2200 BRAND=1,NBRAND                                               5630
      EXCESS= DUMMY* PROPORTION(BRAND)                                     5635
      IF (SHORTTERM) EXCESS=MINFREE/NBRAND                                 5640
      IF (UNBALANCED(BRAND).LT.EXCESS) UNBALANCED(BRAND)=EXCESS            5645
      IF (UNBAR1(BRAND).LT.EXCESS)     UNBAR1(BRAND)=EXCESS                5650
                                                                           5680
 2200 CONTINUE                                                             5700
C                                                                          5703
C        SEE IF THIS MANUFACTURING GROUP IS STILL NEEDED                   5710
      IF (LASTWEEKOFPLAN-ENDWEEK) 110,20,20                                5810
C        WRITE END RECORD THEN PUT END OF FILE ON
```

```
 9900 CALL OUTPUT(JENERAL,17)                                          5820
      ENDFILE 20                                                       5830
      STOP                                                             5850
      END                                                              5880

 END OF SEGMENT, LENGTH = 3165, NAME  IM30
```

```
      SUBROUTINE SHORTTERMREQTS                                          6000
      LOGICAL BALANCEUP,FIRSTLOOP,DAILY,SHORTTERM                        6020
      INTEGER STOCK,SIZEROLL,SIZE                                        6030
      INTEGER PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME,WEEK,STARTWEEK      6040
      INTEGER WEEKSOFF,ENDWEEK,BRAND,PRODN                               6050
      COMMON/ARRAYS/ MANGRPSCHED(60,5),MLDSCHED(60,5),NSHIFTSCHED(60,5)  6060
     1   , KOLOURSCHED(60,5),LISTNO(10),KOLOUR(10)                       60601
     2   , KUMRELEASES(10),ISTOCK(10),MCDA(40),ISTMACH(5),KUMREQ(10,25)  60602
     3   , SIZEROLL(40,10),KOSTEXPEDITE(40),MEASURE(40)                  60603
     4   , JENERAL(40),MACHINES(10),INITSTK(10),NTHCOLOUR(5)             60604
     5   , NTHSTART(5),NEWSHIFTS(10)                                     60605
     6   , ENITIALREQ(10),FINALREQ(10),TOTALREQ(10),TNETREQ(10)          60606
     7   , COVER(10),PROPORTION(10),PROPCOL(10)                          60607
     8   , TCUMREQ(20),RELATIVEFREE(15),SMOOTHEDREQ(15)                  60608
     9   , IREQSIZE(40),NSHIFTS(10),KUMPRODN(5)                          60609
     A   , TCUMPRODN(15),UNBALANCED(10),UNBAR1(10)                       60610
      COMMON/VARS/ MCTYPE,MANGRP,BRAND,ENDWEEK,PRODN                     6070
     1   , PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME                        60701
     2   , INPUTNOW,INPUTRECS,BALANCEUP,DAILY,FIRSTLOOP                  60702
     3   , LASTWEEKOFPLAN,STARTWEEK,WEEK,WEEKSOFF                        60703
     4   , MONTH,MONTHSTART,LASTMONTH,MONTHOLD                           60704
     5   , MACH,NMACH,MACHINUSE,KOLOR,KOLORTOMAKE                        60705
     6   , NBRAND,NCOLOUR,NSHIFT,NSHIFTSET,NSHIFTTOT                     60706
     7   , MINFREE,INITSTOCKTOTAL,KUMRELEASED,IDUM,IFLAG,NUM             60707
      COMMON/REALS/ ONE,THOUSAND,ONEMILLION,DUMMY                        6080
     1   , FREE,FREESZ,AVERAGEFREE,FRACTION                              60801
     2   , TCUMREQTS,TOTALPROD,WEEKLY                                    60802
C                                                                        6100
C        DETERMINE REQUIREMENTS FOR A SHORT RUN                          6102
C                                                                        6104
      IF (NCOLOUR-1) 0,0,40                                              6110
      NSHIFTS(KOLOUR(NBRAND))= NSHIFTTOT                                 6120
      GO TO 300                                                          6130
C        SET  APPROPRIATE VARIABLES                                      6200
   40 MINIMUM=PLANNINGUNIT                                               6210
      IF (DAILY) MINIMUM=6                                               6220
      MONTH=0                                                            6225
      ICOUNT=NSHIFTSET                                                   6230
   50 MONTH=MONTH+1                                                      6245
      DO 70 KOLOR=1,8                                                    6260
      TNETREQ(KOLOR)=0.                                                  6265
      NSHIFTS(KOLOR)=NEWSHIFTS(KOLOR)                                    6270
   70 CONTINUE                                                           6275
      NSHIFTSET=ICOUNT                                                   6285
      ICOUNT=0                                                           6290
      IF (MONTH-20) 100,100,0                                            6292
      WRITE(30,1011) MCTYPE,MANGRP                                       6293
C        NOT ALL SHIFTS CAN BE ASSIGNED                                  6296
 1011 FORMAT(//42H *WARNING* INSUFFICIENT REQTS - MAN.GROUP ,2I3//)       6298
      GO TO 200                                                          6299
C        DETERMINE THE NUMBER OF DAYS EACH COLOUR WILL RUN               6300
C                                                                        6303
C        ACCUMULATE REQTS UNTIL THE NUMBER OF DAYS OF EACH COLOUR        6305
C        REQUIRED TO MEET REQTS EQUALS DAYS AVAILABLE                    6307
C                                                                        6310
  100 IF (NSHIFTSET-NSHIFTTOT) 0,300,300                                 6315
      DO 120 BRAND=1,NBRAND
```

```
      DUMMY= XDEREQ(BRAND,MONTH) - ISTOCK(BRAND)                          6320
      IF ( DUMMY + UNBALANCED(BRAND) ) 120,120,0                          6325
      TNETREQ(KOLOUR(BRAND))=TNETREQ(KOLOUR(BRAND)) + DUMMY               6330
C        ACCUMULATE THE REQUIREMENTS OF EACH COLOUR TO MEET               6335
C        DEMAND TO START OF'MONTH'                                        6340
  120 CONTINUE                                                            6350
C        WORK OUT DAYS NEEDED OF EACH COLOUR                              6400
      DO 140 KOLOR=1,8                                                    6410
      IDUM=0                                                              6420
      IF (TNETREQ(KOLOR)) 0,130,0                                         6430
C        'IDUM' IS NO OF SHIFTS NEEDED ROUNDED UP TO MULTIPLE OF 5        6435
      IDUM= (INT(TNETREQ(KOLOR)/ (5*PRODN) ) +1) * PLANNINGUNIT           6440
      IF (IDUM.LT.MINUMUM) IDUM=MINUMUM                                   6445
  130 IF (IDUM.LT.NSHIFTS(KOLOR)) IDUM=  NSHIFTS(KOLOR)                   6455
      NEWSHIFTS(KOLOR)=IDUM                                               6460
  140 ICOUNT= ICOUNT + IDUM                                               6470
      IF (ICOUNT-NSHIFTOT-PLANNINGUNIT) 50,50,0                           6480
C        IF BELOW - REPEAT LOOP                                           6488
C        HAVE NOW ALLOCATED TOO MANY DAYS IF ABOVE                        6503
C        MUST ALLOCATE THE LAST BATCH IN ORDER OF URGENCY                 6505
  200 DO 240 KOLOR=1,8                                                    6515
      IF (NSHIFTS(KOLOR)) 0,0,220                                         6520
      COVER(KOLOR)=-ONEMILLION                                            6525
      IF (TNETREQ(KOLOR)) 0,240,0                                         6530
C        SEE IF ENOUGH TIME FOR A TWO-DAY RUN (OR FULL-WEEK IF WEEKLY)    6535
      IF (NSHIFTOT-NSHIFTSET-MINUMUM) 250,0,0                             6540
      NSHIFTS(KOLOR)=MINUMUM                                              6545
      NSHIFTSET= NSHIFTSET + MINUMUM                                      6550
C        CALCULATE THE RATIO OF THE NEED TO THE PART MET                  6560
  220 COVER(KOLOR)= TNETREQ(KOLOR)/ NSHIFTS(KOLOR)                        6565
  240 CONTINUE                                                            6570
  250 SHORTFALL= -ONEMILLION                                              6575
C        SEARCH FOR COLOUR WITH HIGHEST RATIO                             6578
      DO 270 IDUM=1,8                                                     6580
      IF (SHORTFALL-COVER(IDUM)) 0,270,270                                6584
      SHORTFALL=COVER(IDUM)                                               6588
      KOLOR=IDUM                                                          6592
  270 CONTINUE                                                            6595
C        ADD EXTRA SHIFTS FOR 'KOLOR'                                     6603
      NSHIFTS(KOLOR)= NSHIFTS(KOLOR) + PLANNINGUNIT                       6610
      COVER(KOLOR)  = TNETREQ(KOLOR)/  NSHIFTS(KOLOR)                     6615
      NSHIFTSET     = NSHIFTSET      + PLANNINGUNIT                     6620
C        ARE ALL SHIFTS ASSIGNED?                                         6630
      IF (NSHIFTSET - NSHIFTOT) 250,0,0                                   6635
      SUM=0                                                               6640
C        FIND THE STARTING DATE FOR EACH COLOUR                           6650
  300 DO 305 KOLOR=1,8                                                    6655
  305 NEWSHIFTS(KOLOR)=NSHIFTS(KOLOR)                                     6657
C        KOLOR NOW EQUALS 9 -THIS IS NEEDED,AT 330 IT IS DECREASED TO 0.  6658
      NUM,NSHIFTSET=1                                                     6660
      WEEK= STARTWEEK-1                                                   6666
      NSHIFT=0                                                            6670
  310 IF (NSHIFT-NSHIFTSET) 0,320,320                                     6675
C        NSHIFT REPRESENTS THE SHIFTS TILL THE END OF'WEEK'               6677
C        NSHIFTSET REPRESENTS THE SHIFT ABOUT TO BE SET                   6680
      WEEK=WEEK+1                                                         6685
```

```
      NSHIFT=NSHIFT + NSHIFTSCHED(WEEK,MACHINUSE)                        6690
C *NB*   POTENTIAL PROBLEMS IF SEVERAL MACHINES ON SHORT RUN             6691
C        WILL NOT OCCUR IN IMMEDIATE FUTURE                              6692
C        CAN RESOLVE BY USING 'LONGTERMREQTS'                            6693
      IF (WEEK-LASTWEEKOFPLAN) 310,310,510                               6695
C        CONTINUE UNTIL WEEK HAS CAUGHT UP WITH 'NSHIFTSET'              6697
  320 KOLORTOMAKE=KOLOURSCHED(WEEK,MACHINUSE)                            6710
      IF (KOLORTOMAKE) 0,0,340                                           6715
  330 KOLOR=KOLOR-1                                                      6730
      IF (KOLOR) 510,510,0                                               6735
      KOLORTOMAKE=KOLOR                                                  6740
C        IF A COLOUR IS SET MAKE THAT COLOUR                             6743
C        OTHERWISE MAKE THE NEXT COLOUR NEEDED                           6746
C        COLOURS ARE IN ORDER OF'LIGHTNESS'                              6749
  340 IF (NEWSHIFTS(KOLORTOMAKE) ) 330,330,350                           6750
C        STOP WHEN EITHER LAST COLOUR OR WEEK PASSED                     6760
  350 DUMMY= NSHIFTTOT - NSHIFTSET                                       6762
      RELATIVEFREE(NUM) = DUMMY*THOUSAND/NSHIFTTOT                       6764
      COVER(KOLORTOMAKE)= NSHIFTS(KOLORTOMAKE)/DUMMY                     6766
      SUM=SUM + COVER(KOLORTOMAKE)                                       6768
      NTHSTART(NUM) =          NSHIFTSET                                 6770
      NTHCOLOUR(NUM)= KOLORTOMAKE                                        6772
      NSHIFTSET=NSHIFTSET + NSHIFTS(KOLORTOMAKE)                         6775
      NEWSHIFTS(KOLORTOMAKE)=0                                           6777
      NUM=NUM+1                                                          6780
      GO TO 310                                                          6790
  510 NTHSTART(NUM)=NSHIFTSET                                            6795
C                                                                        6800
C        WORK OUT INITIAL AND TOTAL REQTS FOR EACH BRAND                 6802
C                                                                        6804
      IDUM=NUM-1                                                         6810
      DO 590 NUM=1,IDUM                                                  6820
      KOLOR=NTHCOLOUR(NUM)                                               6825
C        WORK OUT PRODUCTION OF'KOLOR                                    6830
C        THIS COLOUR WILL BE RUNNING FOR'NSHIFTS'; 'PROPORTION' GIVES    6831
C        THE FAIR SHARE FOR EACH BRAND.                                  6832
C        SINCE PRODUCTION OF THIS COLOUR DOES NOT START TILL             6833
C        'NTHSTART',WE ADJUST THE REQTS SO THEY ARE NOT EFFECTIVE TILL   6834
C        THIS TIME. THIS MAKES THE 'ENITIALREQTS' MISLEADING.            6836
C                 ** SEE LOGIC FOR FULL DETAILS **                       6839
      SHORTFALL=1.5*TOTALPROD * COVER(KOLOR)/PROPCOL(KOLOR)              6845
      DUMMY= 5*(NSHIFTS(KOLOR)*PRODN/PLANNINGUNIT)/PROPCOL(KOLOR)        6848
      DO 560 BRAND=1,NBRAND                                              6850
      IF (KOLOR-KOLOUR(BRAND)) 560,0,560                                 6855
C        ONLY DEALS WITH BRANDS OF SAME COLOUR                           6860
      BRANDPROD=DUMMY*PROPORTION(BRAND)                                  6861
      FINALREQ(BRAND)=TSTOCK(BRAND)*BRANDPROD - MINFREE/NBRAND           6863
C        THE MINIMUM FREESTOCK NEEDED IS PROPORTIONAL TO THE NUMBER OF   6865
C        SIZES OF EACH BRAND.                                            6866
C        WITH SIMILAR BRANDS IT IS CORRECT TO DIVIDE BY NBRAND           6867
      ENITIALREQ(BRAND)= FINALREQ(BRAND) - SHORTFALL*PROPORTION(BRAND)   6870
      BALSTOCK= FINALREQ(BRAND) - KUMREQ(BRAND,MONTHSTART)               6873
      WRITE(30,1002) LISTNO(BRAND),ISTOCK(BRAND),UNBALANCED(BRAND),      6880
     1   TOTALREQ(BRAND),BALSTOCK,BRANDPROD,NTHSTART(NUM)                6880 1
 1002 FORMAT( // I15,2F10.0,2F15.0,21X,F9.0,6X,5HSHIFT,I4,F7.2 )         6882
                                                                         6885
  560 CONTINUE
```

```
C
  590 CONTINUE                                                          6890
C                                                                       6900
C         NOW CREATING THE DETAILS FOR THE 'BS1C' RECORD                6902
C                                                                       6909
      AVERAGEFREE=(TOTALPROD*0.24*MCDA(17)-MINEREE)/(MCDA(37)*PRODN)    6920
C         THIS SHOULD GIVE A LAP EQUAL TO THE SCHEDULE LENGTH           6921
      IF (.NOT.DAILY) GO TO 630                                         6937
      JENERAL(1)=7*JENERAL(1)                                           6940
      JENERAL(2)=7*JENERAL(2)-2                                         6942
C         ASSUMES NO WEEKEND OVERTIME IN LAST WEEK                      6943
C     JENERAL(3)=0                                                      6945
  630 JENERAL(4)=1                                                      6947
      JENERAL(7)=1+JENERAL(2)/4                                         6950
      JENERAL(8)=THOUSAND*( 1.5*SUM - (MINEREE/TOTALPROD) )             6952
C         GIVES THE RELATIVE VALUES OF TOTAL REQTS TO PRODN (=1000)     6955
      IDUM=JENERAL(2)+1                                                 6962
      INCREASE=(1000*NSHIFTOT)/(NMACH*PLANNINGUNIT*JENERAL(2))          6965
      JENERAL(40)= INCREASE*JENERAL(2)                                  6968
      DO 690 I=3,IDUM                                                   6970
  690 JENERAL(42-I)= JENERAL(40)- INCREASE*I                            6975
      RETURN                                                            6980
      END                                                               6990

END OF SEGMENT, LENGTH  1028, NAME  SHORTTERMREQTS
```

```
      SUBROUTINE LONGTERMREQTS                                                  7000
      LOGICAL BALANCEUP,FIRSTLOOP,DAILY,SHORTTERM                               7020
      INTEGER STOCK,SIZEROLL,SIZE                                               7040
      INTEGER PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME,WEEK,STARTWEEK             7045
      INTEGER WEEKSOFF,ENDWEEK,BRAND,PRODN                                      7050
      COMMON/ARRAYS/ MANGRPSCHED(60,5),MLDSCHED(60,5),NSHIFTSCHED(60,5)         7070
     1    , KOLOURSCHED(60,5),LISTNO(10),KOLOUR(10)                            70701
     2    , KUMRELEASES(10),ISTOCK(10),MCDA(40),ISTMACH(5),KUMPEQ(10,25)       70702
     3    , SIZEROLL(40,10),COSTEXPEDITE(40),MEASURE(40)                       70703
     4    , GENERAL(40),MACHINES(10),INITSTK(10),NTHCOLOUR(5)                  70704
     5    , NTHSTART(5),NEWSHIFTS(10)                                          70705
     6    , ENITIALREQ(10),FINALREQ(10),TOTALREQ(10),TNETREQ(10)               70706
     7    , COVER(10),PROPORTION(10),PROPCOL(10)                               70707
     8    , TCUMREQ(20),RELATIVEFREE(15),SMOUTHEDREQ(15)                       70708
     9    , PROJECTION(20),NSHIFTS(10),KUMPRODN(5)                             70709
     A    , TCUMPRODN(15),UNBALANCED(10),UNBAR1(10)                            70710
C         *NB*  PROJECTION (REAL) AND IREQSIZE(INTEGER) USE SAME STORAGE       7075
C         IREQSIZE IS USED ONLY IN SETUP                                        7076
      COMMON/VARS/ MCTYPE,MANGRP,BRAND,ENDWEEK,PRODN                            7080
     1    , PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME                             70801
     2    , INPUTNOW,INPUTREQS,BALANCEUP,DAILY,FIRSTLOOP                       70802
     3    , LASTWEEKOFPLAN,STARTWEEK,WEEK,WEEKSOFF                             70803
     4    , MONTH,MONTHSTART,LASTMONTH,MONTHOLD                                70804
     5    , MACH,NMACH,MACHINUSE,KOLOR,KOLORTOMAKE                             70805
     6    , NBRAND,NCOLOUR,NSHIFT,NSHIFTSET,NSHIFTTOT                          70806
     7    , MINFREE,INITSTOCKTOTAL,KUMRELEASED,IDUM,IFLAG,NUM                  70807
      COMMON/REALS/ ONE,THOUSAND,ONEMILLION,DUMMY                               7090
     1    , FREE,FREESZ,AVERAGEFREE,FRACTION                                   70901
     2    , TCUMREQTS,TOTALPROD,WEEKLY                                         70902
      AVERAGEFREE=0.                                                            7120
C                                                                               7130
C         EVALUATE THE OPERATING FREESTOCK EACH MONTH                           7132
C                                                                               7134
      FRACTION= ONE - MCDA(28)/THOUSAND                                         7140
C         FRACTION SHOWS WHAT PART OF SURPLUS STOCK CAN BE USED FOR             7142
C         PRODUCTION PURPOSES.'FREESZ'REPRESENTS THE ACTUAL ADVANTAGE           7144
C         GAINED, AND IS HIGHER WITH FEWER SIZES AND COLOURS OR LESS            7146
C         RESTRICTIVE SIZE RANGES FOR EACH MACHINE.                             7148
      DUMMY= MCDA(37)/( 9*MCDA(26)*FREESZ )                                     7180
C         DUMMY IS THE FREESTOCK NEEDED FOR THE MAX MOULD CHANGING RATE         7182
      PARTAFTERPLAN=LASTMONTH - LASTWEEKOFPLAN*0.25                             7190
      DO 200 MONTH=MONTHSTART,LASTMONTH                                         7210
      FREE=TCUMPRODN(MONTH)+INITSTOCKTOTAL-TCUMREQ(MONTH)-MCDA(17)              7220
      IF (FREE) 140,150,0                                                       7225
      IF (LASTMONTH-MONTH) 0,0,120                                              7230
      IF (BALANCEUP) GO TO 140                                                  7235
C         IN THE LASTMONTH OF A TERMINATING RUN WE WISH TO BALANCEUP            7240
C         SO THE ADVANTAGE OF CONTINUING WITH THE SAME SIZE IS REDUCED          7243
C         OTHERWISE ALLOW FOR INCOMPLETE MONTH                                  7246
      FREE= (FREE+ PARTAFTERPLAN*(TCUMREQ(MONTH)-TCUMREQ(MONTH-1)))*0.75        7250
  120 FREE= FREE* FRACTION                                                      7260
      GO TO 150                                                                 7265
  140 FREE=0.                                                                   7270
C         SET 'SMOOTHED' REQUIREMENTS TO MONTH                                  7277
  150 FREE= FREE + MCDA(17)-MINFREE                                             7280
      IF (FREE.LT.DUMMY) FREE=DUMMY                                             7282
```

```
      SMOOTHEDREQ(MONTH)=TCUMPRODN(MONTH)+INITSTOCKTOTAL - FREE-MINFREE   7285
      RELATIVEFREE(MONTH),FREE= FREE*FREESZ                               7290
      AVERAGEFREE=AVERAGEFREE + FREE                                      7295
  200 CONTINUE                                                            7299
      AVERAGEFREE=AVERAGEFREE/(LASTMONTH+1-MONTHSTART)                    7330
C     JENERAL(7)=5*AVERAGEFREE                                            7332
      DO 250 IDUM=MONTHSTART,LASTMONTH                                    7335
      MONTHOLD=LASTMONTH+ MONTHSTART - IDUM                               7360
      MONTH= MONTHOLD+1                                                   7365
      RELATIVEFREE(MONTHOLD)=RELATIVEFREE(MONTHOLD)*THOUSAND/AVERAGEFREE  7370
      IF (MONTH-LASTMONTH) 0,0,250                                        7375
C        SEE IF THE REQTS ARE INCREASING TOO FAST                         7377
C        IF INCREASE MORE THAN 50% GREATER THAN CHANGE IN PRODUCTION      7379
C     1  THEN INCREASE EARLIER REQTS.                                     7380
      DUMMY= SMOOTHEDREQ(MONTH) - 1.5*(TCUMPRODN(MONTH)                   7385
     1                                 -  TCUMPRODN(MONTHOLD))            73851
      IF (SMOOTHEDREQ(MONTHOLD).LT.DUMMY) SMOOTHEDREQ(MONTHOLD)=DUMMY     7390
  250 CONTINUE                                                            7399
C        THE GROSS REQUIREMENTS HAVE NOW BEEN FIXED                       7502
C        SET-UP OUTPUTS                                                   7504
      REQINITIAL= SMOOTHEDREQ(MONTHSTART)-TCUMPRODN(MONTHSTART)           7510
      JENERAL(8)=1000                                                     7515
      WEEK=JENERAL(2)                                                     7520
      WEEKLY=5*NMACH*PRODN*(SMOOTHEDREQ(LASTMONTH)-REQINITIAL)/TOTALPROD  7525
C        THIS IS THE AVERAGE WEEKLY REQTS                                 7528
      WEEKSOFF= (TCUMREQTS- SMOOTHEDREQ(LASTMONTH))/WEEKLY                7535
      IF (BALANCEUP) WEEKSOFF=1                                           7540
      IF (WEEK+WEEKSOFF.GT.26) WEEKSOFF=26-WEEK                           7545
C        THIS IS THE NUMBER OF WEEKS AFTER THE SCHEDULE END               7548
      JENERAL(3)=WEEKSOFF                                                 7555
C        SET THE TARGETS FOR EACH WEEK FOR SALEABLE STOCK                 7560
C        BY 'JENERAL(3)' WEEKS AFTER THE END ALL REQTS SHOULD BE MET      7565
C        IN EARLIER WEEKS THIS SHOWS THE NUMBER OF THOUSANDTHS COMPLETED  7566
      DUMMY=THOUSAND/WEEKLY                                               7570
      KWEK2=LASTWEEKOFPLAN + WEEKSOFF                                     7575
      KWEK1=LASTWEEKOFPLAN                                                7580
      MONTH=LASTMONTH                                                     7585
      IFLAG=40                                                            7590
      ITOP,ILOW= (TCUMREQTS-REQINITIAL) * DUMMY                           7595
C        STARTING FROM THE FINAL WEEK PROCEED BACKWARDS TO THE FIRST      7602
C        WEEK, DECREASING THE REQTS EVENLY IN EACH MONTH                  7604
C                                                                        7605
C           ITOP REPRESENTS THE NUMBER OF THOUSANDTHS COMPLETED           7607
      IF (WEEKSOFF) 370,370,0                                             7609
  330 ILOW= (SMOOTHEDREQ(MONTH)- REQINITIAL)* DUMMY                       7610
  340 INCREASE=(ITOP-ILOW)/(KWEK2-KWEK1)                                  7620
C        PROCEED TO FILL UP'JENERAL' SO THAT THE CHANGE IS EVEN           7623
C        IN EACH MONTH                                                   7626
  350 JENERAL(IFLAG)=ITOP                                                 7630
      KWEK2=KWEK2-1                                                       7635
      IFLAG=IFLAG-1                                                       7640
      ITOP= ITOP-INCREASE                                                 7645
      IF (KWEK2-KWEK1) 370,370,350                                        7650
  370 ITOP=ILOW                                                           7655
      MONTH=MONTH-1                                                       7660
      IF (MONTH-MONTHSTART+1) 510,390,0                                   7665
```

```
      KWEK1= 4*MONTH                                                          7670
      GO TO 330                                                               7675
  390 KWEK1=STARTWEEK-1                                                       7680
      ILOW=-ILOW/2                                                            7682
C        FOR THE FIRST FOUR WEEKS THE REQUIREMENTS ARE 50% UP                 7684
C        THIS PREVENTS NEEDING MANY MORE MOULD CHANGES IN STARTWEEK.          7685
C        THE'ENITIALREQTS' ARE NOT DECREASED BECAUSE THIS WOULD               7686
C        INFLATE THE AVERAGE DEMAND.                                          7687
      GO TO 340                                                               7690
C                                                                             7700
C        DETERMINE THE DETAILED REQTS FOR EACH BRAND                          7702
C        SET FIRST VALUES FOR INITIAL REQTS                                   7705
  510 DO 520 BRAND=1,NBRAND                                                   7710
      KOLOR=KOLOUR(BRAND)                                                     7720
      IF (KOLOR) 520,520,0                                                    7722
      FINALREQ(BRAND)=TOTALREQ(BRAND)                                         7725
      ENITIALREQ(BRAND)= TSTOCK(BRAND) - PROPORTION(BRAND)*                   7730
     1        (KUMRELEASED + INITSTK(KOLOR)/PROPCOL(KOLOR) )                   77301
  520 CONTINUE                                                                7732
      TSHORTFALL=0                                                            7735
      IFLAG=1                                                                 7740
      IDUM= (MONTHSTART+LASTMONTH)/2                                          7745
  550 DO 700 BRAND=1,NBRAND                                                   7760
      SHORTFALL,STOCKOUT=0.                                                   7765
C        RECALCULATE THE PROPORTION OF THE TOTAL REQTS OF TYPE'BRAND'         7769
      PROPORTION(BRAND)=(FINALREQ(BRAND)-ENITIALREQ(BRAND))/TCUMREQTS         7770
      MONTHOUT=MONTHSTART                                                     7780
C        CANNOT DO ANYTHING ABOUT INITIAL STOCKOUTS SO IGNORE                 7790
C        (NOR FINAL REQTS AS THESE ARE EVENLY BALANCED)                       7793
C        PROJECT SALEABLE STOCKS FOR EACH MONTH                               7802
      DO 530 MONTH=MONTHSTART,IDUM                                            7810
C  *NB*  EXCESS,STOCKOUT,SHORTFALL ARE ALL POSITIVE WHEN STOCKS ARE -VE       7812
      EXCESS  =          -ENITIALREQ(BRAND) + KUMREQ(BRAND,MONTH)             7820
     1                    - PROPORTION(BRAND)*SMOOTHEDREQ(MONTH)               78201
      IF (MONTH.EQ.LASTMONTH) EXCESS=EXCESS  - PARTAFTERPLAN*                 7822
     1          (KUMREQ(BRAND,MONTH) - KUMREQ(BRAND,MONTH-1) )                78221
      IF (EXCESS) 530,530,0                                                   7825
      IF (STOCKOUT.LT.EXCESS) STOCKOUT=EXCESS                                 7830
      DUMMY= KUMREQ(BRAND,MONTH)-ENITIALREQ(BRAND)                            7835
     1      -   PROPORTION(BRAND)*(TCUMREQ(MONTH)+TCUMPRODN(MONTH)*0.1)       78351
C        IF A STOCKOUT OCCURS SEE IF IT IS AVOIDABLE                          7857
      IF (EXCESS.LT.DUMMY) DUMMY=EXCESS                                       7840
      IF (DUMMY.LT.SHORTFALL) GO TO 530                                       7842
C        SHORTFALLS ARE NORMALLY AVOIDABLE(EXCEPT IN MONTH 1)                 7844
      SHORTFALL=DUMMY                                                         7845
      IF (MONTHOUT.EQ.MONTHSTART) MONTHOUT=MONTH                              7848
  530 PROJECTION(MONTH)= -EXCESS                                              7850
C        ON FIRST LOOP ADJUST INITIAL STOCKS                                  7852
      IF (IFLAG.GT.1) GO TO 560                                               7855
      SHORTFALL=SHORTFALL+SHORTFALL                                           7860
C        FIRST LOOP ONLY COVERS EARLY MONTHS                                  7862
C        ALLOW FOR TWICE THE SHORTFALL                                        7863
      DUMMY=2.*PROPORTION(BRAND)*WEEKLY                                       7865
      IF (SHORTFALL.GT.DUMMY) SHORTFALL=DUMMY                                 7870
C        FIRST TEST: DONT ALLOW MORE THAN TWO WEEKS SALES                     7872
C        SECONDLY:   BALANCED STOCK CANNOT INCREASE AT TWICE THE              7874
```

```
C                       RATE OF PRODUCTION                                      7876
      DUMMY= TSTOCK(BRAND) + 4.*DUMMY - UNBART(BRAND)                           7880
     1    - (KUMREQ(BRAND,MONTHSTART) + PROJECTION(MONTHSTART) )               78801
      IF (SHORTFALL.GT.DUMMY) SHORTFALL=DUMMY                                   7885
      ENITIALREQ(BRAND)=ENITIALREQ(BRAND)+ SHORTFALL                            7890
      TSHORTFALL= TSHORTFALL + SHORTFALL                                        7895
      GO TO 700                                                                 7897
  560 WRITE(30,1002) LISTNO(BRAND),TSTOCK(BRAND),UNBALANCED(BRAND),             7910
     1   TOTALREQ  (BRAND), (PROJECTION(MONTH),MONTH=MONTHSTART,               79101
     2   LASTMONTH)                                                            79102
 1002 FORMAT( // 115,2F10.0,2F15.0,7F8.0 )                                      7920
      IF (STOCKOUT) 600,600,0                                                   7924
      WRITE(30,1003)                                                            7928
 1003 FORMAT(1H+,105X,14H** STOCKOUT **)                                        7932
      IF (MONTHOUT.NE.MONTHSTART.AND.MONTHOUT.LE.LASTMONTH)                     7936
     1   LASTMONTH=MONTHOUT                                                    79361
C        CHANGE THE TERMINAL MONTH IF THERE IS AN AVOIDABLE SHORTFALL           7940
  600 WRITE(30,1014) (KUMREQ(BRAND,MONTH),MONTH=MONTHSTART,LASTMONTH)           7942
 1014 FORMAT( 44X,5HREQTS,7X,7I8)                                               7944
  700 CONTINUE                                                                  7945
C        ON FIRST LOOP ADJUST INITIAL REQTS                                     7950
      IF (IFLAG.EQ.2) GO TO 750                                                 7954
      IFLAG=2                                                                   7958
      IDUM= LASTMONTH                                                           7962
      DO 720 BRAND=1,NBRAND                                                     7965
  720 ENITIALREQ(BRAND)= ENITIALREQ(BRAND)- TSHORTFALL*PROPORTION(BRAND)        7970
      GO TO 550                                                                 7972
C        ON SECOND LOOP INCREASE INITIAL REQTS SO TOTAL IS NOW                  7975
C        'REQ INITIAL' NOT ZERO.                                                7976
C        RESET 'PROPORTION'                                                     7977
  750 DO 770 BRAND=1,NBRAND                                                     7980
      ENITIALREQ(BRAND)=ENITIALREQ(BRAND) + REQINITIAL*PROPORTION(BRAND)        7984
      PROPORTION(BRAND)= (TOTALREQ(BRAND)-TSTOCK(BRAND) )                       7986
     1                  / TCUMPRODN(LASTMONTH)                                 79861
  770 CONTINUE                                                                  7990
      RETURN                                                                    7996
      END                                                                       7999

END OF SEGMENT, LENGTH  1204, NAME  LONGTERMREQTS
```

```
      SUBROUTINE INOUT(LOWTYPE,HIGHTYPE,PROCESS)                          8000
      LOGICAL BALANCEUP,DAILY,FIRSTLOOP                                   8020
      INTEGER STOCK,SIZEROLL,BRAND,ENDWEEK,PRODN,PROCESS,HIGHTYPE         8030
      INTEGER PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME                      8040
      INTEGER RECTYPE                                                     8042
      DIMENSION INFORMATION(40,20),IBUFFER(40)                            8050
      DIMENSION ICLEAR(800)                                               8055
      DIMENSION LISTNO(10),KOLOUR(10)                                     8060
      COMMON/ARRAYS/KSCHED(60,5,4),LISTNO(10),KOLOUR(10)                  80602
     2    , KUMRELEASES(10),ISTOCK(10),MCDA(40),ISTMACH(5),KUMREC(10,25)  80602
     3    , SIZEROLL(40,10),STOCK(40,10)                                  8070
      COMMON/VARS/ MCTYPE,MANGRP,BRAND,ENDWEEK,PRODN                      80701
     1    , PLANNINGUNIT,PLANNINGWEEK,PLANNINGTIME                        80702
     2    , INPUTNOW,INPUTRECS,BALANCEUP,DAILY,FIRSTLOOP                  8080
      COMMON/RECORDS/ NAME(20),NOUTPUTREC(20),KEY(8)                      8090
      EQUIVALENCE (SIZEROLL(1,1),INFORMATION(1,1))                        8095
      EQUIVALENCE (ICLEAR(1),LISTNO(1))                                   8100
C                                                                         8102
C        ALL RECORDS ARE READ IN THROUGH THIS SUBROUTINE                  8103
C        THE KEYS ARE CHECKED, AND IF APPLICABLE NOW                      8105
C        THE INFORMATION IS STORED OR OUTPUT                              8110
      INPUTNOW=0                                                          8118
C        READ A RECORD IF NONE YET READ                                   8120
   20 IF (KEY(1) )  40,150,0                                              8130
C        CHECK WHETHER THE CURRENT RECORD IS VALID NOW                    8135
      IF(KEY(1)-MCTYPE) 40,0,40                                           8140
      IF (KEY(2)-MANGRP) 50,0,50                                          8145
      IF (KEY(3)-PLANNINGWEEK) 0,0,900                                    8150
      IF (KEY(4)-HIGHTYPE)  0,0,60                                        8155
      IF (KEY(4)- LOWTYPE) 70,0,0                                         8160
C        ACCEPTABLE RECORDS SHOULD PASS ALL THESE TESTS                   8165
C        THE PROCESSING DEPENDS ON THE PROCESS TYPE                       8170
C        IF THE RECORD IS FOR LATER PROCESSING-RETURN (GO TO 900)         8210
      IF (PROCESS-2) 270,350,500                                          8220
C        SCHD RECORDS SHOULD START A NEW MCTYPE                           8225
   40 IF (PROCESS-2) 220,210,900                                          8230
C        A 'MCDA' RECORD SHOULD START A NEW MANGRP                        8235
   50 IF (PROCESS-2) 300,310,900                                          8240
C        GENERALLY THESE RECORDS ARE FOR LATER PROCESSING                 8243
C        BUT IN RARE CASES WHEN OUT OF SEQUENCE THEY MAY BE REJECTED      8245
   60 IF (INPUTNOW.GT.0.OR.PROCESS.GT.2) GO TO 900                        8250
C        REJECT THE RECORD AS OUT OF SEQUENCE                             8252
C        RECORD TYPE IS NOT AS EXPECTED                                   8254
   70 IREJECTED=IREJECTED+1                                               8256
      WRITE(30,9001) KEY                                                  8258
 9001 FORMAT(/// 28H ** REJECTED RECORD : KEYS =,5I4,A6,2I8//)            8259
      GO TO 150                                                           8260
C        RECORD ACCEPTED                                                  8265
  120 INPUTACC=INPUTACC+1                                                 8267
      INPUTNOW=INPUTNOW+1                                                 8280
C        READ IN NEXT RECORD                                              8282
C        THIS RECORD IS STORED UNTIL IT HAS BEEN PROCESSED                8285
  150 READ(10,9000) KEY,IBUFFER                                           8288
 9000 FORMAT(48A4)                                                        8290
      INPUTRECS=INPUTRECS+1                                               8293
      GO TO 20                                                            8300
C        DEAL WITH 'SCHD' RECORDS
```

```
  210 IF (INPUTNOW) 0,0,900                                                  8310
  220 PROCESS=1                                                              8312
      IF (MCTYPE) 250,250,0                                                  8315
C        WRITE OUT DETAILS FOR OLD MACHINE TYPE                              8320
      WRITE(30,9002) MCTYPE,INPUTRECS,INPUTACC,IREJECTED                     8325
     1    ,   (NAME(I),NOUTPUTREC(I),I=1,20)                                8325.1
 9002 FORMAT(16H1   MACHINE TYPE,I5,9X,12HRECORDS READ,I5,9X,8HACCEPTED,    8330
     1    I5,9X,8HREJECTED,I5//39X,14HOUTPUT RECORDS/20(/39X,A4,I10)/1H1)    8330.1
C        CLEAR SCHEDULE ARRAY  AND OUTPUT COUNTS                             8340
      CALL CLEAR(NOUTPUTREC,20)                                              8343
      INPUTRECS,INPUTACC,IREJECTED=0                                         8345
      CALL CLEAR(KSCHED,1200)                                                8348
  250 MCTYPE=KEY(1)                                                          8362
      MANGRP=0                                                               8365
      IF (KEY(1)) 900, 70,20                                                 8367
C        RETURN IF NEGATIVE,REJT RECORD IF ZERO, CHECK RECORD IF POS.        8360
C        FILL UP SCHEDULE ARRAY                                              8380
  270 MACH=KEY(5)                                                            8382
      KWEEK=KEY(3)                                                           8385
      DO 280 I=1,4                                                           8390
  280 KSCHED(KWEEK,MACH,I)=IBUFFER(I)                                        8395
      GO TO 120                                                              8398
C        PROCESS 'MCDA' RECORD                                               8402
C        REJECT IF NO SCHED RECORDS FOR THAT MCTYPE                          8409
  300 IF (INPUTNOW) 70,70,0                                                  8410
      PROCESS=2                                                              8414
      INPUTNOW=0                                                             8420
C        DEFINE NEW MANUFACTURING GROUP                                      8425
  310 MANGRP=KEY(2)                                                          8430
C        CLEAR ALL ARRAYS EG STOCKS,SIZEROLL (MORE CLEARED IN IM30)          8435
      CALL CLEAR(ICLEAR,800)                                                 8440
      FIRSTLOOP=.TRUE.                                                       8445
      GO TO 20                                                               8450
C        STORE 'MCDA' RECORD                                                 8455
  350 PLANNINGUNIT=KEY(7)*3                                                  8460
C        THIS INDICATES NO OF SHIFTS PER PLANNING UNIT (DAY OR WEEK)         8462
      DAILY=PLANNINGUNIT.EQ.3                                                8465
      DO 360 I=1,5                                                           8470
      MCDA(I+1)=IBUFFER(I+1)*PLANNINGUNIT/15                                 8472
  360 ISTMACH(I)=IBUFFER(6+I)                                                8475
      DO 370 I=12,34                                                         8480
  370 MCDA(I)=IBUFFER(I)                                                     8485
      PRODN,MCDA(1)= IBUFFER(1)*PLANNINGUNIT/15                              8490
      ENDWEEK=KEY(8)                                                         8495
      PLANNINGWEEK=KEY(3)                                                    8510
      IF (PLANNINGWEEK.EQ.0) PLANNINGWEEK=1                                  8515
      GO TO 120                                                              8520
C        DETERMINE THE RECORD TYPE AND STORE INFORMATION OR WRITE OUT        8700
  500 BRAND=KEY(5)                                                           8710
      RECTYPE=KEY(4)                                                         8715
C        FOR SOME REC.TYPES 'BRAND' IS A MACHINE NO.                         8717
C                                                                           8718
C        PROCESS=4   - OUTPUT                                               8719
C        PROCESS=6   - STORE AND OUTPUT                                     8721
C        PROCESS=8   - STORE INFORMATION                                    8723
      IF (PROCESS-6) 0,0,520                                                 8725
```

```
C                                                                       8729
C          OUTPUT RECORD                                                8730
      I=0                                                               8735
      CALL OUTPUT(IBUFFER(1),I)                                         8740
C          DONT KNOW RECORD TYPE SO TYPE=ZERO                           8745
      IF (PROCESS-6) 120,6,0                                            8750
C          DETERMINE THE RECORD TYPE                                    8760
  520 NUM=0                                                             8765
      IF (RECTYPE.EQ.30) GO TO 530                                      8770
      IF (RECTYPE.EQ.35) GO TO 560                                      8775
      IF (RECTYPE.EQ.40) NUM=BRAND                                      8778
      IF (RECTYPE.EQ.45) GO TO 610                                      8780
      IF (RECTYPE.EQ.50) NUM=12                                         8785
      IF (RECTYPE.EQ.60) NUM=11                                         8790
C          IF NONE OF THESE CONDITIONS ARE SATISFIED,REJECT RECORD      8795
      IF (NUM) 70,70,540                                                8797
C          PROCESS A 'STKS' RECORD                                      8800
  530 NUM=BRAND +10                                                     8810
      NUMRELEASES(BRAND)=KEY(7)                                         8815
      TSTOCK(BRAND)=KEY(8)                                              8820
C          STORE INFORMATION                                            8835
  540 DO 550 I=1,40                                                     8840
      INFORMATION(I,NUM)=IBUFFER(I)                                     8845
  550 CONTINUE                                                          8850
      GO TO 120                                                         8855
C          PROCESS 'PROD' CARD                                          8865
C          IF PLANNINGWEEK=1,ADD TO STOCKS, OTHERWISE OUTPUT            8868
  560 IF (PLANNINGWEEK-1) 570,570,0                                     8870
      CALL OUTPUT(IBUFFER(1),6)                                         8875
      GO TO 120                                                         8880
  570 DO 580 I=1,40                                                     8883
      STOCK(I,BRAND)=STOCK(I,BRAND) + IBUFFER(I)                        8885
  580 CONTINUE                                                          8890
      TSTOCK(BRAND)=TSTOCK(BRAND) + KEY(8)                              8893
      GO TO 120                                                         8895
C          CUMREQ CONTAINS THE CUMULATIVE REQUIREMENTS TO THE START OF MTH 8900
  610 LISTNO(BRAND)=KEY(7)                                              8910
      KOLOUR(BRAND)=KEY(8)                                              8920
      DO 630 I=1,25                                                     8930
  630 KUMREQ(BRAND,I)=IBUFFER(I+1)                                      8940
      GO TO 120                                                         8945
  900 RETURN                                                            8990
      END                                                               8995


END OF SEGMENT, LENGTH   647, NAME  INOUT
```

```
      SUBROUTINE OUTPUT(IARRAY,IRECTYPE)                                9000
      INTEGER BRAND,PLANNINGTIME                                        9020
      DIMENSION IARRAY(40)                                              9040
      COMMON/VARS/ MCTYPE,MANGRP,BRAND,I1,I2,I3,I4,PLANNINGTIME         9050
      COMMON/RECORDS/ NAME(20),NOUTPUTREC(19),NTOTAL,KEY(8)             9070
C                                                                       9100
C        THIS SUBROUTINE WRITES THE OUTPUT RECORDS TO TAPE              9102
C        AND STORES THE TOTALS,PRINTED AFTER EACH MACHINE TYPE          9105
C                                                                       9107
      IF (IRECTYPE) 0,0,40                                              9110
      IDESC=KEY(6)                                                      9120
      IRECTYPE=14                                                       9130
   10 IF (IDESC.EQ.NAME(IRECTYPE)) GO TO 60                             9150
      IRECTYPE=IRECTYPE-1                                               9160
      IF (IRECTYPE)  0,0,10                                             9170
C        IF DESCRIPTION IS NOT RECOGNISED  NOTE IT AS SUCH              9175
      IRECTYPE=18                                                       9180
   40 IDESC=NAME(IRECTYPE)                                              9210
   60 NOUTPUTREC(IRECTYPE)=NOUTPUTREC(IRECTYPE)+1                       9220
      NTOTAL= NTOTAL +1                                                 9230
      WRITE(20,1001) IDESC,MCTYPE,MANGRP,PLANNINGTIME,                  9250
     1               IRECTYPE,BRAND,IARRAY                              92501
 1001 FORMAT(46A4)                                                      9260
 1002 FORMAT(1X,A4,2514/25X,2014/)                                      9261A
      WRITE(30,1002) IDESC,MCTYPE,MANGRP,PLANNINGTIME,                  9265A
     1               IRECTYPE,BRAND,IARRAY                              9266A
      CALL OVERFL(IDUM)                                                 9270
      RETURN                                                            9290
      END                                                               9299

END OF SEGMENT, LENGTH   122, NAME  OUTPUT
```

```
      BLOCK DATA                                                        9400
      COMMON/RECORDS/NAME(20)                                           9410
      COMMON/REALS/ ONE,THOUSAND,ONEMILLION                             9420
      DATA ONE/1./,THOUSAND/1E3/,ONEMILLION/1E6/                        9440
      DATA NAME/    4HRSIC,4HMCDA,4HSTKS,4HSZRL,4HREQS,                 9460
     1              4HFREE,4HPROD,4HZZ  ,4HFORC,4HMLDS,                 94601
     2              4HZZ  ,4HZZ  ,4HMCLD,4HMATS,4HWKLY,                 94602
     3              4HCONT,4HEND ,4HUNRE,4H    ,4HTOTL/                 94603
      END                                                               9490
```

```
      SUBROUTINE CLEAR(IRESET,NUM)                                  9600
      DIMENSION IRESET(NUM)                                         9620
C        RESET ARRAY(S) TO ZERO                                     9630
      DO 10 I=1,NUM                                                 9650
   10 IRESET(I)=0                                                   9660
      RETURN                                                        9680
      END                                                           9690

END OF SEGMENT, LENGTH    30, NAME  CLEAR
```

APPENDIX 8 THE MOULD SCHEDULING PROGRAM

```
                                                                        100
      MASTER IM40                                                       110
      INTEGER REQMENT,FREESTOCK,FRACTION,ASSIGN                         115
      INTEGER SIZE,BRAND,PRODN,WEEK,WEEKSLEFT,SIGN                      120
      INTEGER GROUPPLACESFILLED                                         125
      LOGICAL SHORTRUN,OUTPUTREQ                                        130
      DIMENSION MPRODUCE(10) , PRIOR(40)                                140
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR           1401
     1    , NMACH,MCSTHISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)      1402
     2    , FREESTOCK(37,10),FRACTION(37,10),REQMENT(37,26)             1403
     3    , INMACH(37,5),MATAVAIL(37,10)                                1404
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                    150
      COMMON/BLOCK1/ FREE,SPREAD,REQTOPROD,LAP,INCREASE,SIGN,MCHLIMIT   1501
     1    ,MAXDESIRESIZE(6),ISTMACH(6),WEIGHT,RANGEFACTOR               1502
     2    , ENITIALREQ(10),TOTALREQ(10),PROPURTION(10),CUMPART(27)       1503
     3    , NWEEKSTOSTART,NWEEKAFTERPLAN,LASTWEEKOFPLAN,LASTWEEKOFREQ   1504
     4    , NCOLOUR,NUMSIZE,NBRANDSIZES                                 170
      COMMON/BLOCK3/ MAKEBRAND(10),COVERS(40),AVUSAGE(40)               1701
     2    , BATCHSIZE(40),COVERINPRODN(40),EXTRACOST(40)                1702
     2    , IHALF(40),MINNUMBOFMLDS(40),NEXTRAMLDS(40)                  1703
     3    , WEEKSLEFT,REQSLEFT                                          180
      COMMON/BLOCK4/ MLDCHANGES,MLDSPACES(6),KTOPRANGE(7)               1801
     1    ,GROUPPLACESFILLED(6),MACHPLACES,HALFWEEKMCS                  190
      COMMON/BLOCK5/ WEEK,KWEEK,MKCOLOR,MACHCOLOUR(6)                   1901
     1    , MLDPLACES(6),MACHPRODN(6)                                   210
      COMMON/ASSORTED/ CHNGCOST,ALTERCOST,COLOURADV,VALFREESTCK         2101
     1    , RELATIVEFREE,IFREE,VALCHANGE                                2102
     2    , SHORTRUN,OUTPUTREQ                                          230
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION 290
      DATA DA/8H AVERAGE/,DB/8H USAGE  /,DC/8H  BATCH /,DD/8HSIZES   /,  2901
     1     DE/8H PEAK CO/,DF/8HVER (WK)/,DG/8HSALES CO/,DI/8HADDITION/,  2902
     1     DJ/8HAL COST /,DK/8HINITIAL /,DL/8H FINAL  /,DM/8HCUT-OFF /,  2903
     3     DP/8HPRIORITY/,DR/8HMOULDS A/,DS/8HSSIGNED /,                 2904
     4     DT/8HHALF-WEE/,DU/8HK MARKER/                                 310
 9300 FORMAT(( //9X,2A8/4(/10(1X,F10.2))))                              320
 9400 FORMAT(1H1,9X,4HWEEK,I4,5X,6HCOLOUR,I3,I6,21H MACHINES THIS COLOUR  3201
     1    ,6I4)                                                         330
 9500 FORMAT(//9X,13HLARGEST SIZES,6I4,12H SIZE RANGES,7I4,7H  TREND,I4) 340
 9600 FORMAT(/(/23X,2A8//2(20X,2014/)))                                 350
 9700 FORMAT(1H1,19X,19HMANUFACTURING GROUP,I6,12/20X,                  3501
     1    20HTOTAL MOULD CHANGES ,I3///6X,5HBRAND,                      3502
     2    34X,12HFINAL STOCKS/(19,10X,3(10I8/19X),7I8//))               360
 9800 FORMAT(/16H *WARNING*  SIZE,I5,10H PRIORITY ,F7.1,10H UNPLACED / ) 500
C                                                                       502
C                    READ IN THE DATA AND SET-UP ARRAYS                 503
C                                                                       510
      MKPERIOD=0                                                        610
   10 CALL INPUT1                                                       620
      IF (MCTYPE) 990,990,0                                             630
      CALL SETUP(IFLAG)                                                 640
      IF (IFLAG.EQ.1) GO TO 999                                         650
      MLDCHNGETOTAL=0                                                   660
      DO 20 SIZE=1,40                                                   664
      IHALF(SIZE)=0                                                     670
   20 PRIOR(SIZE)=0                                                     680
      DO 30 NUM=1,7                                                     690
   30 KTOPRANGE(NUM)=0
```

```
      WRITE(30,9300) DA,DB,AVUSAGE,DC,DD,BATCHSIZE,DE,DF,COVERINPRODN      710
      WEEK=NWEEKSTOSTART                                                   730
      KWEEK=0                                                               735
      WEEKSLEFT=LASTWEEKOFREQ                                              740
      LASTWEEKOFPLAN=LASTWEEKOFREQ - LASTWEEKOFPLAN                        745
  100 WEEK=WEEK+1                                                          750
C                                                                          800
C         READ IN ANY DATA FOR THIS WEEK                                   802C
C                                                                          805
      IF (KWEEK.LE.WEEK) CALL INPUT2                                       810
      MLDCHNGETOTAL=MLDCHNGETOTAL+MLDCHANGES                               820
      MLDCHANGES=0                                                         830
      IF (WEEK-510) 0,130,130                                               850
      IF (LASTWEEKOFPLAN - NWEEKAFTERPLAN) 0,0,110                         910
      LASTWEEKOFPLAN=LASTWEEKOFPLAN+1                                      920
      GO TO 120                                                            925
  110 WEEKSLEFT=WEEKSLEFT - 1                                              940
  120 MKPERIOD= 1+ (WEEK-1)/12                                             950
C         WEEK IS COUNTED FROM THE START OF PLANNING                       960
C         WE COUNT IN WEEKS TO GO FOR THE SCHEDULE                         963
C         LASTWEEKOFPLAN IS THE FINAL WEEK IN WHICH THIS                   966
C              MANUFACTURING GROUP IS TO BE MADE                           969
C         THE REQUIREMENTS CONTINUE FOR ANITHER 'NWEEKAFTERPLAN'           973
      IF (WEEKSLEFT - LASTWEEKOFPLAN) 0,150,150                            980
  130 WRITE (30,9700) MCTYPE,MANGRP,MLDCHNGETOTAL,                         985
     1 (LISTNO(BRAND),(FREESTOCK(SIZE,BRAND),SIZE=1,37),BRAND=1,NBRAND)    9851
      GO TO 10                                                              990
C                                                                          1000
C                    START THE SCHEDULE FOR 'WEEKOFPLAN'                   1002
C                                                                          1004
C                                                                          1010
  150 IFLAG=1                                                               1035
      REQSLEFT= CUMPART(1) - CUMPART(WEEKSLEFT)                            1040
      IF (.NOT.SHORTRUN) REQSLEFT=REQSLEFT + CUMPART(1)                    10401
     1                          - CUMPART(NWEEKAFTERPLAN)                 1050
      DO 220 SIZE=MINSIZE,MAXSIZE                                          1055
      ASSIGN(SIZE)=0                                                       1060
      DO 210 BRAND=1,NBRAND                                                1065
C         REDUCE STOCKS BY THE WEEK'S REQUIREMENTS                         1075
  210 FREESTOCK(SIZE,BRAND)=FREESTOCK(SIZE,BRAND) - REQMENT(SIZE,          10751
     1    WEEKSLEFT)*(FRACTION(SIZE,BRAND)*THOUSANDTH) + HALF              1110
      DO 220 MLD=1,3                                                       1115
      MACH=INMACH(SIZE,MLD)                                                1120
      IF (MACH) 0,220,215                                                  1125
C         THIS CAN BE NEGATIVE IF THERE WAS A HALF-WEEK OF ANOTHER COLOUR  1130
C          SEE ALSO  STATEMENT 1480                                        1150
      INMACH(SIZE,MLD)=0                                                   1155
      GO TO 220                                                            1170
C         THE DESIRED SIZE IN ANY MACHINE IS A WEIGHTED AVERAGE            1172
C         IT MAY ALSO BE ADJUSTED FOR AN UPWARD OR DOWNWARD TREND          1180
  215 MAXDESIRESIZE(MACH)=MAXDESIRESIZE(MACH)*(ONE -WEIGHT)                11801
     1              + SIZE*WEIGHT + 0.9                                   1195
  220 CONTINUE                                                             1300
C                                                                          1302
C                    CHECK COLOUR COMPATIBILITY                            1304
C                                                                          1306
C         WITH SEVERAL MACHINES THE COLOUR MUST BE PRE-DETERMINED
```

```
C         WITH ONE COLOUR IT MAY BE FIXED OR DECIDED BY STOCK-LEVELS          1307
      IF (NMACH-1) 999,340,0                                                  1315
      KOLOR1=10                                                               1320
  310 KOLOR1=KOLOR1-1                                                         1322
      IF (KOLOR1) 100,100,0                                                   1325
      MCSTHISCOLOUR=0                                                         1330
      DO 320 MACH=1,5                                                         1335
  320 IF (MACHCOLOUR(MACH).EQ.KOLOR1) MCSTHISCOLOUR=MCSTHISCOLOUR+1           1340
      IF (MCSTHISCOLOUR) 310,310,390                                          1350
  340 MCSTHISCOLOUR=1                                                         1380
      KOLOR1=MKCOLOR                                                          1385
      IF (KOLOR1) 100,100,0                                                   1385
      IF (KOLOR1-10) 380,0,0                                                  1390
C         WITH NO COLOUR PROVIDED DETERMINE THE NUMBER OF WEEKS COVER         1400
C         EACH BRAND HAS. GIVE THE CURRENT COLOUR AN ADVANTAGE                1402
      CALL PRODUCTCOVER(0,DUMMY,BRAND,KOLOR)                                  1420
      KOLOR1=KOLOUR(BRAND)                                                    1430
  380 MACHCOLOUR(ISTMACH(1))=KOLOR1                                           1435
  390 KOLOR=KOLOR1                                                            1440
C          THIS IS THE COLOUR TO BE MADE THIS WEEK                            1450
      DO 400 BRAND=1,NBRAND                                                   1460
      MAKEBRAND(BRAND)=1                                                      1465
  400 IF (KOLOUR(BRAND).NE.KOLOR) MAKEBRAND(BRAND)=0                          1470
C                                                                             1500
C         DECIDE WHICH MACHINES ARE TO BE USED,CALLED 'MACHINUSE'             1502
C         DECIDE HOW MANY MOULD PLACES ARE AVAILABLE                          1505
C                                                                             1507
      MACHPLACES,HALFWEEKMCS=0                                                1510
      J=1                                                                     1513
      GROUPPLACESFILLED(1)=0                                                  1520
C         THESE ARE USED IN 'DESIRE' NOT THE MAIN PROGRAM                     1523
      DO 430 I=1,NMACH                                                        1530
      MACH=ISTMACH(I)                                                         1540
      IF (MACHCOLOUR(MACH)-KOLOR) 430,0,430                                   1545
      MLDSPACES(MACH)=MLDPLACES(MACH)*2                                       1550
      MACHPLACES=MACHPLACES + MLDSPACES(MACH)                                 1555
      MACHINUSE(J)=MACH                                                       1560
      J=J+1                                                                   1565
  430 GROUPPLACESFILLED(I+1)=0                                                1580
      IF (MACHPLACES) 1600,1600,0                                             1583
      IF (MCSTHISCOLOUR-NMACH)     0,480,999                                  1590
C                                                                             1700
C          IF DIFFERENT MACHINES CONTAIN DIFFERENT COLOURS THEN THIS           1702
C          REARRANGES 'INMACH' SO THAT THE CURRENT COLOUR IS FIRST.            1704
C          VALID FOR UP TO 3 MOULDS.                                          1706
C         THIS LOOKS AT THE COLOUR EACH MOULD WILL MAKE, AND MOVES            1708
C         THE MOULD TO THE BACK IF WRONG AND TO THE FRONT IF RIGHT            1710
      DO 450 SIZE=MINSIZE,MAXSIZE                                             1720
      NEXTMLD=ASSIGN(SIZE)+1                                                  1725
      DO 450 MLD=ASSIGN(SIZE)+1,3                                             1730
      MACH=INMACH(SIZE,MLD)                                                   1740
      INMACH(SIZE,MLD)=0                                                      1745
      IF (MACH) 450,450,0                                                     1755
      IF (MACHCOLOUR(MACH)-KOLOR) 0,440,0                                     1760
      INMACH(SIZE,6-MLD)=MACH                                                 1770
      GO TO 450                                                               1775
```

```
                                                                        1780
  440 INMACH(SIZE,NEXTMLD)=MACH                                         1785
      NEXTMLD=NEXTMLD+1                                                 1795
  450 CONTINUE                                                           1990
  480 WRITE(30,9400) WEEK,KOLOR,MCSTHISCOLOUR,                          19901
     1               (MACHINUSE(I),I=1,MCSTHISCOLOUR)                   2000
C                                                                       2006
C                                                                       2030
      DO 510 SIZE=MINSIZE,MAXSIZE                                       2032
      COVERS(SIZE)=ONEMILLION                                            2035
      IF (NUMBOFMLDS(SIZE)) 510,510,0                                    2040
      NEXTRAMLDS(SIZE)=0                                                 2050
      IHALF(SIZE)=0                                                      2060
      CALL PRODUCTCOVER(SIZE,COVERS(SIZE),BRAND,MATERIAL)                2070
      EXTRACOST(SIZE)=ALTERCOST*MATERIAL                                 2085
  510 CONTINUE                                                           2110
      IF (SIGN.NE.0) CALL REARRANGE                                      2130
      DO 530 NUM=1,MCSTHISCOLOUR                                         2135
      MAXOLD=MAX                                                         2140
      MACH=MACHINUSE(NUM)                                                2150
      MAX=MAXDESIRESIZE(MACH)                                            2160
      KTOPRANGE(NUM)=MAXOLD + (7+MAX-MAXOLD)/5                           2166
C        THIS IS WEIGHTED TOWARDS THE LARGEST SIZE FOR SMALLER MACHINE   2180
  530 CONTINUE                                                          2210
      KTOPRANGE(MCSTHISCOLOUR+1)= MAXSIZE+1                             2213
      KTOPRANGE(1)= MAXDESIRESIZE(MACHINUSE(1))/2                       2218
      MACHINUSE(MCSTHISCOLOUR+1) = MACHINUSE(MCSTHISCOLOUR)              2220
      IF (SPREAD) 610,610,0                                              2230
      IF (MCSTHISCOLOUR-2) 540,0,540                                     2240
      KSPREAD=SPREAD                                                    2260
      KDIFFERENCE=MAX-MAXOLD                                             2265
      IF (KSPREAD - KDIFFERENCE*5) 0,0,540                              2270
      IF (KSPREAD.LE.KDIFFERENCE) KSPREAD=KDIFFERENCE  +1               2275
      KTOPRANGE(1)=MAX     - 2*(KSPREAD+1)/3                            2280
      KTOPRANGE(2)=MAXOLD +     KSPREAD    /3                            2285
C        THIS COVERS A COMMON '704' CASE WITH TWO MACHINES               2288
C        BUT A LOW SPREAD OF SIZES WANTED                               2500
C                                                                       2501
C        NOW CALCULATE THE EFFECT OF RUNNING EACH SIZE WITH THE OTHERS  2502
C                 ADJUST THE PRIORITY FOR OTHER SIZES IN THE MACHINES   2504
C                                                                       2510
  540 NUM=1                                                             2512
      I=2                                                               2515
      MACH1,MACH2=MACHINUSE(1)                                          2520
      DO 590 SIZE=MINSIZE,MAXSIZE                                        2530
      IF (NUMBOFMLDS(SIZE)) 590,590,0                                   2535
      IF (SIZE.LT.KTOPRANGE(NUM)) GO TO 550                             2540
      NUM,I=NUM+1                                                       2555
      MACH1=MACH2                                                       2560
      MACH2=MACHINUSE(NUM)                                              2565
  550 MLD=ASSIGN(SIZE) + 1                                              2570
      MACH=INMACH(SIZE,MLD)                                             2575
C        IF 'SIZE' IS IN AN UNSUITABLE MACHINE, REMOVE IT               2580
      IF (MACH.NE.MACH1.AND.MACH.NE.MACH2) MACH,INMACH(SIZE,MLD)=0      2585
      IF (MACH.EQ.0) MACH=MACH1                                         2640
C        COMPARE THE COST OF MAKING'SIZE'NOW,WITH THAT EXPECTED         2645
C        NORMALLY,WHEN'IXPMAX' IS THE LARGEST SIZE
```

```
      DUMMY=HALF                                                          2660
      IDUM= 20* (2*I-1) / (NCSTHISCOLOUR+2)                               2670
C        ***  CHOSEN TO FIT 1974 CIRCUMSTANCES  ***                       2675
  570 DIFF=(IDUM-SIZE)*DUMMY                                               2710
      COST=RANGEFACTOR*DIFF*DUMMY                                         2715
      IF (DIFF) 0,575,575                                                 2725
      COST=-4.*COST                                                       2730
      DIFF=-2.*DIFF                                                       2735
C        IF 'SIZE' IS ABOVE THE IDEAL SIZE IT IS PENALISED MORE HEAVILY   2740
  575 IF (DIFF.GE.SPREAD) COST=COST + (DIFF/SPREAD)**8                     2745
C        THERE IS NO ADDITION UP TO HALF THE MAXIMUM SPREAD                2750
      IF (DUMMY-ONE) 0,580,0                                              2760
      SUB=COST                                                            2765
      DUMMY=ONE                                                           2770
      IDUM=MAXDESIRESIZE(MACH)                                            2780
      GO TO 570                                                           2790
  580 IF (COST.GT.SUB) EXTRACOST(SIZE)=EXTRACOST(SIZE) + COST - SUB       2795
  590 CONTINUE                                                             2850
  610 WRITE(30,9300) DG,DF,COVERS,DI,DJ,EXTRACOST                          2890
      WRITE(30,9500) MAXDESIRESIZE,KTOPRANGE,SIGN                         2895
C                                                                          3000
C        CALCULATE THE BASIC PRIORITY                                      3003
C                                                                          3006
      DO 700 SIZE=MINSIZE,MAXSIZE                                          3040
      PRIOR(SIZE)=-THOUSAND                                               3050
      IF (COVERS(SIZE)-ONEMILLION) 0,700,700                              3070
      PRIOR(SIZE)=PRIORITY(SIZE)                                          3080
  700 CONTINUE                                                             3295
      WRITE(30,9300) DK,DP,PRIOR                                           3990
      IFLAG=2                                                             3993
C                                                                         4000
C                    NOW DECIDE WHICH SIZES TO MAKE                       4002
C        PICK SIZE OF HIGHEST PRIORITY AND ATTEMPT TO SCHEDULE IT          4002
C                                                                         4009
  850 TOPPRIOR=-500.                                                      4010
      IBESTSZE=0                                                          4013
      INDEX=2                                                             4016
      IF (MACHPLACES.LE.HALFWEEKMCS) INDEX=1                              4020
      DO 870 SIZE=MINSIZE,MAXSIZE                                         4050
      IF (TOPPRIOR-PRIOR(SIZE) ) 0,870,870                                4060
      IF (INMACH(SIZE,ASSIGN(SIZE)+1)) 0,0,860                            4065
C        CHECK THE MOULDCHANGE LIMIT HAS NOT BEEN EXCEEDED                 4070
C                    OR THAT ONE IS NECESSARY                              4075
      IF (IFLAG.NE.100.AND.MLDCHANGES.GE.MCHLIMIT) GO TO 870              4080
  860 TOPPRIOR=PRIOR(SIZE)                                                4085
      IBESTSZE=SIZE                                                       4090
  870 CONTINUE                                                            4095
C        IBESTSZE HAS THE HIGHEST PRIORITY, SO ASSIGN IT                  4105
      IF (IBESTSZE) 940,940,0                                             4115
      SIZE=IBESTSZE                                                       4120
      MLD=ASSIGN(SIZE) + 1 + IHALF(SIZE)                                  4130
C        DECIDE IF ONLY HALF A WEEK IS NEEDED                             4150
      IF (PATCHSIZE(SIZE)*PROPORTION(KOLOR).LE.                           4160
     1    PRODN*(HALF-NEXTRAMLDS(SIZE)) ) INDEX=1                         41601
  875 IF (INDEX.EQ.1.AND.NEXTRAMLDS(SIZE).GT.0) GO TO 920                 4190
C                                                                         4200
```

```
C          DETERMINE IF THERE IS A SUITABLE PLACE FOR 'IBESTSZE'                4202
C                                                                               4209
C                                                                                4210
      CALL DESIRE(IBESTSZE,MLD,INDEX)                                            4230
      IF (INDEX) 0,920,877                                                       4232
C          IF INDEX IS POSITIVE SIZE WILL BE MADE                               4235
C          IF INDEX IS NEGATIVE A HALF WEEK WILL BE MADE                        4240
      INDEX=1                                                                    4245
      GO TO 875                                                                  4310
  877 IHALF(SIZE)=INDEX-2 - IHALF(SIZE)                                          4312
C          IF INDEX IS 2 A FULL WEEK IS PLANNED                                 4315
C          IF INDEX IS 1 AN EXTRA HALF WEEK IS PLANNED                          4320
C          ADJUST IHALF(SIZE) APPROPRIATELY                                     4330
      ASSIGN(SIZE)=MLD                                                           4335
      NEXTRAMLDS(SIZE)=NEXTRAMLDS(SIZE) + 1 + IHALF(SIZE)                        4340
C          IF ONLY A HALF WEEK IS PLANNED THE EXTRA MOULD IS NOT NEEDED         4342
C          DONT COUNT AN EXTRA MOULD IF ONLY A HALF WEEK USE                    4350
      PRIOR(SIZE)=PRIORITY(SIZE)                                                 4360
      MACHPLACES=MACHPLACES - INDEX                                              4370
      IF (MACHPLACES) 999,1000,850                                               4400
C          THERE IS NO SUITABLE PLACE FOR 'IBESTSZE'                            4410
  920 PRIOR(IBESTSZE)= -1500                                                     4420
      IF (TOPPRIOR.GT.HUNDRED) WRITE(30,9800) IBESTSZE,TOPPRIOR                  4430
      GO TO 850                                                                  4460
  940 IF (IFLAG-100) 0,999,999                                                   4470
      IFLAG=100                                                                  4475
      GO TO 850                                                                  4490
 1000 NUM=1                                                                      4495
      WRITE(30,9300) DL,DP,PRIOR,DM,DP,TOPPRIOR                                  4500
C                                                                               4502
C          STARTING WITH THE LARGEST SIZES,PLACE THEM IN THE MOST               4505
C          CONVENIENT MACHINES WITH VACANT PLACES.                              4509
C                                                                               4510
      IFLAG=11                                                                   4520
      DO 1200 SIZE=MINSIZE,MAXSIZE                                               4530
      NMLD=ASSIGN(SIZE)                                                          4540
      IF (NMLD) 999,1200,0                                                       4545
      IF (IHALF(SIZE)) 1120,0,1200                                               4553
 1020 DO 1100 MLD=1,NMLD                                                         4560
      IF (INMACH(SIZE,MLD)) 1100,1040,1100                                       4575
 1030 NUM=NUM+1                                                                  4580
 1040 MACH=MACHINUSE(NUM)                                                        4610
      IF (MLDSPACES(MACH)) 999,1030,0                                            4620
      MLDSPACES(MACH)=MLDSPACES(MACH) - 2                                        4630
 1070 INMACH(SIZE,MLD)=MACH                                                      4635
 1100 CONTINUE                                                                   4645
      GO TO 1200                                                                 4700
C                                                                               4702
C          SECTION ON HALF WEEK RUNS                                            4704
C          FIND A SUITABLE SIZE TO FILL THE OTHER HALF WEEK                     4820
 1120 IF (BATCHSIZE(SIZE)*PROPORTION(KOLOR).LT.HALF*PRODN) IHALF(SIZE)=1         4890
 1200 CONTINUE                                                                   4905
C          NOW CLEAR FURTHER MOULDS OF THIS COLOUR                              4910
      DO 1250 SIZE=MINSIZE,MAXSIZE                                               4920
      IDUM,NEXTMLD=ASSIGN(SIZE) + 1                                              4925
      DO 1250 MLD=IDUM,5                                                         4930
 1210 MACH=INMACH(SIZE,MLD)
```

```
      INMACH(SIZE,MLD)=0                                                    4935
      IF (MACH) 1250,1250,0                                                  4940
      IF (MACHCOLOUR(MACH)- KOLOR) 0,1250,1250                              4945
C        THIS COLOUR HAS YET TO BE DONE. MOVE MOULD TO FRONT                 4950
      INMACH(SIZE,NEXTMLD)=MACH                                             4955
      NEXTMLD=NEXTMLD+1                                                     4960
 1250 CONTINUE                                                              4975
      WRITE(30,9600) DR,DS,ASSIGN,DT,DU,IHALF                               4990
C                                                                           5000
C        DETERMINE WHICH BRANDS ARE TO BE MADE,AND WRITE THESE OUT          5002
C                                                                           5009
      IFLAG=20                                                              5012
      DO 1500 MACH=1,5                                                      5020
      IF (MACHCOLOUR(MACH).NE.KOLOR.OR.MLDPLACES(MACH).LE.0) GO TO 1500     5025
      NUM=MACHPRODN(MACH)/2                                                 5028
      DO 1400 SIZE=MINSIZE,MAXSIZE                                          5030
C        COUNT THE NUMBER OF MOULDS OF SIZE 'SIZE' IN THIS MACHINE          5033
      NMLD=0                                                                5035
      DO 1320 MLD=1,3                                                       5040
 1320 IF (INMACH(SIZE,MLD).EQ.MACH) NMLD=NMLD+1                             5045
      IF (NMLD) 0,1480,0                                                    5050
C        'INDEX'IS A MEASURE OF WHOLE OR HALF WEEKS                         5060
      INDEX=2                                                               5062
      IF (IHALF(SIZE).NE.0) INDEX=1                                         5065
C                  DECIDE THE BRAND TO MAKE                                 5068
      IF (MCTYPE -MANGRP.EQ.608) IF (INMACH(SIZE,2)-MACH) 0,1360,0          5070
 1350 CALL PRODUCTCOVER(SIZE,COVER,BRAND,MATERIAL)                          5075
      IF (BRAND) 999,999,1370                                               5078
C  *NB*  ROUTINE FOR BRIGHT AND DULL WELLIES                                5080
C        NOTE THIS ROUTINE CAN ONLY BE ENTERED ONCE PER SIZE                5082
C        THE DUPLICATE MOULDS ONLY TAKE DUNLOP PRODUCTS                     5083
 1360 BRAND=1                                                               5085
C        THE SECOND WELLINGTON MOULD TAKES ONLY'DUNLOP' BRANDS              5085
      IF (SIZE.GT.7.AND.SIZE.EQ.2*(SIZE/2)) BRAND=3                         5090
      GO TO 1400                                                            5095
C        IF THE BATCH-QUANTITY REQUIRED IS BELOW 2/3 WEEK'S PRODN           5113
C        THEN MAKE TWO BRANDS,IF DESIRABLE                                  5115
 1370 IF (INDEX.EQ.1.OR.NEXTRAMLDS(SIZE).GE.1) GO TO 1400                   5120
      IF (BATCHSIZE(SIZE)*FRACTION(SIZE,BRAND)-THOUSAND*PRODN) 0,0,1400     5125
      INDEX=1                                                               5128
      NMLD=NMLD*2                                                           5130
 1400 MPRODUCE(BRAND)=MPRODUCE(BRAND)+ INDEX                                5135
C        ADJUST 'FREESTOCKS' AND MATERIAL AVAILABILITY                      5150
      FREESTOCK(SIZE,BRAND)=FREESTOCK(SIZE,BRAND) + INDEX*NUM               5155
      MATAVAIL(SIZE,BRAND)=MATAVAIL(SIZE,BRAND) - INDEX*NUM                 5165
      NMLD=NMLD-1                                                           5170
      IF (NMLD) 0,0,1350                                                    5177
C                                                                           5200
C        WRITE OUT PLANNED PRODUCTION FOR THAT MACHINE AND WEEK             5202
C                                                                           5209
      DO 1420 BRAND=1,NBRAND                                                5220
      IF (MPRODUCE(BRAND)) 1420,1420,0                                      5230
      WRITE(20,9100) MCTYPE,MACH,MANGRP,MKPERIOD,SIZE,                      5240
     1               BRAND,WEEK,MPRODUCE(BRAND)                             52401
 9100 FORMAT(2A4,4H0002,6A4)                                                5245
 1420 MPRODUCE(BRAND)=0                                                     5250
```

```
      IF (IHALF(SIZE).EQ.1) INMACH(SIZE,ASSIGN(SIZE)) =-1                    5270
 1480 CONTINUE                                                               5290
C                                                                            5300
C         NOW WRITE OUT MACHINE DETAILS                                      5305
      WRITE(20,9200) MCTYPE,MACH,WEEK,MANGRP,KOLOR,MACHPRODN(MACH)           5320
 9200 FORMAT(2A4,4HU001,4A4,8H          )                                    5325
 1500 CONTINUE                                                               5340
C         PROCEED TO NEXT COLOUR OR WEEK                                     5360
 1600 IF (NMACH-1) 100,100,510                                               5390
  999 WRITE(30,9999) MCTYPE,MANGRP,WEEK,IFLAG                                5410
 9999 FORMAT(////20X,23HRUN ABANDONED FOR GROUP,I5,I2,8H IN WEEK,I3/          5430
     1    30X,22HDUE TO INTERNAL ERROR ,I4/1H1)                             54301
      WEEK=510                                                               5450
      GO TO 100                                                              5470
  990 ENDFILE 20                                                             5510
      STOP                                                                   5550
      END                                                                    5580

END OF SEGMENT, LENGTH  1961, NAME  IM40
```

```
      SUBROUTINE INPUT1                                                  6000
      INTEGER SIZE,BRAND,PRODN,WEEK,WEEKSLEFT,SIGN                       6100
      INTEGER REQMENT,FREESTOCK,SIZEROLL ,ASSIGN                         6110
      INTEGER FORM,DESCRIPTION                                           6115
      LOGICAL SHORTRUN,OUTPUTREQ                                         6120
      DIMENSION ICLEAR(2397),CLEAR(57)                                   6125
      COMMON/ASSORTED/ CHNGCOST,ALTERCOST,COLOURADV,VALFREESTCK          6130
     1    , RELATIVEFREE,IFREE,VALCHANGE                                61301
     2    , SHORTRUN,OUTPUTREQ                                          61302
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION 6135
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR            6140
     1    , NMACH,MCSTHISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)       61401
     2    , FREESTOCK(37,10),SIZEROLL(37,10),REQMENT(37,26)              61402
     3    , INMACH(37,5),MATAVAIL(37,10)                                 61403
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                     61404
      COMMON/BLOCK1/ FREE,SPREAD,REQTOPROD,LAP,INCREASE,SIGN,MCHLIMIT    6150
     1    ,MAXDESIRESIZE(6),ISTMACH(6),WEIGHT,RANGEFACTOR                61501
     2    , ENITIALREQ(10),TOTALREQ(10),PROPORTION(10),COMPART(27)       61502
     3    , NWEEKSTOSTART,NWEEKAFTERPLAN,LASTWEEKOFPLAN,LASTWEEKOFREQ    61503
     4    , NCOLOUR,NUMSIZE,NBRANDSIZES                                  61504
      COMMON/BLOCK2/ KEY(6),IBUFFER(40),INPUTRECS,INPUTACC,IREJECTED     6160
      EQUIVALENCE(ICLEAR(1),KOLOUR(1))                                   6170
      EQUIVALENCE(CLEAR(1),ENITIALREQ(1))                                6175
C                                                                        6300
C          THIS ROUTINE STORES ALL INITIAL INPUT DATA                    6302
C            (WEEKLY INFORMATION - SEE INPUT2)                           6303
C                                                                        6309
C                                                                        6310
C          KEY CONTAINS CHECK INFORMATION - VALIDATE EACH RECORD         6312
      WRITE(30,1005)                                                     6313
 1005 FORMAT(1H1)                                                        6315
      WEEK=510                                                           6320
   20 IF (KEY(2)) 950,90,0                                               6325
      IF (KEY(2)-MCTYPE) 100,0,100                                       6330
      IF (KEY(3)-MANGRP) 100,0,100                                       6335
      IF (KEY(4)-WEEK-1) 0,0,900                                         6340
      IF (KEY(5)-10) 0,0,900                                             6342
C          ACCEPTABLE RECORDS SHOULD PASS ALL THESE TESTS                6345
      BRAND=KEY(6)                                                       6347
      ISET=KEY(5)                                                        6348
      GO TO (200,300,400,450,500,550,600,550,700,750) ,ISET              6350
C          RECORD TYPE  INVALID OR OUT OF SEQUENCE                       6352
   50 IREJECTED=IREJECTED+1                                              6355
      WRITE(30,1003) KEY                                                 6357
 1003 FORMAT(///24H ** REJECTION ** - KEYS ,A4,5I4/ )                    6359
      GO TO 90                                                           6360
C          RECORD ACCEPTED                                               6362
   70 INPUTACC=INPUTACC+1                                                6365
      IF (OUTPUTREQ) WRITE(30,1002) KEY,IBUFFER                          6368
 1002 FORMAT(1X,A4,2514/25X,2014/  )                                     6370
      WEEK=KEY(4)                                                        6375
   90 READ (10,1001) KEY,IBUFFER                                         6377
 1001 FORMAT(46A4)                                                       6380
      INPUTRECS=INPUTRECS+1                                              6383
      GO TO 20                                                           6400
C                                                                        6402
C          PREPARE FOR NEW MANGRP
```

```
  100 IF (INPUTRECS-1) 0,170,0                                          6410
      DO 110 I=1,2397                                                   6420
  110 ICLEAR(I)=0                                                       6425
C         SET ALL LARGE ARRAYS TO ZERO                                  6430
      DO 120 I=1,57                                                     6435
  120 CLEAR(I)=0.                                                       6440
  170 MCTYPE=KEY(2)                                                     6480
      MANGRP=KEY(3)                                                     6485
      OUTPUTREQ=.TRUE.                                                  6490
      DO 180 I=1,37                                                     6491TE
  180 NUMBOFMLDS(I)=2                                                   6492TE
      GO TO 20                                                          6495
C                                                                       6500
C         PROCESS 'BSIC' RECORD                                         6502
  200 NWEEKSTOSTART=IBUFFER(1)                                          6510
      LASTWEEKOFPLAN= IBUFFER(2)                                        6513
      NWEEKAFTERPLAN= IBUFFER(3)                                        6516
      LASTWEEKOFREQ = LASTWEEKOFPLAN + NWEEKAFTERPLAN                   6519
      SHORTRUN= IBUFFER(4).EQ.1                                         6522
      NMACH=IBUFFER(6)                                                  6525
      LAP  =IBUFFER(7)                                                  6528
      REQTOPROD= IBUFFER(8) *THOUSANDTH                                 6530
      COLOURADV= IBUFFER(9)                                             6533
      FREE =IBUFFER(10)*THOUSANDTH                                      6536
      IFREE= IBUFFER(11)                                                6538
      DO 220 I=1,27                                                     6540
  220 CUMPART(I)= IBUFFER(41-I)*THOUSANDTH                              6543
      IF (LASTWEEKOFREQ.GT.26) LASTWEEKOFREQ=26                         6546
      WEEK=NWEEKSTOSTART                                                6549
      GO TO 70                                                          6550
C                                                                       6600
C         PROCESS 'MCDA' RECORD                                         6602
  300 PRODN= IBUFFER(1)                                                 6610
      DO 320 I=1,5                                                      6620
      ISTMACH(I)  = IBUFFER(I+6)                                        6625
      MAXDESIRESIZE(I)= IBUFFER(I+11)                                   6628
  320 CONTINUE                                                          6630
C         READ IN COST INFORMATION - USED TO DECIDE THE PRIORITIES OF   6640
C         MOULD CHANGES,COLOUR CHANGES AND WIDER SPREADS.               6641
      CHNGCOST= IBUFFER(22)                                             6643
      RANGEFACTOR= IBUFFER(24)*THOUSANDTH                               6645
      SPREAD  = IBUFFER(25)*.7                                          6646
C         ONLY EXCEED MOULD CHANGE LIMIT IF, AFTER THE PERMITTED NO.    6650
C         OF CHANGES, IT IS IMPOSSIBLE TO FILL THE REMAINING PLACES     6651
C         WITH SIZES THAT WERE MADE LAST WEEK                           6652
      MCHLIMIT= IBUFFER(26)                                             6654
C         MAXDESIRESIZE GIVES THE LARGEST SIZE DESIRED IN EACH MACHINE  6660
C         WITH AN EXPECTED SPREAD OF A THIRD 'SPREAD' ABOVE AND TWO-THIRD 6661
C         BELOW.                                                        6662
C         'WEIGHT' GIVES THE RELATIVE EMPHASIS OF THE CURRENT LARGEST SZE 6663
C         AND THE FORMER VALUE.                                         6664
C         'WEIGHT'=0 GIVES A CONSTANT VALUE TO MAXDESIRESIZE AS INPUT   6665
C         'SIGN' IS NORMALLY ZERO;BUT,IF + OR -1, THIS INDICATES THAT THE 6666
C         MAXDESIRESIZE WILL SHIFT AS THE SET OF SIZES IN THE MACHINE   6667
C         SNAKES UP AND DOWN THE SIZE RANGE.                            6668
      WEIGHT= IBUFFER(27)*THOUSANDTH                                    6670
```

```
      SIGN   = IBUFFER(29)                                                  6672
C        STORE INFORMATION ABOUT BRANDS AND SIZES                          6680
      NCOLOUR= IBUFFER(35)                                                  6682
      NBRAND = IBUFFER(36)                                                  6683
      NUMSIZE= IBUFFER(37)                                                  6684
      NBRANDSIZES= IBUFFER(38)                                              6686
      MINSIZE= IBUFFER(39)                                                  6687
      MAXSIZE= IBUFFER(40)                                                  6688
      GO TO 70                                                              6697
C                                                                           6700
C        PROCESS 'STKS' RECORD                                              6702
C                                                                           6709
  400 CALL STORE(FREESTOCK(1,BRAND))                                        6710
      GO TO 70                                                              6715
C                                                                           6730
C        PROCESS 'SZRL' RECORD                                              6732
  450 CALL STORE(SIZEROLL(1,BRAND) )                                        6735
      GO TO 70                                                              6738
C                                                                           6760
C        PROCESS 'REQS' RECORD                                              6762
  500 LISTNO(BRAND)= IBUFFER(1)                                             6765
      KOLOUR(BRAND),KOLOR= IBUFFER(2)                                       6768
      ENITIALREQ(BRAND)= IBUFFER(3)*THOUSANDTH                              6772
      TOTALREQ(BRAND)  = IBUFFER(4)*THOUSANDTH                              6775
      PROPORTION(KOLOR)= IBUFFER(5)/THOUSAND                                6778
      GO TO 70                                                              6780
C                                                                           6800
C        UNUSED AT PRESENT - REJECT IF THESE OCCUR                          6806
  550 GO TO 50                                                              6810
C        PROCESS 'PROD'                                                     6820
C                                                                           6821
C        NO PROCESSING AT PRESENT                                           6823
C        COULD BE USED TO FORCE CERTAIN PROGRAMMES                          6824
C        UNTIL THEN REJECT                                                  6825
  600 GO TO 50                                                              6830
C                                                                           6850
C        PROCESS 'FORC' RECORD                                              6852
  700 CALL STORE(MACHFORCE)                                                 6855
      GO TO 70                                                              6857
C                                                                           6870
C        PROCESS 'MLDS' RECORD                                              6872
  750 CALL STORE(NUMBOFMLDS)                                                6875
      GO TO 70                                                              6877
C        CURRENT RECORD IS FOR LATER PROCESSING                             6900
C        REJECT RECORD IF NONE ACCEPTED YET,OTHERWISE RETURN                6902
  900 IF (WEEK.EQ.510) GO TO 50                                             6910
      RETURN                                                                6920
C        'END' RECORD READ AND PROCESSING FINISHED                          6950
  950 MCTYPE= KEY(2)                                                        6960
      WRITE(30,1004) INPUTRECS,INPUTACC,IREJECTED                           6970
 1004 FORMAT(1H1,40X,12HRECORDS READ,I5/45X,8HACCEPTED,I5/                  6975
     1   45X,8HREJECTED,I5/50X,8HEND     1  )                              69751
      RETURN                                                                6980
      END                                                                   6990
```

```
      SUBROUTINE INPUT2                                                  7000
      INTEGER FORM,DESCRIPTION                                           7110
      INTEGER SIZE,BRAND,PRODN,WEEK                                      7120
      INTEGER REQMENT,FREESTOCK,FRACTION ,ASSIGN                         7130
      LOGICAL SHORTRUN,OUTPUTREQ                                         7135
      COMMON/ASSORTED/ CHNGCOST,ALTERCOST,COLOURADV,VALFREESTCK          7140
     1    , RELATIVEFREE,IFREE,VALCHANGE                                71401
     2    , SHORTRUN,OUTPUTREQ                                          71402
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION 7150
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR            7160
     1    , NMACH,NCSTHISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)      71601
     2    , FREESTOCK(37,10),FRACTION(37,10),REQMENT(37,26)             71602
     3    , INMACH(37,5),MATAVAIL(37,10)                                71603
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                    71604
      COMMON/BLOCK2/ KEY(6),IBUFFER(40),INPUTRECS,INPUTACC,IREJECTED     7170
      COMMON/BLOCK5/ WEEK,KWEEK,MKCOLOR,MACHCOLOUR(6)                    7180
     1    , MLDPLACES(6),MACHPRODN(6)                                   71801
C                                                                        7300
C         THIS ROUTINE CHECKS ALL WEEKLY INPUT DATA                      7302
C                                                                        7309
C         KEY CONTAINS CHECK INFORMATION                                 7311
C         ONLY PROCESS INFORMATION FOR CURRENT MCTYPE,MANGRP AND WEEK    7313
   20 IF (WEEK.LT.KWEEK) GO TO 920                                       7320
      IF (MCTYPE.NE.KEY(2).OR.MANGRP.NE.KEY(3)) GO TO 900                7325
      IF (KEY(5)-11) 300,50,0                                            7330
      BRAND=KEY(6)                                                       7335
      IF (KEY(5)-13) 50,400,0                                            7338
      IF (KEY(5)-15) 500,600,0                                           7342
C         RECORD TYPE INVALID OR OUT OF SEQUENCE                         7350
   50 IREJECTED=IREJECTED+1                                              7355
      WRITE(30,1003) KEY,WEEK                                            7360
 1003 FORMAT(///24H ** REJECTION ** - KEYS ,A4,5I4,6H  WEEK,I3/)         7365
      GO TO 150                                                          7370
C                                                                        7400
C         RECORD ACCEPTED                                                7402
  100 INPUTACC=INPUTACC+1                                                7410
      IF (OUTPUTREQ) WRITE(30,1002) KEY,IBUFFER                          7415
 1002 FORMAT(1X,A4,I4,I2,3I3,2(20I5/20X) )                               7420
C         READ IN NEXT RECORD                                            7430
  150 READ(10,1001) KEY,IBUFFER                                          7433
 1001 FORMAT(46A4)                                                       7437
      KWEEK=KEY(4)                                                       7440
      INPUTRECS=INPUTRECS+1                                              7444
      GO TO 20                                                           7448
  300 IF (KEY(5).EQ.4.AND.KWEEK.EQ.WEEK) GO TO 900                       7450
C         IF A SIZEROLL CARD MAY BE FOR CONTINUATION OF THIS GROUP       7452
      IF (KEY(5)-9) 50,310,330                                           7455
C         PROCESS 'FORC' RECORD                                          7460
  310 CALL STORE(MACHFORCE)                                              7463
      GO TO 100                                                          7467
C                                                                        7480
C         PROCESS 'MLDS' RECORD                                          7482
  330 CALL STORE(NUMBOFMLDS)                                             7484
      GO TO 100                                                          7487
C                                                                        7500
C         PROCESS 'MCLD' RECORD   - NOTE BRAND IS A MACHINE NO.          7502
```

```
  400 MACH=BRAND                                                          7510
      DO 450 SIZE=MINSIZE,MAXSIZE                                         7520
      NUM=IBUFFER(SIZE)                                                   7525
      IF (NUM) 450,450,0                                                  7528
      DO 430 MLD=1,NUM                                                    7532
      INMACH(SIZE,MLD+1)=INMACH(SIZE,MLD)                                 7535
  430 INMACH(SIZE,MLD)  =MACH                                             7538
C        MOVE CURRENT MOULD OUT TO NEXT MACHINE                           7536
  450 CONTINUE                                                            7545
      GO TO 100                                                           7549
C                                                                         7600
C        PROCESS 'MATS' RECORD                                            7602
C        MATERIAL AVAILABILITY IS ADDITIVE                                7606
C                                                                         7609
  500 DO 530 SIZE=MINSIZE,MAXSIZE                                         7620
      MATAVAIL(SIZE,BRAND)= MATAVAIL(SIZE,BRAND) + IBUFFER(SIZE)          7625
  530 CONTINUE                                                            7630
      GO TO 100                                                           7635
C                                                                         7700
C        PROCESS 'WKLY' RECORD                                            7702
  600 MKCOLOR= IBUFFER(16)                                                7710
      ALTERCOST= IBUFFER(39)                                              7715
      RELATIVEFREE= IBUFFER(40)*THOUSANDTH                                7720
      IF (ALTERCOST.LT.50.) ALTERCOST=ALTERCOST/VALFREESTCK               7725
      DO 630 MACH=1,5                                                     7740
      MLDPLACES(MACH)= IBUFFER(MACH)                                      7743
      MACHPRODN(MACH)= IBUFFER(MACH+5)                                    7746
      MACHCOLOUR(MACH)=IBUFFER(MACH+10)                                   7749
  630 CONTINUE                                                            7751
      IF (IBUFFER(17)) 680,100,0                                          7754
C        CLEAR MOULDS FROM ANY EMPTY MACHINES                             7762
      DO 660 SIZE=MINSIZE,MAXSIZE                                         7770
      NMLD=NUMBOFMLDS(SIZE)                                               7772
      IF (NMLD) 660,660,0                                                 7775
      DO 650 NUM=1,NMLD                                                   7777
      MLD=NMLD+1-NUM                                                      7780
      MACH= INMACH(SIZE,MLD)                                              7782
      IF (MACH) 650,650,0                                                 7784
      IF (MLDPLACES(MACH)) 0,0,650                                        7786
C        IF NO PLACES IN THE MACHINE, THEN RELEASE THE MOULD              7787
      DO 640 IDUM=MLD,NMLD                                                7790
  640 INMACH(SIZE,IDUM)=INMACH(SIZE,IDUM+1)                               7792
  650 CONTINUE                                                            7794
  660 CONTINUE                                                            7796
      GO TO 100                                                           7799
C        IF THERE IS AN INTERVAL BETWEEN SCHEDULES,IT IS ASSUMED          7802
C        THAT THE MOULDS ARE REMOVED                                      7803
  680 DO 690 SIZE=MINSIZE,MAXSIZE                                         7810
      DO 690 MLD=1,5                                                      7815
  690 INMACH(SIZE,MLD)=0                                                  7820
      GO TO 100                                                           7825
C        FOR FUTURE MAN.GRP - NO MORE INPUTS FOR THIS GROUP               7902
  900 KWEEK=520                                                           7915
  920 RETURN                                                              7920
      END                                                                 7995
```

```
      FUNCTION PRIORITY(SIZE)                                                  8000
      INTEGER SIZE,BRAND,PRODN,WEEK,WEEKSLEFT,SIGN                             8010
      INTEGER REQUENT,FREESTOCK,FRACTION ,ASSIGN                               8020
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR                  8060
     1    , NMACH,COSTRISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)             80601
     2    , FREESTOCK(37,10),FRACTION(37,10),REQMENT(37,26)                    80602
     3    , INMACH(37,5),MATAVAIL(37,10)                                       80603
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                           80604
      COMMON/BLOCK1/ FREE,SPREAD,RENTOPROD,LAP,INCREASE,SIGN,MCHLIMIT          8070
     1    , MAXDESIRESIZE(6),ISTMACH(6),WEIGHT,RANGEFACTOR                     80701
     2    , ENITIALREQ(10),TOTALREQ(10),PROPORTION(10),CUMPART(27)             80702
      COMMON/BLOCK3/ MAKERRAND(10),COVERS(40),AVUSAGE(40)                      8080
     2    , BATCHSIZE(40),COVERINPRODN(40),EXTRACOST(40)                       80801
     2    , IHALF(40),MINNUMBOFMLDS(40),NEXTRAMLDS(40)                         80802
     3    , WEEKSLEFT,REQSLEFT                                                 80803
      COMMON/ASSORTED/ CHNGCOST,ALTERCOST,COLOURADV,VALFREESTCK                8090
     1    , RELATIVEFREE,IFREE,VALCHANGE                                       80901
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION       8100
C                                                                              8155
C        THIS FUNCTION EVALUATES THE BASIC PRIORITY OF MAKING                  8160
C        THE MOST NEEDED BRAND FROM THE MOULD 'SIZE' THIS WEEK                 8162
C                                                                              8165
C        THE CALCULATION OF THE PRIORITY DEPENDS ON THE PLANNING HORIZON       8180
C                  AND ON THE MACHINE STATUS                                   8181
C        IF 'SIZE'IS NOT IN ANY MACHINE,THE PRIORITY DEPENDS ONLY ON           8183
C        THE WEEKS COVER PROVIDED BY THE CURRENT STOCK                         8184
C                                                                              8186
C        OTHERWISE WITH A LONG HORIZON,THE PRIORITY IS INCREASED               8188
C        SO IT REMAINS POSITIVE IF STOCKS ARE BELOW THEIR DESIRED              8189
C        MAXIMUM, TWICE THE AVERAGE STOCK.                                     8190
C        WITH A SHORT HORIZON THE TOTAL QUANTITY STILL NEEDED IS               8192
C        ESTIMATED, THE PRIORITY IS FOUND BY COMPARING THE ALTERNATIVES        8193
C        OF MAKING THEM ALL NOW WITH THAT OF HAVING ANOTHER BATCH              8194
C                                                                              8195
      EXCESS(A)=A+A+COVERINPRODN(SIZE)*RELATIVEFREE + VALCHANGE                8210
      MLD=ASSIGN(SIZE) + IHALF(SIZE) + 1                                       8310
      IF (MLD-NUMBOFMLDS(SIZE)) 0,0,800                                        8320
      DUMMY= PRODN/AVUSAGE(SIZE)                                               8350
      EXTRACOVER=DUMMY*NEXTRAMLDS(SIZE)                                        8355
      COVER=COVERS(SIZE)+ EXTRACOVER/PROPORTION(KOLOR)                         8357
      IF (IHALF(SIZE).LT.0) COVER=COVER+HALF*DUMMY/PROPORTION(KOLOR)           8360
      MACHSTATUS=0                                                             8370
      IF (INMACH(SIZE,MLD).GT.0) MACHSTATUS=1                                  8375
      IF (NEXTRAMLDS(SIZE)- MINNUMBOFMLDS(SIZE)) 250,0,300                     8410
   30 IF (COVER) 120,120,0                                                     8420
C        PROVIDE HIGH PRIORITY IF NEGATIVE COVER                               8422
      IF (MACHSTATUS.GT.0.AND.LAP.GT.REQSLEFT) GO TO 400                       8430
      IF (NEXTRAMLDS(SIZE)) 0,0,350                                            8440
   40 IF (COVER.GE.REQSLEFT) COVER=EXCESS(COVER)                               8460
C        CALCULATE PRIORITY FOR NORAAL CASES                                   8500
   50 PRIOR=COVERINPRODN(SIZE)*RELATIVEFREE*MACHSTATUS - COVER                 8510
      IF (PRIOR + .2*COVER - EXTRACOST(SIZE)) 150,0,0                          8530
      PRIORITY= TEN + (PRIOR-EXTRACOST(SIZE))/COVER                            8540
      RETURN                                                                   8545
  120 PRIOR= HUNDRED + TEN*(MACHSTATUS - COVER)                                8560
  150 IF (EXTRACOST(SIZE).GT.190) PRIOR=PRIOR/HUNDRED                          8580
```

```
      PRIORITY=PRIOR - EXTRACOST(SIZE)                                  8585
      RETURN                                                            8590
C        ASSIGN UP TO MINIMUM NUMBER OF MOULDS                          8600
  250 IF (NMACH-MCSTHISCOLOUR*2) 0,30,30                                8610
      PRIOR=500.                                                        8620
      GO TO 150                                                         8630
C        EVALUATE THE PRIORITY WHEN THE MOULD IS SURPLUS                8645
C        IF AFTER 3 MORE WEEKS WITH PRODUCTION AT CURRENT RATE          8646
C        THERE WILL STILL BE A SHORTAGE  THEN TREAT AS URGENT           8647
C        CLEAR ANY DEFICIT BY SCHEDULE END. (HORIZON THEN BELOW 3)      8648
C        OTHERWISE PENALISE FOR ANY MOULDCHANGES NEEDED                 8649
  300 HORIZON= WEEKSLEFT-1                                              8650
      IF  (HORIZON.GT.3)  HORIZON=3                                     8652
      COVER=COVER + EXTRACOVER*HORIZON*REQTOPROD                        8655
      IF (COVER-HORIZON) 120,120,0                                      8660
      IF (COVER.GT.REQSLEFT) COVER=EXCESS(COVER)                        8665
      PRIOR= (MACHSTATUS-ONE)*VALCHANGE - COVER                         8670
      GO TO 150                                                         8690
C        THIS IS A DUPLICATE MOULD BUT OF A SIZE WHERE DUPLICATES       8700
C        ARE NEEDED. IF MOULD IS NEEDED TREAT AS URGENT                 8702
C        OTHERWISE ESTIMATE WHEN THE DUPLICATE WILL NEXT BE REQUIRED    8705
  350 DUM= COVER + (WEEKSLEFT-1)*EXTRACOVER                             8720
      COVER=COVER/( ONE -EXTRACOVER)                                    8730
      IF (COVER.GT.DUM) COVER=DUM                                       8740
      GO TO 40                                                          8745
C                                                                       8800
C        THE END IN MIND, THERE WILL EITHER BE ONE MORE BATCH OR NONE   8803
C        NEAR THE END OF A SCHEDULE CALCULATE THE PRIORITY WITH         8802
C                                                                       8808
  400 COVER=COVER + (WEEKSLEFT-1)*EXTRACOVER                            8810
      KVALUE=REQMENT(SIZE,1)/PRODN                                      8815
      IF (KVALUE*PRODN.NE.REQMENT(SIZE,WEEKSLEFT) ) GO TO 430           8820
      MOULDSNEEDED=(WEEKSLEFT-1)*KVALUE - IFIX(COVER/DUMMY)             8830
      IF (MOULDSNEEDED) 0,0,450                                         8835
      COVER=REQSLEFT - MOULDSNEEDED*DUMMY                               8840
C        IF NO MORE MOULDS NEEDED SET EXCESS COVER                      8848
  430 IF (COVER.GE.REQSLEFT) GO TO 40                                   8860
      MOULDSNEEDED= 1+ (REQSLEFT-COVER)/DUMMY                           8870
  450 IF (MOULDSNEEDED.GT.WEEKSLEFT) GO TO 480                          8890
C        IF ONLY ONE MORE BATCH IS TO BE MADE THE SAVING IS THE VALUE   8901
C        OF A MOULD CHANGE DIVIDED BY THE REMAINING NUMBER OF MOULDS    8902
      DUM= VALCHANGE/MOULDSNEEDED                                       8910
C        IF THIS IS NOT THE LAST BATCH THERE MAY BE STILL BE AN         8911
C        ADVANTAGE BY CONTINUING THE CURRENT RUN. THIS IS THE NUMBER OF 8912
C        FURTHER MOULDS NEEDED TIMES THE SAVING MADE (=DUMMY WEEKS) BY  8913
C        DELAYING THE START OF THE NEXT BATCH                           8914
      PRIOR= (MOULDSNEEDED-1)*DUMMY                                     8920
      IF (PRIOR.LT.DUM) PRIOR=DUM                                       8922
      PRIOR=PRIOR-COVER                                                 8925
      IF (PRIOR - HUNDRED) 150,150,0                                    8930
  480 PRIOR=HUNDRED                                                     8935
      GO TO 150                                                         8940
C        THERE ARE NO MORE MOULDS                                       8950
  800 PRIORITY= -2000.                                                  8960
      RETURN                                                            8990
      END                                                               8995
```

```
      GO TO 450
```

```
      SUBROUTINE DESIRE(SIZE,MLD,INDEX)                                  9000
      INTEGER SIZE,BRAND,PRODN                                           9110
      INTEGER REQMENT,FREESTOCK,FRACTION ,ASSIGN                         9115
      INTEGER GROUPPLACESFILLED                                          9120
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR            9140
     1    , NMACH,MCSTHISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)        91401
     2    , FREESTOCK(37,10),FRACTION(37,10),REQMENT(37,26)               91402
     3    , INMACH(37,5),MATAVAIL(37,10)                                  91403
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                      91404
      COMMON/BLOCK4/ MLDCHANGES,MLDSPACES(6),KTOPRANGE(7)                9170
     1    ,GROUPPLACESFILLED(6),MACHPLACES,HALFWEEKMCS                   91701
      IVEN(J)=4*(J/2)+1 -J-J                                             9190
C        IVEN IS +1 IF J EVEN, -1 IF J ODD                               9191
C                                                                        9199
C        THIS SUBROUTINE COUNTS THE REMAINING SPACES IN EACH MACHINE     9200
C                  AND ALSO THE MOULD CHANGES                            9202
C        IT REJECTS ANY SIZE FOR WHICH A SUITABLE MACHINE CANNOT BE FOUND9204
C        THE SIZES ARE DIVIDED INTO GROUPS (KTOPRANGE) CHOSEN SO THAT    9206
C        THEIR MEMBERS ARE SUITABLE FOR EITHER OF TWO MACHINES           9208
C                                                                        9209
      MLDCH=0                                                            9210
      MACH=INMACH(SIZE,MLD)                                              9220
      IF (MACH) 0,0,40                                                   9230
      MLDCH=1                                                            9240
      MACH=MACHFORCE(SIZE)                                               9260
      IF (MACH) 0 ,0,40                                                  9270
      IF (IVEN(INDEX)) 30,0,0                                            9280
C                                                                        9300
C        IF NO SPECIFIC MACHINE IS TO BE USED,FIND APPROPRIATE SIZE GP   9302
C                                                                        9308
      NUM=0                                                              9310
   20 NUM=NUM+1                                                          9320
      IF (SIZE.GT.KTOPRANGE(NUM)) GO TO 20                               9330
      GROUPPLACESFILLED(NUM)=GROUPPLACESFILLED(NUM) + INDEX              9350
      GO TO 50                                                           9360
   30 NUM=1 + ((SIZE-MINSIZE)*MCSTHISCOLOUR/(MAXSIZE-MINSIZE))           9363
      MACH=MACHINUSE(NUM)                                                9366
   40 MLDSPACES(MACH),I=MLDSPACES(MACH) - INDEX                          9370
      IF (MLDSPACES(MACH)) 45,0,0                                        9371
      IF (IVEN(INDEX)) 0,0,50                                            9372
      HALFWEEKMCS=HALFWEEKMCS - IVEN(I)                                  9374
C        HALFWEEKMCS IS THE NUMBER OF MACHINES WITH UNPAIRED HALF-SIZES  9375
C        REJECT 'SIZE' IF WE CANNOT PAIR ALL FUTURE HALF-SIZES           9377
      IF (MACHPLACES-HALFWEEKMCS) 0,0,50                                 9380
      HALFWEEKMCS=HALFWEEKMCS -1                                         9387
   45 IMPOSSIBLE=-1                                                      9389
      GO TO 250                                                          9393
C                                                                        9400
C        CHECK TO SEE IF THERE ARE MORE MOULDS IN ANY GROUP THAN         9401
C        AVAILABLE SPACES IN SUITABLE MACHINES.                          9402
C                                                                        9404
C        THIS INVOLVES SCANNING FIRST UPARDS,THEN DOWNWARDS              9407
C                                                                        9409
C                                                                        9410
   50 IF (MCSTHISCOLOUR-1) 300,300,0                                     9415
      INCLUSIVE,IMPOSSIBLE=0                                             9430
      DO 60 J=1,MCSTHISCOLOUR-1
```

GO TO 450

```
      INCLUSIVE=INCLUSIVE - GROUPPLACESFILLED(J)                          9435
      IF (INCLUSIVE.GT.0)  INCLUSIVE=0                                    9440
      INCLUSIVE=INCLUSIVE + MLDSPACES(MACHINUSE(J))                       9445
      IF (INCLUSIVE.LT.IMPOSSIBLE) IMPOSSIBLE=INCLUSIVE                   9450
   60 CONTINUE                                                            9455
      INCLUSIVE=0                                                         9460
      DO 80 I=2,MCSTHISCOLOUR                                             9620
      J=MCSTHISCOLOUR +2 -I                                               9625
      INCLUSIVE=INCLUSIVE - GROUPPLACESFILLED(J+1)                        9630
      IF (INCLUSIVE.GT.0)  INCLUSIVE=0                                    9635
      INCLUSIVE=INCLUSIVE + MLDSPACES(MACHINUSE(J))                       9640
      IF (INCLUSIVE.LT.IMPOSSIBLE) IMPOSSIBLE=INCLUSIVE                   9645
   80 CONTINUE                                                            9650
C                                                                         9700
C        IF 'IMPOSSIBLE' IS NEGATIVE THE MOULD WILL NOT FIT               9702
C        RETURN TO FORMER SITUATION, BUT EXCLUDE THIS MOULD               9704
C                                                                         9709
C                                                                         9710
  200 IF (IMPOSSIBLE)  0,300,0                                            9730
      IF (MACH) 0,0,250                                                   9740
      GROUPPLACESFILLED(NUM)=GROUPPLACESFILLED(NUM) - INDEX               9750
      GO TO 260                                                           9760
  250 MLDSPACES(MACH)=MLDSPACES(MACH) + INDEX                             9770
  260 INDEX=-INDEX - IMPOSSIBLE                                           9780
      RETURN                                                              9800
  300 MLDCHANGES=MLDCHANGES + MLDCH                                       9810
      INMACH(SIZE,MLD)=MACH                                               9820
      RETURN                                                              9830
      END

END OF SEGMENT, LENGTH   315, NAME  DESIRE
```

```
      SUBROUTINE SETUP(IOVERFLOW)                                          11000
      INTEGER REQMENT,FREESTOCK,SIZEROLL,FRACTION,ASSIGN                   11010
      INTEGER SIZE,BRAND,PRODN,WEEK,WEEKSLEFT,SIGN                         11013
      LOGICAL SHORTRUN,OUTPUTREQ                                           11014
      DIMENSION FRACTION(37,10)                                            11012
      DIMENSION CLEAR(200)                                                 11020
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR              11030
     1    , NMACH,MCSTRISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)         110301
     2    , FREESTOCK(37,10),SIZEROLL(37,10),REQMENT(37,26)                110302
     3    , INMACH(37,5),MATAVAIL(37,10)                                   110303
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                       110304
      COMMON/BLOCK1/ FREE,SPREAD,REQTOPROD,LAP,INCREASE,SIGN,MCHLIMIT      11040
     1    ,MAXDESIRESIZE(6),ISTMACH(6),WEIGHT,RANGEFACTOR                  110401
     2    , ENITIALREQ(10),TOTALREQ(10),PROPORTION(10),CUMPART(27)         110402
     3    , NWEEKSTOSTART,NWEEKAFTERPLAN,LASTWEEKOFPLAN,LASTWEEKOFREQ      110403
     4    , NCOLOUR,NUMSIZE,NBRANDSIZES                                    110404
      COMMON/BLOCK3/ MAKEBRAND(10),COVERS(40),AVUSAGE(40)                  11045
     2    , BATCHSIZE(40),COVERINPRODN(40),EXTRACOST(40)                   110451
     2    , IHALF(40),MINNUMBOFMLDS(40),NEXTRAMLDS(40)                     110452
     3    , WEEKSLEFT,REQSLEFT                                             110453
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION   11050
      COMMON/ASSORTED/ CHAGCOST,ALTERCOST,COLOURADV,VALFREESTCK             11055
     1    , RELATIVEFREE,IFREE,VALCHANGE                                   110551
     2    , SHORTRUN,OUTPUTREQ                                             110552
      EQUIVALENCE (SIZEROLL(1,1),FRACTION(1,1))                            11060
      EQUIVALENCE(COVERS(1),CLEAR(1))                                      11065
      EQUIVALENCE(COLOURADV,COLOURCHANGE)                                  11070
      DO 10 I=1,200                                                        11130
   10 CLEAR(I)=0.                                                          11140
      IXCESSTOCK,INITIALFREE=0                                             11160
C                                                                          11200
C         THIS SUBROUTINE PROCESSES THE INPUT DATA                         11201
C                  NOW CREATE THE REQUIREMENT FILE                         11203
C                                                                          11208
C                                                                          11210
      DO 200 SIZE=MINSIZE,MAXSIZE                                          11212
      INITSTOCK,KTOTAL=0                                                   11222
      DO 120 BRAND=1,NBRAND                                                11226
      KSIZEROLL=SIZEROLL(SIZE,BRAND)                                       11230
      IF (KSIZEROLL) 120,120,0                                             11234
      FREESTOCK(SIZE,BRAND),KSTOCK=FREESTOCK(SIZE,BRAND)-                  112341
     1        ENITIALREQ(BRAND)*KSIZEROLL                                  11236
      IDUM=TOTALREQ(BRAND)*KSIZEROLL                                       11242
      IF (KSTOCK-IDUM) 110,110,0                                           11244
      IXCESSTOCK=IXCESSTOCK + KSTOCK - IDUM                                11246
      KSTOCK=IDUM                                                          11248
  110 INITSTOCK=INITSTOCK + KSTOCK                                         11249
      KTOTAL=KTOTAL+IDUM                                                   11251
  120 CONTINUE                                                             11252
C         KTOTAL IS THE TOTAL REQUIREMENTS OF THIS SIZE OVER THE SCHEDULE  11254
C         INITSTOCK IS THE INITIAL STOCK AFTER ALLOWING FOR THE            11256
C         INITIAL REQUIREMENTS                                             11260
      IF (KTOTAL) 0,200,0                                                  11266
      INITIALFREE=INITIALFREE + INITSTOCK                                  11275
      DO 140 BRAND=1,NBRAND                                                11280
  140 FRACTION(SIZE,BRAND)=SIZEROLL(SIZE,BRAND) *TOTALREQ(BRAND)           112801
     1   *THOUSAND/KTOTAL
```

```
      AVUSAGE(SIZE)= KTOTAL/CUMPART(1)                                          11305
      MINNUMBOFMLDS(SIZE)=(KTOTAL-INITSTOCK)/((CUMPART(1)-ONE)* PRODN)          11310
      KVALUE=PRODN* NUMBOFMLDS(SIZE)                                            11315
C        THIS IS THE MAXIMUM PRODUCTION RATE                                    11320
C        HOWEVER IT ASSUMES ALL COLOURS ARE BEING MADE                          11322
C        WITH SEVERAL COLOURS AS IN MOST SHORT RUNS YOU CAN                     11324
C        MAKE GREATER REQUIREMENTS THAN THESE AND STILL SATIFY THEM             11326
C        HENCE WE INCREASE THE REQUIREMENTS INT HE LAST WEEKS BY PRODN          11328
      IF (SHORTRUN) KVALUE=KVALUE+PRODN                                         11333
C                                                                               11340
C        IF THE REQMENTS FOR THE LAST WEEK ARE LARGE,THEN BRING THEM            11342
C        FORWARD SO THAT IN NO WEEK ARE TOO MANY MOULDS NEEDED                  11344
      LASTREQ=KTOTAL                                                            11348
C        THE REQUIREMENT FILE IS NOW SET UP                                     11386
C        THE REQUIREMENTS OF A PARTICULAR BRAND ARE FOUND BY MULTIPLYING        11388
C        THE WEEKS REQMENTS OF THAT SIZE BY THE FRACTION CORRESPONDING          11390
C        TO THE BRAND                                                           11391
C                                                                               11392
      DO 170 WEEK=1,LASTWEEKOFREQ                                               11410
      NOWREQ=LASTREQ                                                            11420
      LASTREQ= CUMPART(WEEK+1)*AVUSAGE(SIZE)                                    11430
      IXCESS= NOWREQ - LASTREQ                                                  11435
      IF (IXCESS-KVALUE) 160,160,0                                              11445
      IF (LASTWEEKOFREQ - WEEK -1) 160,160,0                                    11450
      LASTREQ=NOWREQ-KVALUE                                                     11455
      IXCESS=KVALUE                                                             11460
  160 REQMENT(SIZE,WEEK)=IXCESS                                                 11465
  170 CONTINUE                                                                  11470
  200 CONTINUE                                                                  11490
      WRITE(30,210) MCTYPE,MANGRP,LASTWEEKOFPLAN,NWEEKSTOSTART,                 11520
     1     LASTWEEKOFREQ, (LISTNO(BRAND),INITIALREQ(BRAND)                    115201
     2    , TOTALREQ(BRAND),BRAND=1,NBRAND)                                   115202
  210 FORMAT(1H1,40X,16HSCHEDULE FOR THE,I4,15H MACHINES WITH ,                 11530
     1    19HMANUFACTURING GROUP,I3/ 50X,10HTO RUN FOR,I3,                    115301
     2    17H WEEKS AFTER WEEK,I3//  20X,5HBRAND,10X,                         115302
     2    29HINITIAL TARGET SALEABLE STOCK,                                   115302
     3    10X,27HPLANNED SALEABLE PRODUCTION/ 80X,4HOVER,I3,6H WEEKS//        115303
     5    (20X,I5,16X,F9.3,26X,F11.3,6H PAIRS ) )                             115305
      WRITE(30,290) INITIALFREE,IXCESSTOCK,IFREE                                11550
  290 FORMAT(//50X,39HTHE STOCK ABOVE INITIAL REQUIREMENTS IS,I8,               11560
     1    6H PAIRS/57X,28HEXCLUDING AN EXCESS STOCK OF,I12, 6H PAIRS/          115601
     2    55X,34HTHE PLANNED UNBALANCED STOCK IS    ,I8,6H PAIRS )            115602
      KSTOCK= (NBRANDSIZES-NUMSIZE + 5*NMACH)*PRODN/2                           11652
      VALCHANGE=TEN*FREE*FREE                                                   11654
C        VALCHANGE IS THE NUMBER OF WEEKS'STOCK IT IS WORTH HOLDING TO          11655
C        SAVE A MOULD CHANGE.                                                   11656
      VALFREESTCK=CHNGCOST/VALCHANGE                                            11660
      CALL OVERFL(IOVERFLOW)                                                    11668
C        TEST IF ANY DIVISION BY ZERO HAS OCCURRED                              11669
      INCREASE= NMACH + (MAXSIZE-MINSIZE)/LAP                                   11684
      RANGEFACTOR=RANGEFACTOR / VALFREESTCK                                     11689
      WRITE(30,292) KSTOCK,COLOURADV,LAP,VALCHANGE                              11690
  292 FORMAT( 38X,8HOF THESE,I8,26H  ALLOW FOR FULL WEEK RUNS/                  11695
     1  40X,7H   AND ,F8.0,32H COVER COLOURS NOT IN PRODUCTION //               116951
     2    38X,30HTHE REST ALLOWS AN AVERAGE OF ,I3,                           116952
     3  41H WEEKS BETWEEN RESTARTING AN AVERAGE SIZE ///  20X,                116953
```

```
     4    30X,33H** ONE MOULD CHANGE IS VALUED AT ,F6.2,                    116954
     5    16H WEEK'S STOCK ** //  )                                         116955
          DO 400 SIZE=MINSIZE,MAXSIZE                                       11720
          IF (AVUSAGE(SIZE)) 400,400,0                                      11725
          WEEKLY=AVUSAGE(SIZE) / PRODN                                      11730
          IF (SHORTRUN) WEEKLY=WEEKLY/REQTOPROD                             11732
C            FOR SHORT RUNS THE AVERAGE USAGES ARE GROSS OVERESTIMATES      11733
C            THIS CORRECTS TO GIVE CORRECT BATCH SIZES                      11734
          IDUM=WEEKLY                                                       11735
C            IDUM IS THE INTEGER PART OF THE WEEKLY USE OF MOULDS           11737
          WEEKLY=WEEKLY-IDUM                                                11740
          DUMMY=SQRT(WEEKLY*(1.1-WEEKLY) )                                  11752
          COVERINPRODN(SIZE)=4*PRODN*FREF*DUMMY/AVUSAGE(SIZE) + IDUM        11756
          BATCHSIZE(SIZE)=(COVERINPRODN(SIZE)*AVUSAGE(SIZE))/(ONE-WEEKLY)   11760
C            IF THE AVERAGE USAGE IS LITTLE GREATER THAN THE PRODUCTION     11769
C            RATE, MOST WEEKS REQTS ARE PROBABLY BELOW THIS. THE            11770
          IF (WEEKLY*IDUM.LT.0.03) BATCHSIZE(SIZE)=HALF*PRODN               11777
C            BATCHSIZE IS THE EXPECTED RUN LENGTH                           11790
C            'COVERINPRODN' IS SET SO THAT A SIZE REMAINS IN PRODUCTION     11793
C            UNTILIT HAS REACHED THIS NUMBER OF EXTRA WEEK'S COVER          11795
   400 CONTINUE                                                             11798
          COLOURADV=COLOURADV - 1.25*(NCOLOUR-1)*PRODN                      11835
          IF (COLOURADV.LT.0) COLOURADV=0.                                  11840
          COLOURADV=.4*COLOURADV/(NMACH*PRODN)                              11845
          IF (LAP.GT.6) LAP=6                                               11850
          CALL OVERFL(IOVERFLOW)                                            11880
          RETURN                                                            11900
          END                                                               11950

END OF SEGMENT, LENGTH   563, NAME  SETUP
```

```
      SUBROUTINE PRODUCTCOVER(KSZE,COVER1,BRAND1,MAKE)                  15000
      INTEGER SIZE,BRAND,PRODN,WEEK,WEEKSLEFT,SIGN                      15010
      INTEGER BRAND1                                                    15015
      INTEGER REQMENT,FREESTOCK,FRACTION ,ASSIGN                        15020
      LOGICAL ALLBRANDS,NOURGENCY                                       15030
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR           15050
     1    , NMACH,MCSTHISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)      150501
     2    , FREESTOCK(37,10),FRACTION(37,10),REQMENT(37,26)             150502
     3    , INMACH(37,5),MATAVAIL(37,10)                                150503
     4    , MACHFORCE(40),NUMBOFMLDS(40), ASSIGN(40)                    150504
      COMMON/BLOCK3/ MAKEBRAND(10),COVERS(40),AVUSAGE(40)               15070
      COMMON/ASSORTED/ CHNGCOST,ALTERCOST,COLOURADV,VALFREESTCK         15080
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION15090
                                                                        15100
C                                                                       15103
C        THIS SUBROUTINE WILL GIVE THE BEST BRAND TO MAKE IF THE SIZE   15107
C        IS SPECIFIED , BUT WILL ALSO GIVE THE BRAND MOST NEEDED        15110
C        IF NO SIZE IS SPECIFIED,  IN THIS CASE THE CURRENT             15115
C        COLOUR IS FED IN AS MAKE AND HAS AN ADVANTAGE                  15130
C                                                                       15155
      NOURGENCY=.TRUE.                                                  15160
      ALLBRANDS= ALTERCOST.LE.0                                         15165
      BRAND1=0                                                          15170
      COVER1=ONEMILLION                                                 15210
   10 DO 120 BRAND=1,NBRAND                                             15220
      ADVANTAGE=0.                                                      15230
      SIZE=KSZE                                                         15240
      IF (KSZE) 20,20,0                                                 15280
      IF (MAKEBRAND(BRAND)) 120,120,50                                  15310
   20 IF (KOLOUR(BRAND).EQ.MAKE) ADVANTAGE=COLOURADV                    15330
   30 SIZE=SIZE+1                                                       15410
   50 IF (FRACTION(SIZE,BRAND)) 100,100,0                               15420
      COVER=FREESTOCK(SIZE,BRAND)*THOUSAND/                             154201
     1              (FRACTION(SIZE,BRAND)*AVUSAGE(SIZE))               15425
C        'COVER' IS THE WEEKS COVER PROVIDED BY THE PRESENT STOCK       15430
      IF (COVER) 0,0,80                                                 15450
      NOURGENCY=.FALSE.                                                 15460
      IF (KSZE.EQ.0) COVER=TEN*COVER                                    15463
C        IF BELOW CURRENT REQTS,INCREASE PRIORITY OF THIS COLOUR        15466
C        THIS REDUCES THE ADVANTAGE OF THE PREVIOUS COLOUR              15510
   80 COVER=COVER - ADVANTAGE                                           15520
      IF (COVER-COVER1) 0,0,100                                         15530
      IF (.NOT.ALLBRANDS) IF (MATAVAIL(SIZE,BRAND)) 100,100,0           15550
      BRAND1=BRAND                                                      15560
      COVER1=COVER                                                      15580
  100 IF (KSZE.EQ.0) IF (SIZE-MAXSIZE) 30,0,0                           15590
  120 CONTINUE                                                          15710
      IF (COVER1) 0,0,220                                               15750
C        IF MAKE IS ZERO THEN MATERIAL SHOULD BE AVAILABLE              15752
C        TO MAKE THE SELECTED BRAND                                     15755
C        IF 1 THEN MATERIAL WILL HAVE TO BE BOUGHT IN (COST ALTERCOST)  15760
  150 MAKE=0                                                            15770
      IF (ALLBRANDS.AND.ALTERCOST.GT.0) MAKE=1                          15780
      RETURN                                                            15810
  220 IF (ALLBRANDS) GO TO 150                                          15800
      IF (BRAND1.GT.0.AND.(ALTERCOST.GT.50..OR.NOURGENCY)) GO TO 150    15840
      ALLBRANDS=.TRUE.
```

```
      GO TO 10                                                          15850
      END                                                               15900

END OF SEGMENT, LENGTH   206, NAME  PRODUCTCOVER
```

```
      SUBROUTINE STORE(IARRAY)                                          17000
      DIMENSION IARRAY(37)                                              17130
      COMMON/BLOCK2/ KEY(6),IBUFFER(40)                                 17160
C                                                                       17300
C        STORE INFORMATION FROM IBUFFER INTO IARRAY                     17302
C                                                                       17309
      DO 50 I=1,37                                                      17320
   50 IARRAY(I)=IBUFFER(I)                                              17340
      RETURN                                                            17380
      END                                                               17400

END OF SEGMENT, LENGTH     34, NAME  STORE
```

```
      SUBROUTINE REARRANGE                                                    20000
      INTEGER SIZE,BRAND,PRODN,WEEK,WEEKSLEFT,SIGN                            20110
      DIMENSION COVERM(3)                                                     20120
      COMMON/NUMERIC/ONE,TEN,HUNDRED,THOUSAND,THOUSANDTH,HALF,ONEMILLION20160
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE,MANGRP,KOLOR                 20170
      COMMON MINSIZE,MAXSIZE,NBRAND,PRODN,MCTYPE(10),LISTNO(10)               201701
     1    , NMACH,MCSTHISCOLOUR,MACHINUSE(6),KOLOUR(10),LISTNO(10)           20180
      COMMON/BLOCK1/ FREE,SPREAD,REQTOPROD,LAP,INCREASE,SIGN,MCHLIMIT         201801
     1    ,MAXDESIRESIZE(6),ISTMACH(6),WEIGHT,RANGEFACTOR                     201802
     2    , ENITIALREQ(10),TOTALREQ(10),PROPORTION(10),CUMPART(27)            20190
      COMMON/BLOCK3/ MAKEBRAND(10),COVERS(40),AVUSAGE(40)                     20200
                                                                              20201
C                                                                             20202
C        THIS SUBROUTINE IS ONLY CALLED WHEN 'SIGN' IS NON-ZERO               20203
C        INDICATING THAT THE  BLOCK OF SIZES IN ANY MACHINE IS EXPECTED       20204
C        TO FLUCTUATE.  THIS MAY MEAN A MACHINE WHICH ORIGINALLY HAD          20206
C        SMALL SIZES NOW CONTAINS LARGE ONES LIKE A SECOND MACHINE            20207
C                                                                             20208
C        TO REDUCE PROBLEMS A MINIMUM SEPARATION OF THE SIZE RANGES FOR       20209
C        EACH MACHINE IS ENFORCED.                                            20210
C                                                                             20220
      MINSEP=15-SPREAD                                                        20240
      IF (MINSEP.LT.5) MINSEP=5                                               20250
      MAX=0                                                                   20260
      DO 50 NUM=1,MCSTHISCOLOUR                                               20265
   10 MAXOLD=MAX                                                              20270
      MACH=MACHINUSE(NUM)                                                     20280
      MAX=MAXDESIRESIZE(MACH)                                                 20285
      IDUM=MAX-MAXOLD                                                         20290
      IF (IDUM+5) 0,0,20                                                      20300
      MACHINUSE(NUM)=MACHINUSE(NUM-1)                                         20310
C        CHANGE THE ORDER OF THE TWO MACHINES                                 20320
      MACHINUSE(NUM-1)=MACH                                                   20350
      GO TO 10                                                                20360
   20 IF (IDUM.GE.MINSEP) GO TO 50                                            20390
      MAX,MAXDESIRESIZE(MACH)= MAXOLD + MINSEP                                20400
   50 CONTINUE                                                                20401
C                                                                             20402
C        SEARCH FOR THE SIZE WITH LOWEST STOCK COVER                          20403
C        IF AN END SIZE - MOVE THE AVERAGE SIZES FOR EACH MACHINE             20405
C        TOWARDS THAT END SIZE                                                20406
C        IF A CENTRAL SIZE -  DO NOT ALTER THE AVERAGE SIZES                  20407
C        TO PREVENT UNDUE FLUCTUATIONS, AND TO ALLOW A REASONABLE             20408
C        PERIOD BETWEEN MAKING EXTREME SIZES, THERE IS SOME INERTIA           20409
C        AGAINST ALTERING THE TREND                                           20410
C                                                                             20420
      DO 190 I=1,3                                                            20510
  190 COVERM(I)=ONEMILLION                                                    20520
      DO 200 SIZE=MINSIZE,MAXSIZE                                             20530
      COVER=COVERS(SIZE)                                                      20540
      IF (COVER.LT.COVERM(2)) COVERM(2)=COVER                                 20550
      IF (SIZE +7 - MAXDESIRESIZE(MACHINUSE(1)) ) 0,0,130                     20560
      IF (COVER.LT.COVERM(1)) COVERM(1)=COVER                                 20570
      IF (COVER.LT.COVERM(3)) COVERM(3)=COVER                                 20590
  130 IF (SIZE - MAXDESIRESIZE(MACHINUSE(MCSTHISCOLOUR))) 200,0,0             20610
  200 CONTINUE                                                                20630
      COVERM(2+SIGN)=COVERM(2+SIGN) - MAXSIZE*HALF/INCREASE
      I=1
```

```
      IF (COVERM(1).GT.COVERM(3)) I=3                                    20640
      IF (COVERM(I).GT.COVERM(2)) GO TO 500                              20650
                                                                         20700
C        THE CHANGE IN AVERAGE SIZES IS 'INCREASE', THIS DEPENDS ON LAP, 20702
CC       (THE AVERAGE TIME BETWEEN REMAKING ANY SIZE).(SEE SETUP)        20704
C                                                                        20709
C                                                                        20710
C                                                                        20730
  300 SIGN=I-2                                                           20740
      DO 350 NUM=1,MCSTHISCOLOUR                                         20750
      MACH=MACHINUSE(NUM)                                                207501
      MAXDESIRESIZE(MACH)=MAXDESIRESIZE(MACH) +                          20780
     1    SIGN*INCREASE/ (MCSTHISCOLOUR+1)                               20910
  350 CONTINUE                                                           20950
  500 RETURN
      END

 END OF SEGMENT, LENGTH   339, 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

Dunlop Footwear Ltd.
Prog. 1M 20

1MF Schedules
from
14/07/75 to 26/01/76

** Machine type No. : 609/2 **
**Manufacturing Group : Bright and Dull Wellingtons **

week commencing

SZ RG	SZ	Prod Mld Colour Product	14/07 1,350 Blk	21/07 1,350 Blk	11/08 1,350 Blk	18/08 1,350 Blk	25/08 1,080 Blk	01/09 1,350 Blk	08/09 1,350 Blk	15/09 855 Blk	22/09 855 Blk	29/09 1,350 Blk	06/10 1,350 Blk	13/10	Total 13,850
J	11	6294 B.S.C.	.	.	** .	.	.	.	.	*	*	.	X	.	1,350
J	12	6260 Dnlp Brgt	.	X	** X	.	.	.	.	*	*	.	.	.	2,700
		6294 B.S.C.	X	.	** .	X	.	.	.	*	*	.	.	.	2,700
J	12	6259 Dnlp Dull	.	.	** .	.	.	.	.	*	*	X	.	.	1,350
		6203 Dull Unb	.	.	** .	.	.	.	.	*	*	.	X	.	1,350
J	13	6260 Dnlp Brgt	.	X	** .	X	X	.	X	*	*	X	.	.	6,480
		6294 B.S.C.	X	.	** X	.	.	X	.	*	*	.	X	.	5,400
J	13	6259 Dnlp Dull	.	.	** X	.	X	.	X	*	*	.	X	.	5,130
		6203 Dull Unb	.	.	** .	X	.	X	.	*	*	X	.	.	4,050
J	1	6260 Dnlp Brgt	.	.	** .	.	.	.	.	*	*	X	.	.	1,350
		6294 B.S.C.	.	.	** .	.	.	.	.	*	*	.	X	.	1,350
J	2	6260 Dnlp Brgt	X	X	** .	.	.	.	.	*	*	.	.	.	2,700
J	2	6259 Dnlp Dull	X	.	** X	.	X	.	X	*	*	.	.	.	5,150
		6203 Dull Unb	.	X	** .	X	.	X	.	*	*	.	.	.	4,050
W	4	6260 Dnlp Brgt	.	.	** X	.	X	.	X	*	*	X	.	.	5,150
		6201 Brgt Unb	.	.	** .	.	X	X	.	*	*	.	.	.	2,450
		6294 B.S.C.	.	.	** .	X	.	.	.	*	*	.	.	.	1,350
W	4	6258 Dnlp Dull	X	X	** .	.	.	X	X	*	*	.	.	.	5,400