EQUIPMENT FORECASTING SIMULATION MODELS

FACILITIES
Facilities Planning

Ralph W. Hawes

THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION
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U.S. ATOMIC ENERGY COMMISSION
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EQUIPMENT FORECASTING SIMULATION MODELS

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Ralph W. Hawes

Abstract. A general description is given of a computerized modeling technique used to determine future equipment requirements. The technique has application also in manpower forecasting and in determining purchase requirements.

Included is a simulation of a hypothetical product with related flow charts and illustrations of a computer modeling program.

DESCRIPTION

Input:

Accurately detailed input has considerable value and can be achieved by use of the described technique. As in all computer programs, the output is only as significant as the input. Therefore, data are obtained from the best available source.

1. Production Control:

a. Production Control provides a list of current and former production items by part number and assembly configuration, commonly called the Bill of Materials.

b. Scrap factors are used by Production Control to facilitate scheduling, and also in the simulation models.

c. Lead times are supplied in weekly units for each part.

d. Safety stock is added by Production Control to provide several extra production items to allow for loss by the customer where replacement would be necessary. These remain as shelf items.

e. Future items which have not been assigned part numbers are given look-alike numbers. This is necessary in order to study future production items by comparing them with parts previously produced.

f. Production Control supplies the production schedules for current and anticipated future production.

2. Industrial Engineering:

a. MACHINE STANDARDS—Industrial Engineering provides the Machine Standard Hours required to make each part on a specific type of equipment. In many cases, the standard is equivalent to the direct-labor standard times, determined by time studies or other techniques.

b. PERCENT PERFORMANCE—The worker will directly affect the time required on a piece of
equipment; therefore, an efficiency factor must be applied to the machine standard. Exceptions include types of equipment that can operate unattended, except for loading and unloading. The Percent Performance for each work center is calculated by the Industrial Engineering group comparing Actual versus Standard hours.

c. AVAILABLE HOURS—The Industrial Engineering group determines the hours per shift that a worker is available for production work. The Job Content Breakdown Report provides these data. Machines or equipment not dependent on an operator will have availability calculated independently by a machine group.

d. FUTURE PRODUCTION—Industrial Engineering will estimate machine standards for future items using whichever technique would be applicable.

3. Product Engineering:

a. DEFINE—Product Engineering will define and describe items which may be in future production.

b. BEST ESTIMATE—Product Engineering will provide a best estimate of the time necessary to make any item which varies considerably in configuration or complexity that the standard times on existing look-alike parts cannot be used.

4. Facilities Engineering:

Facilities Engineering will provide the quantity and location of each type of equipment to be available at some predetermined time in the future.

Information will be changed as needed capability and technologies require revisions.

5. Shop Personnel:

a. Time required on special order work not appearing on a schedule is provided by shop personnel. Such work classified as Cash Sales has been relatively constant year to year.

b. Future production items are discussed with shop personnel to obtain the best estimate as to required machine times. Personnel also identify the process and equipment types which may be used on future items.

c. Shop personnel also provide Industrial Engineering the information needed in studies of Machine Standard Hours.

6. Research and Development:

Research and Development personnel assist to resolve questions on how an item may be built, to identify or supply data on machines to be used and to establish or define processes for use on future items.

7. Data Processing:

Data Processing provides the mechanics and support to program and run the models.

BUILDING THE MODEL

The products to serve as forecasting models must be determined. To show how a model may be constructed, a hypothetical product is selected. For example, a roller skate used as the model was analyzed, coded, and run with a flow chart prepared to designate each step. The procedures and data obtained for the roller-skate model illustrate the identical approach to be used if a production product were selected.

Constructing a model of each product has advantages. However some products, which may be one-of-a-kind or a special prototype, are not easily defined for purposes of building an appropriate model. To overcome such an obstacle, a procedure has been worked out to compensate for time spent on nonmodel products and is noted in Table I, Available Hours Program. (See Hours for Special Orders.)

Data required for production models can be compiled from various sources. Using the Roller Skate (No. 9000) as the product, a Flow Chart (Figure 1) was prepared showing Section A—Flow of Parts and Subassemblies and Section B—Flow of Operations. Section A serves to prepare Section B from which Coding can then be done directly. Data were compiled also from the following sources:

- Bill of Materials, Figure 2
- Operation Process Sheet, Figure 3
- Sketch of Parts, Figure 4
- Machine Group Code Numbers, Figure 5

Flow Chart Construction:

To construct the Flow Chart, the following steps are proposed:

1 Illustrations are grouped at end of text.
1. Determine the product configuration from the Bill of Materials (Figure 2) and the Sketch of Parts (Figure 4).

2. Construct the Flow of Parts and Subassemblies (Figure 1, Section A).

3. Construct Flow of Operations (Figure 1, Section B) by use of Operation Process Sheets (Figure 3).

4. Fill in all data required as per nomenclature given in Figure 1.

**TABLE I. Available Hours Program.**

<table>
<thead>
<tr>
<th>Calculations for Required Machine Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Quantity = (Quantity of Parts × Scrap Factor) + Safety Stock</td>
</tr>
<tr>
<td>Required Hours per Machine Group (A) = (Required Quantity × Machine Standards) + Percent Performance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculations for Available Hours and Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours per Machine (C) = (Available Hours per Shift Days per Shift) × (Quantity of Machine) - (Hours for Special Orders)</td>
</tr>
<tr>
<td>Available Hours per Machine Group (B)</td>
</tr>
<tr>
<td>Required Machines = Required Hours (A) - Available Hours (B)</td>
</tr>
<tr>
<td>Variance = Required Machines ± Available Machines</td>
</tr>
</tbody>
</table>

**Lead Time:**

General Purpose Simulation System (GPSS) is a time per event computer language. Lead times are programmed into the models and will be evidenced by differences in part quantities within given time periods.

The quantities of finished assemblies in a specific time period (quarter) will usually be different from the hardware part finished within that same period because of lead times. Scrap factors and safety stock also influence this quantity.

Notice that the flow charts are constructed with the product to be shipped at the apex and all subassemblies and parts are extended from the final product. The flow procedure continues from the top to bottom, exactly opposite from the way in which a product is actually built. The reason for developing the flow chart (Figure 1) in reverse was to show that the final product is the controlling item on the schedule. The model is also coded and run in the same reverse method.

**Machine Group Code Numbers** can be applicable to several work centers. Therefore, both Machine Group Code Numbers and Account (work center) Numbers are necessary to identify a particular equipment capability. Usually equipment although identical is not interchangeable between work centers. A representative list of code numbers is presented in Figure 5, Page 12.

**CODING AND RUNNING THE MODELS**

The models are coded in GPSS language which provides a relatively simple tool for simulating the data identified by the flow charts. Although GPSS can provide statistical output on queuing facilities and storage usages, the data needed are tabulated in matrices.

The actual coding of the model is not explained in detail as a programmer experienced in GPSS should have little difficulty following the logic. Figures 6 through 9 are excerpts from the GPSS run of the hypothetical product. Figure 10 is part of the actual matrix output.

The computer core must be reallocated to provide core for the blocks which are used in this simulation. A typical reallocation:
REALLOCATE VAR, 40, FSV, 80, HSV, 0, CHA, 0, GRP, 0, BVR, 0, FMS, 30
REALLOCATE HMS, 0, XAC, 100, BLO, 3000, FAC, 0, STO, 0, QUE, 0, LOG, 0
REALLOCATE TAB, 0, FUN, 6, MAC, 6, COM, 80000

The reallocate cards follow the JCL cards and must precede the SIMULATE card noted in Figure 6.

The FIRST FUNCTION is the schedule of products to be shipped during each quarter. This sample schedule specifies a quantity of 10 products per quarter, each quarter until the internal clock reaches 79. At time 79, the quantity changes to 15. At clock time 82, the quantity changes to 20, etc. The function quantity could change each quarter if necessary.

The DATE FUNCTION identifies the column in the matrix output into which the statistics are to be placed (see Figure 10). This function also uses the clock as a timer. At clock times 5 and 10, the output is to be placed in Column 30. At clock time 14, the output is to be placed in Column 28; etc. Columns 1 through 28 accumulate the actual data for the 28 quarters studied.

Macro-notation is used consistently throughout the model. This reduces the coding significantly as only one, or possibly two, cards are necessary for each block on the flow chart. One card is needed for the Part Number statistics, another for the Machine Hours and Group.

ONE MACRO is used for the determination of part quantity by applying scrap factors and spares to the quantity specified either in the First Function table or in Parameter 5.

TWO MACRO calculates the Hours Required, by Machine Group, using the quantity calculated in the ONE MACRO.

FOUR MACRO is used to write the matrix output onto magnetic tape or disk for input into the match and sum programs.

Table 1 shows the calculations used in the models and in the Available Hours program.

Summary of Individual Models:

Upon completion of a model for each individual product, the model must be summarized to determine the entire plant requirements. Figure 11 is a flow chart showing the sequence of computer operations. The Initial Match and Sum is a program which will set up matrices for each work center and machine group to be summarized. The format is exactly the same as shown in Figure 10. At this point, the contents of all the matrices will be zero. A FORTRAN program will read data from both the Initial Match and Sum and the first model and place the contents of each matrix of the model into the appropriate matrix produced by the Initial Match and Sum program. The process is repeated for each model, each time accumulating the data to obtain a total summation.

After all the models have been run, an Available Hours matrix is introduced (see Figure 11). This model contains data which represent the actual hours each machine group has available. The data are provided by using the quantity of machines per work center, hours per shift the machines are available, the shifts per week, and weeks per period.

A FORTRAN program is utilized to make the required comparison of required machine hours and actual machine hours and thus produce the variance hours report.

By using a FORTRAN program for the final output, the format can be arranged to suit the users' specific needs. Currently in use are three different outputs, one for Facilities Planning, one for Manufacturing, and the third for Production Control.

Validation of the output is possible by using the matrix printouts of each individual model. Should there be any errors, the entire set of models do not have to be rerun if tapes are retained until validation has been determined. Thus duplication of effort can be eliminated and a savings in computer time realized.

CONCLUSIONS

The use of computer simulation to provide a management tool is becoming increasingly important.

The equipment forecasting technique offers advantages because of ease in manipulation and in validation of data. Both manpower and computer time savings are achieved. The technique is relatively straightforward and comprehensible which allows for minimum error in interpretation and coding.
ILLUSTRATIONS
SECTION A. Flow of Parts and Subassemblies:

FIGURE 1. Flow Chart for Model.
SECTION B. Flow of Operations:

```
SECTION B. Flow of Operations:

RFP-1527

3000
  - 2177
    - 100 2

BBB
  Δ2
  PURCHASED
  105 10

CCC
  Δ2
  PURCHASED
  105 10

AAA
  Δ2

ABA
  Δ3
  1077 3600
  1581 84
  0.50 105 5

ABC
  Δ3
  1293 2600
  1444 76
  0.12 105 5

ACA
  Δ1
  5009 2200
  1444 76
  0.45 105 10

ACD
  Δ1
  5241
  PURCHASED

ABD
  Δ3
  8391 4100
  1477 76
  0.20 105 4

ADA
  Δ1
  PURCHASED
  100 20

ADB
  Δ1
  2144
  PURCHASED

ADC
  Δ1
  3673 3610
  1581 84
  0.50 105 10

ADD
  Δ1
  2100 4400
  0.00 100 10

ADE
  Δ1
  4000 2210
  1444 76
  0.60 100 20

(continued)
```
FIGURE 2. Bill of Materials.

NAME OF PRODUCT: SKATE - ROLLER - STREET, NO. 9000.

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1077</td>
<td>1</td>
<td>Toe Plate</td>
</tr>
<tr>
<td>1078</td>
<td>1</td>
<td>Heel Plate</td>
</tr>
<tr>
<td>1293</td>
<td>1</td>
<td>Front Frame</td>
</tr>
<tr>
<td>1294</td>
<td>1</td>
<td>Rear Frame</td>
</tr>
<tr>
<td>5009</td>
<td>1</td>
<td>Adjusting Screw</td>
</tr>
<tr>
<td>3644</td>
<td>2</td>
<td>Toe Clamp</td>
</tr>
<tr>
<td>3673</td>
<td>2</td>
<td>Axle Frame</td>
</tr>
<tr>
<td>4900</td>
<td>2</td>
<td>Axle</td>
</tr>
<tr>
<td>6000</td>
<td>4</td>
<td>Wheels</td>
</tr>
<tr>
<td>6100</td>
<td>4</td>
<td>Bearing</td>
</tr>
<tr>
<td>5207</td>
<td>6</td>
<td>Rivet</td>
</tr>
<tr>
<td>5210</td>
<td>2</td>
<td>Shouldered Rivets</td>
</tr>
<tr>
<td>5220</td>
<td>1</td>
<td>Adjusting Bolt</td>
</tr>
<tr>
<td>7000</td>
<td>1</td>
<td>Strap with Buckle</td>
</tr>
<tr>
<td>5228</td>
<td>4</td>
<td>Axle Retainers</td>
</tr>
<tr>
<td>5209</td>
<td>4</td>
<td>Washers</td>
</tr>
<tr>
<td>8501</td>
<td>1</td>
<td>Wheel Subassembly 5209, 5228, 6100, 6000, 3673, and 4900</td>
</tr>
<tr>
<td>8600</td>
<td>1</td>
<td>Front Subassembly 1077, 1293, 8601, 3644, 5009, 5210, and 5207</td>
</tr>
<tr>
<td>8700</td>
<td>1</td>
<td>Rear Subassembly 1294 and 1078</td>
</tr>
<tr>
<td>9000</td>
<td>1</td>
<td>Final Assembly 8600, 8700, 5220, and 7000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Step</th>
<th>Work Center</th>
<th>Machine Group</th>
<th>Standard Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Account</td>
<td>Procedure</td>
<td></td>
</tr>
<tr>
<td>1077</td>
<td>1</td>
<td>1583</td>
<td>Cut and Form</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1581</td>
<td>Drill 6 Places</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1581</td>
<td>Dress Edges</td>
<td>1700</td>
</tr>
<tr>
<td>1078</td>
<td>1</td>
<td>1583</td>
<td>Cut and Form</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1583</td>
<td>Punch Holes for Straps</td>
<td>3610</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1581</td>
<td>Drill 4 Places</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1581</td>
<td>Dress Edges</td>
<td>1700</td>
</tr>
<tr>
<td>1293</td>
<td>1</td>
<td>1444</td>
<td>Cut Off Tube</td>
<td>2600</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1444</td>
<td>Drill</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1444</td>
<td>Clean</td>
<td>4000</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1444</td>
<td>Paint</td>
<td>5000</td>
</tr>
<tr>
<td>1294</td>
<td>1</td>
<td>1444</td>
<td>Cut Off Tube</td>
<td>2600</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1444</td>
<td>Drill</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1583</td>
<td>Punch Slot</td>
<td>3610</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1444</td>
<td>Clean</td>
<td>4000</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1444</td>
<td>Paint</td>
<td>5000</td>
</tr>
<tr>
<td>5009</td>
<td>1</td>
<td>1444</td>
<td>Turn Screw</td>
<td>2200</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1444</td>
<td>Dress</td>
<td>1700</td>
</tr>
<tr>
<td>3644</td>
<td>1</td>
<td>1583</td>
<td>Punch</td>
<td>3610</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1583</td>
<td>Form</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1581</td>
<td>Dress</td>
<td>1700</td>
</tr>
<tr>
<td>3673</td>
<td>1</td>
<td>1583</td>
<td>Punch</td>
<td>3610</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1583</td>
<td>Form</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1581</td>
<td>Dress</td>
<td>1700</td>
</tr>
<tr>
<td>4900</td>
<td>1</td>
<td>1444</td>
<td>Form Grind Axle</td>
<td>2210</td>
</tr>
<tr>
<td>6000</td>
<td>1</td>
<td>2100</td>
<td>Inspect Wheels</td>
<td>4400</td>
</tr>
<tr>
<td>6100</td>
<td>1</td>
<td>2100</td>
<td>Inspect Bearings</td>
<td>4400</td>
</tr>
</tbody>
</table>

Subassemblies:

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Step</th>
<th>Work Center</th>
<th>Procedure</th>
<th>Machine Group</th>
<th>Standard Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>8501</td>
<td>1</td>
<td>1477</td>
<td>Assemble Axle Frame, Axle</td>
<td>None</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1477</td>
<td>Press Bearing in Wheels</td>
<td>4100</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1477</td>
<td>Assemble Wheels on Axle</td>
<td>None</td>
<td>–</td>
</tr>
<tr>
<td>8600</td>
<td>1</td>
<td>1477</td>
<td>Rivet Frame to Toe Plate</td>
<td>3300</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1477</td>
<td>Install Shouldered Rivets</td>
<td>3400</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1477</td>
<td>Rivet Wheel Assembly to Plate</td>
<td>3300</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1477</td>
<td>Assemble Toe Clamps</td>
<td>None</td>
<td>–</td>
</tr>
<tr>
<td>8700</td>
<td>1</td>
<td>1477</td>
<td>Weld Frame to Plate</td>
<td>3700</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1477</td>
<td>Rivet Wheel Assembly to Plate</td>
<td>3300</td>
<td>0.15</td>
</tr>
<tr>
<td>9000</td>
<td>1</td>
<td>1477</td>
<td>Assemble Skate</td>
<td>None</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1477</td>
<td>Install Strap</td>
<td>None</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2177</td>
<td>Inspect</td>
<td>None</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2177</td>
<td>Package</td>
<td>None</td>
<td>–</td>
</tr>
</tbody>
</table>
FIGURES 4(a) and (b). Sketch of Parts, Roller Skate Model No. 9000: Frames (a) and Parts (b).

1700  Buffer and Grinder  3600  Hydraulic Forming Press
2100  Drill Press  3610  Punch Press
2200  Threading Lathe  3700  Welder
2210  Contour Grinder  4000  Degreaser
2600  Cut-off Saw  4100  Arbor Press
3300  Riveting Machine  4400  Inspection Machine
3400  Hand Riveter  5000  Spray Booth

FIGURE 6. Sample General Purpose Simulation System Program.

*LOC OPERATION A,B,C,D,E,F,G  COMMENTS
* SAMPLE PROBLEM TO DEMONSTRATE THE CAP/CAR SYSTEM
* CAP/CAR IS A SERIES OF EQUIPMENT FORCASTING MODELS
FIRST FUNCTION C1,D5  SCHEDULE OF PRODUCTS
1,10/79,15/82,20/86,15/89,10
DATA FUNCTION C1#332  SELECTS MATRIX COLUMN FOR OUTPUT
5,10/13,15/14,20/18,12/21,26/27,25/31,24/36,23/40,22/44,21/49,20/53,19
37,18/62,17/68,16/72,15/77,14/80,11/81,10/82,9/83,8/84,7
57,6/86,5/88,4/88,3/89,2/90,1/100,30/105,30
* COLUMN 30 IS A DUMMY COLUMN AND IS NOT NEEDED
* 1 MATRIX x,7,37  ACCOUNT 1444 LIGHT FABRICATION
  2 MATRIX x,4,37  ACCOUNT 1677 ASSEMBLY
  3 MATRIX x,7,37  ACCOUNT 1581 DRILL AND TRIM
  4 MATRIX x,2,37  ACCOUNT 1583 HEAVY FORMING
  5 MATRIX x,1,37  ACCOUNT 2100 INSPECTION
  6 MATRIX x,20,37  PART REQUIRED
* MATRIX OUTPUT SUPPLIES EXCELLENT DIAGNOSTIC STATISTICS
* TEST CLOCK TO DETERMINE IF SPARES SHOULD BE INCLUDED
* CALCULATE THE QUANTITY OF PARTS REQUIRED
ONE STARTMACRO
ASSIGN 33,#A  ACCOUNT NUMBER
ASSIGN 34,#B  PART NUMBER
ASSIGN 35,=#  SCRAP FACTOR
ASSIGN 4,#D  SPARES
TEST C C1#0,1# TEST AND LABEL FOR FALSE EXIT
ASSIGN 6,=0  SET PARAMETER TO ZERO
#1 MSAVEVALUE #G,#F,33,P33  PLACE ACCOUNT NUMBER IN COLUMN 33
PC5 VARIABLE (P5*P3)/100+P4
ADVANCE #E  LEAD TIME DELAYS THE TRANSACTION
MSAVEVALUE #H,#F,PNDATE,P5  PLACE QUANTITY IN SPECIFIC COLUMN
MSAVEVALUE #N,#F,31,P5  TOTAL QUANTITY IS PLACED IN 31
ASSIGN 5,V$PCS
ONE ENDMACRO
*  CALCULATE MACHINE HOURS PER GROUP
TWO STARTMACRO
ASSIGN 1,#A  PERCENT PERFORMANCE
ASSIGN 2,#B  MACHINE STANDARD HOURS
ASSIGN 33,#C  ACCOUNT NUMBER
ASSIGN 34,#D  MACHINE GROUP
EHR FSAVEVALUE ((P2*P5)/P1)*10  CALCULATION
MSAVEVALUE #G,#E,PNDATE,VEHR  PLACE HOURS IN SPECIFIC COLUMN
MSAVEVALUE #F,#E,33,P33  PLACE ACCOUNT NUMBER IN COLUMN 33
MSAVEVALUE #F,#E,31,P34  PLACE MACHINE GROUP IN COLUMN 34
TWO ENDMACRO
* MACRO TRANSFERS MATRIX STATISTICS TO DISK OR MAG TAPE

FOUR
STARTMACRO
ASSIGN 35,#A TOTAL ROWS IN MATRIX
ASSIGN 36,39
ASSIGN 38,#A
ASSIGN 39,37

#B ASSIGN 39,37
#C ASSIGN *39,#0 MATRIX NUMBER
LOOP 39,#C LABEL FOR LOOP
WRITE JOBTA1 LOOP 38,#B LABEL FOR LOOP

FOUR ENOMACRO

* THE MACRO CARDS ARE THE SAME FOR ALL MODELS

1 GENERATE 1, ,1,39,F
2 TEST LE C1,100,FIN TEST TO PREVENT RUNAWAY MODEL
3 ASSIGN 5,FSFIRST ENTER SCHEDULE DATA

* START OF ACTUAL MODEL CODING DATA

ONE MACRO 2177,9000,100,2,0,1,6,6+,TEST1
ASSIGN 33,2177
ASSIGN 34,9000
ASSIGN 3,100
ASSIGN 4,2
TEST L C1,90,TEST1
ASSIGN 4,0

10 TEST1 MSAVEVALUE 6,1,33,P33
11 MSAVEVALUE 6,1,34,P34
12 PCS VARIABLE (P5*P3)/100+P4
13 ADVANCE 0
14 MSAVEVALUE 6+,1,FSDATE,P5
15 MSAVEVALUE 6+,1,31,P5
16 ASSIGN 5,VSPCS

* NO EQUIPMENT NEEDED IN THIS OPERATION
* QUANTITY OF PARTS ENTERED IN MATRIX NUMBER FIVE

16 SPLIT 1,AAA TRANSACTION SPLITS PER FLOW CHART
ONE MACRO 1477,8600,101,2,2,2,6,6+,TEST2
ASSIGN 33,1477
ASSIGN 34,8600
ASSIGN 3,101
ASSIGN 4,2
TEST L C1,90,TEST2
ASSIGN 4,0

23 TEST2 MSAVEVALUE 6,2,33,P33
24 MSAVEVALUE 6,2,34,P34
25 PCS VARIABLE (P5*P3)/100+P4
26 ADVANCE 2
27 MSAVEVALUE 6+,2,FSDATE,P5
28 MSAVEVALUE 6+,2,31,P5
29 ASSIGN 5,VSPCS

* PROCESS FOLLOWS THE FLOW CHART

TWO MACRO 78,25,1477,3300,1,2,2+ RIVET FRAME
ASSIGN 1,78

FIGURE 7. Sample of Model Coding.
FIGURE 8. Sample of Model Coding.

RFP-1527
FIGURE 9. Sample of Model Coding.
**MATRIX FULLWORD SAVEVALUE**

**REPORTING RECORD**

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*Titles inserted, not computer output.

FIGURE 10. Matrix Output.