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Computer Aided Production Planning in a Tyre Factory

Fast, accurate and up-to-date knowledge of time-dependent and time-independent part requirements is extremely important in formulating an optimum production planning policy. A new method for improving the efficiency of Loewner's algorithm for computing the parts requirements is presented. The importance of computer-aided production planning in large scale manufacturing systems is illustrated by means of a case study in tyre manufacturing.

1. INTRODUCTION

Production planning is the core of any manufacturing activity and the managerial efficiency is equally important as the technology itself. In a multi-stage system, the manufacture of the final product requires the completion of several operations or stages and a stage consists of an operation such as procurement of raw materials, fabrication of parts or assemblies. A fixed sequence of operations is necessary and the output from one stage forms the input to an immediate stage. The final stage is a special case where the output is a finished product used to satisfy a customer demand.

2. TREE-DIAGRAMS

The computation of parts requirements is one of the basic problems in production planning and control, especially when the finished product consists of hundreds of raw materials and/or sub-assemblies. The demand for a product will generate a demand for sub-assemblies which, in turn, generate a demand for raw materials at different points in time. Several important properties of an assembly system can be illustrated by a Tree-diagram (see Fig. 1)where a unique part-number is associated with each part entering the non-cyclic manufacturing operations. The tree-diagram represents not only the number of units (raw materials and/or sub-assemblies) needed to make the final pro-

duct but also the order in which they are assembled. The number of arrows in any path is the number of units of a specified part (sub-assembly) along that directed path and the length of the path is a measure of the "lead time". The tree-diagrammatic representation of a production process becomes highly complex and impractical when the manufacturing activity involves a large number of parts. The logical alternative is to build a mathematical model of the assembly system which can be manipulated on a high speed digital computer

3. MATRIX METHODS

VAZSONYI[5] was the first one to introduce matrix algebra to the bill of materials and other related structural problems. The parts requirements can be arranged in a $n \times n$ matrix N (Fig. 1) called Precedence matrix or Next-assembly matrix. It can be easily shown[2] that the $(i, j)^{th}$ element of N^k represents the quantity of part i needed to make one unit of part j, k steps away where $0 \leqslant k < L$; $N^L = 0$; $N^{L-1} \neq 0$ and $d = L - 1$ is the longest distance in the corresponding tree-diagram. In other words, the matrix N is nilpotent [1] of index $L (L = 4$ and $d = 3$ in Fig. 1) and hence it can be triangularised by rearranging its rows and columns.

It follows that the total parts requirements is the sum of the requirements at distances 0, 1, 2 ... d and is given by

$$R = T \cdot D = (I + N + N^2 + ... + N^d) \cdot D... \qquad (1)$$

where

R = requirements vector
D = demand vector
T = total requirement matrix

Loewner[3] has developed methods for computing Simple requirements, Edited requirements, Reorder requirements and Time dependent requirements by using a Semitriangular version N_{RT} of N as follows:

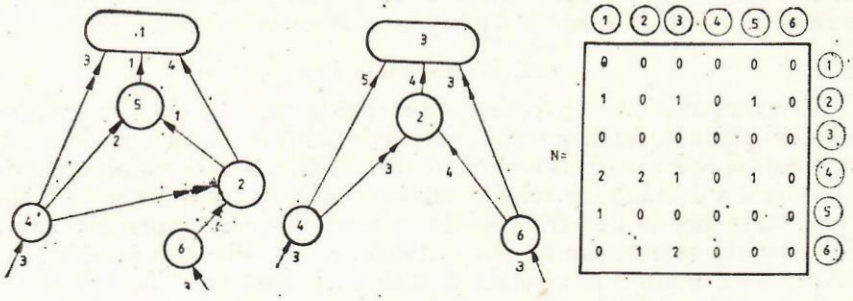


Fig. 1

Algorithm 1 (Reorder requirements)
notations used:

D = *Demand Vector*
A = Availability Vector
A^* = *Netted (edited) availability Vector; a_j^* are elements of A^**
K = Reorder Point Vector
Q = Reorder Quantity Vector; q_j are elements of Q
R = Requirements Vector; r_j are elements of R
V = Level Vector
L = Total number of levels
${}_{(i)}M$ = Rows of any matrix M belonging to level i.
$Z^{(i)}$ = Elements of any vector belonging to level i
F = $D - A + K$.

Step 1

Set $i = 1$; $R = 0$ and rearrange F, K, Q in level order.

Step 2

$E^{(i)} = F^{(i)} + {}_{(i)}N_{RT} \cdot R$ (elements of R in natural order)

Step 3

Letting $e_j^{(i)}$ represent the j^{th} element in $E^{(i)}$, the i^{th} level of E, for $j = 1, 2, \ldots m_i$ (where m_i denotes the no. of parts in level i)

$$r_j^{(i)} = 0 \text{ for } e_j^{(i)} \leqslant 0;$$

$$r_j^{(i)} = q_j^{(i)} \text{ for } 0 < e_j^{(i)} \leqslant q_j^{(i)}$$

$$r_j^{(i)} = e_j^{(i)} \text{ for } q_j^{(i)} < e_j^{(i)}$$

Note: elements r_j are computed in level order and are to be stored in natural order for use in step 2.

$a^{*(i)}_j = max\ (k_j^{(i)} - e_j^{(i)}, 0)$ (elements of A^* are in level order.)

Step 4

If $i < L$, increase i by 1 and go to step 2.

Step 5

Print out R and A^*

When $K = Q = 0$, the above algorithm yields Edited requirements and when $K = Q = A = 0$, we get Simple requirements.

Algorithm 2 (time dependent requirements)

$$r_{i,t} = d_{i,t+b_i} + \sum_{j=1}^{p} n_{i,j}\, r_{j,t+b_i}$$

$$h_j = b_j + Max\,(h_i) \text{ for } \eta_{i,j} \neq 0$$

where

$d_{i,t}$ = demand for part i at time t
= elements of demand matrix D

b_i = number of time intervals required by part i from start to availability
= largest (unique) lead time of part i

$r_{i,t}$ = quantity of part i on which work must be started at time t
= elements of requirement matrix R

h_i = planning horizons of immediate predecessors.

When $b_i = h_i = 0$ the time dependent requirements reduce to Simple requirements. The flow chart for the implementation of algorithm 1 (PROG. 1) and Algorithm 2 (PROG. 2) are shown[4] in Fig. 2, Fig. 3 and Fig. 4.

4. IMPROVED ALGORITHM FOR THE COMPUTATION OF N_{RT}

We present here a better method for the computation of N_{RT} which improves the overall efficiency of Lowener's algorithms.

The semitriangular matrix N_{RT} is generated from N by rearranging the rows of N according to the part levels which can be determined very easily (no matrix multiplications involved) as follows:

(i) find rows $i_1, i_2, ..., i_k$ of N with all zero elements and enter these row subscripts in a $\eta \times 1$ array $\bar{A}$

(ii) find columns $j_1, j_2, ... j_m$ of N with all zero elements and enter those column subscripts which are different from $i_1, i_2, ... i_k$ in a $\eta \times 1$ array $\bar{B}$

(iii) delete both the rows and columns of N with subscripts $i_1, i_2, ... i_k, j_1, j_2, \cdots j_m$

(iv) If the combined total number of entries in $\bar{A}$ and $\bar{B}$ is less than n, go back to step 1

(v) Merge the elements of $\bar{A}$ and $\bar{B}$ to form a $n \times 1$ array $\bar{C}$ (Fig. 5) to get the level order.

The full description of the algorithm is beyond the scope of this paper; however, it is interesting to note that, in general, our algorithm isolates two levels per iteration while Loewner's algorithm gives only one.

The level order generated by the two algorithms need not necesarily be the same always (see Fig. 6) and this is due to the difference in logical definition of the tree structure which does not affect the final results.

Fig. 2

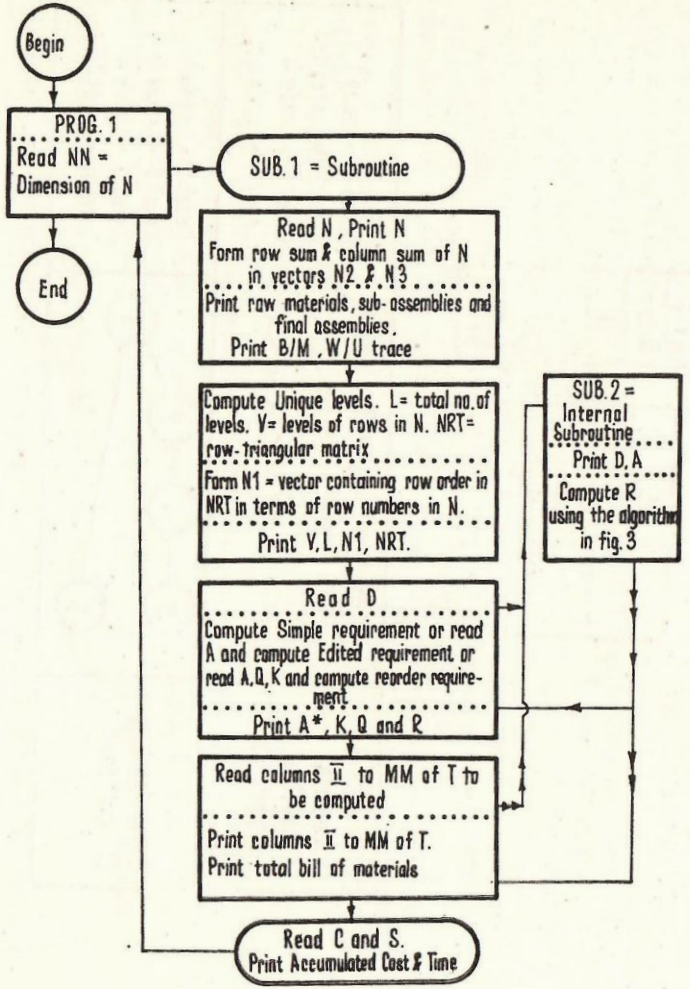
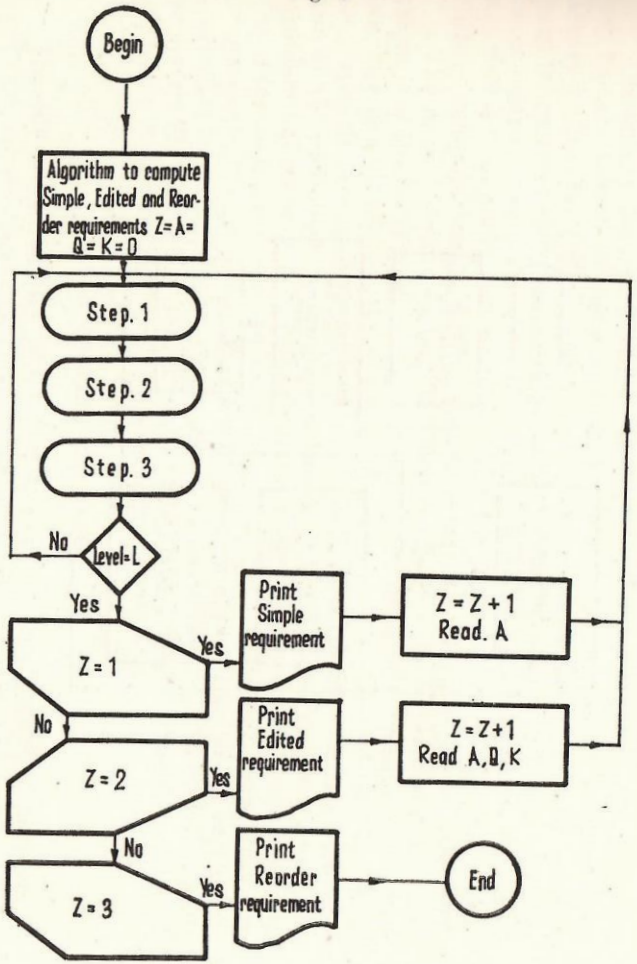

Begin
PROG. 1
Read NN = Dimension of N
End
SUB. 1 = Subroutine
Read N, Print N
Form row sum & column sum of N in vectors N2 & N3
Print raw materials, sub-assemblies and final assemblies.
Print B/M, W/U trace
Compute Unique levels. L= total no. of levels. V= levels of rows in N. NRT= row-triangular matrix
Form N1 = vector containing row order in NRT in terms of row numbers in N.
Print V, L, N1, NRT.
Read D
Compute Simple requirement or read A and compute Edited requirement or read A, Q, K and compute reorder requirement
Print A*, K, Q and R
Read columns II to MM of T to be computed
Print columns II to MM of T.
Print total bill of materials
Read C and S.
Print Accumulated Cost & Time
SUB. 2 = Internal Subroutine
Print D, A
Compute R using the algorithm in fig. 3

Fig. 3


Begin
Algorithm to compute Simple, Edited and Reorder requirements Z=A=Q=K=0
Step. 1
Step. 2
Step. 3
Level=L
No
Yes
Z = 1
Yes
Print Simple requirement
Z = Z + 1 Read. A
No
Z = 2
Yes
Print Edited requirement
Z = Z+1 Read A, Q, K
No
Z = 3
Yes
Print Reorder requirement
End

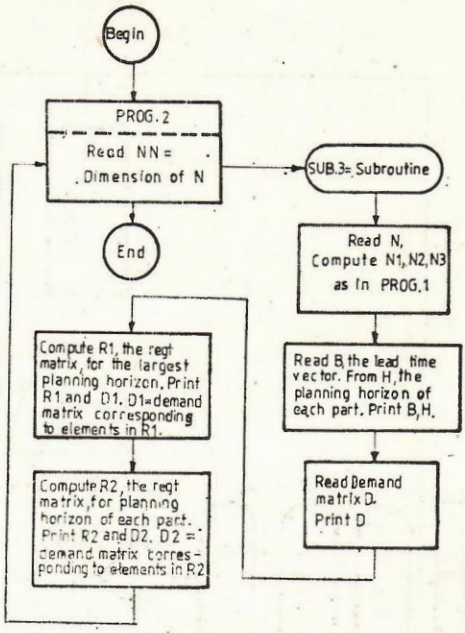


Fig. 4

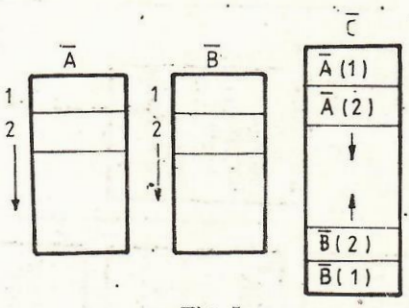


Fig. 5

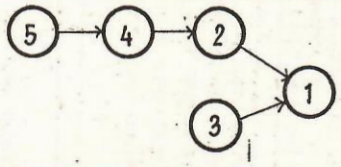
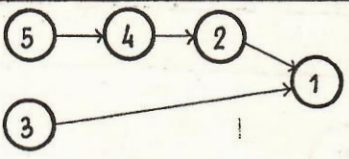
Loewner's algorithm (4 iterations)		Level 1 = node 1 Level 2 = nodes 2, 3 Level 3 = node 4 Level 4 = node 5
This algorithm (2 iterations)		Level 1 = node 1 Level 2 = node 2 Level 3 = node 4 Level 4 = node 3,5

Fig. 6

5. APPLICATIONS TO TYRE MANUFACTURING

The theory discussed earlier was applied for production planning in a tyre factory whose identity cannot be revealed for obvious reasons. The factory makes about 40 different types of tyres every day and on an average about 25 parts go into the assembly of each tyre. Roughly, 1000 types of tyre components are needed to meet the daily production programme, which varies from one day to another. Hence the need for fast, accurate, up-to-date and efficient computation of parts requirements for daily production planning.

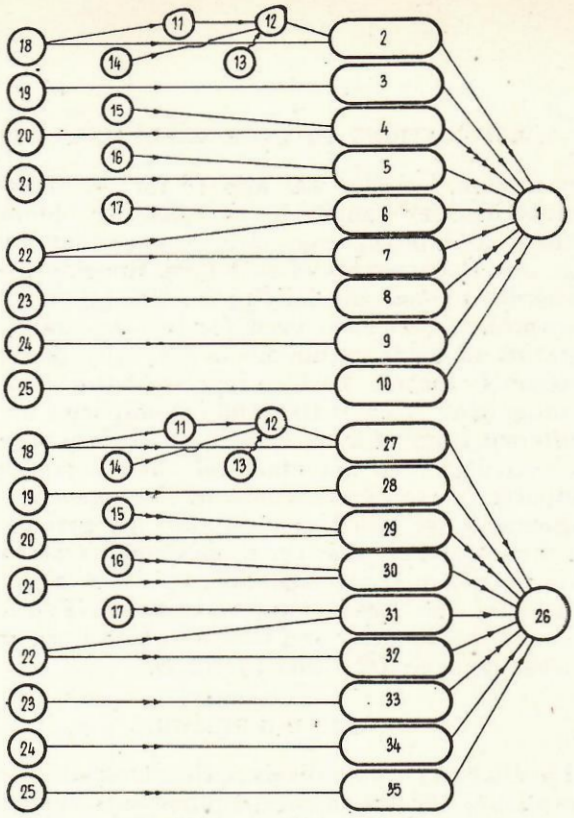
The next assembly matrix N which represents the whole manufacturing system is of the order of $40 \times 25 = 1000$ and for simplicity we have considered here only two different types of tyres (Fig. 7) and it is assumed that the same raw materials are used in their manufacture. The cut section of a tyre and some of the computer printouts are shown in the appendix, where the time dependent requirements are based upon a planning period of one planning horizon for each part. Assuming that the production is started right from the raw materials, the entries in D corresponding to the '*' sign in D2 can never be satisfied because of the "lead time" restrictions (Fig. A4 and Fig. A5). The matrix $R2$ shows the quantity and time at which work should be started in order to meet the demand $D2$ derived from D.

6. CONCLUDING REMARKS

The edited availability which displays the stock situation of each component (not shown here) and the reorder requirements vector (Fig. A3) which specifies the production programme (or buying from outside) of each component were found to be extremely valuable. Similarly, the time dependent requirement computations which identified the quantity and time at which work to be started were of immense use to the production manager in formulating an optimum production planning programme. In a large scale manufacturing environment, customer orders fluctuate continuously and it is impossible to produce fast, accurate and up-to-date schedules and orders by manual methods. Computer-aided production planning fills this gap and furthermore, it is now possible to forecast the implications of shortages of components or the cancellation of orders or the effect of engineering changes on the overall production programme and delivery schedules. The computerised planning system collects a wide variety of statistics which are vital for forward planning in several areas such as physical planning, financial planning and manpower planning.

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Tree Diagram of Tyre Assembly

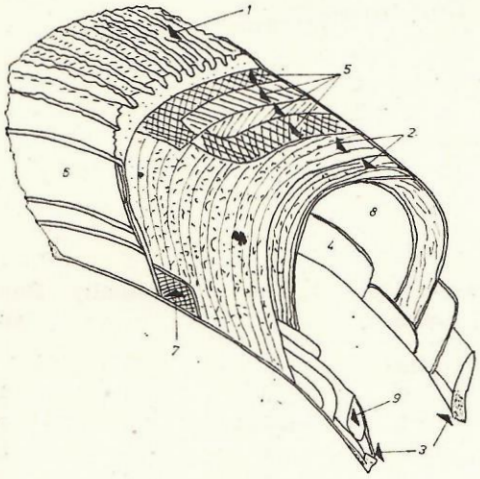
Part No.	Name	Lead Time
1 (26)	Finished Tyre.	6
2 (27)	Beads	4
3 (28)	Tread	5
4 (29)	Breakers	4
5 (30)	Chafers	6
6 (31)	Ply. 2	6
7 (32)	Ply. 1	5
8 (33)	Sidewalls.	7
9 (34)	Strips	6
10 (35)	Undertread.	9
11	Fillered apex.	2
12	Apexed bead	5
13	Friction-Material	3
14	SteelWire.	3
15	Fabric. 1.	3
16	Woolcloth.	3
17	Fabric. 2	3
18	Ruber Compoun. 1.	3
19	„ „ 2.	3
20	„ „ 3.	3
21	„ „ 4.	3
22	„ „ 5.	3
23	„ „ 6.	3
24	„ „ 7.	3
25	„ „ 8.	3

FIGURE 7b

APPENDIX

FIGURE A1

CUT SECTION OF A TYRE.



1. Tread.
2. Plies.
3. Beads.
4. Chafer.
5. Breakers.
6. Sidewall.
7. Chafer Strip.
8. Inner Lining.
9. Fillered Apex.

Matrix N

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0
0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 0 0 0 0
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

FIGURE A2

Part Number	Level Number
1, 26	1
2—5, 7—10, 27—30, 32—35	2
1 2	3
6, 11, 31	4
13—25	5

Reorder Requirements

Part no	Demand vector	Availability vector	R. Point	R. quantity	Requirement vector
1	90	12	20	15	98
2	0	9	3	6	190
3	0	2	7	6	103
4	0	5	6	5	393
5	0	6	4	2	194
6	0	3	5	8	196
7	0	4	2	5	96
8	0	2	2	2	196
9	0	6	7	1	197
10	0	8	5	1	95
11	0	0	0	0	339
12	0	0	0	0	339
13	0	0	0	7	339
14	0	0	9	8	348
15	0	0	0	6	995
16	0	0	5	6	489
17	0	0	7	8	485
18	0	0	0	0	827
19	0	0	0	0	247
20	0	0	0	0	995
21	0	0	0	0	484
22	0	0	0	0	722
23	0	0	0	0	484
24	0	0	0	0	493
25	0	0	0	0	251
26	70	10	15	10	75
27	0	3	2	6	149
28	0	4	1	7	72
29	0	5	6	5	301
30	0	7	2	4	145
31	0	6	8	2	146
32	0	8	2	3	69
33	0	9	3	5	144
34	0	6	4	6	148
35	0	2	5	5	78

FIGURE A3

PART NO	LEAD TIME	PLANING HORIZON	PART NO	LEAD TIME	PLANNING HORIZON
1	6	21	18	3	3
2	4	14	19	3	3
3	5	8	20	3	3
4	4	7	21	3	3
5	6	9	22	3	3
6	7	10	23	3	3
7	5	15	24	3	3
8	7	10	25	3	3
9	6	9	26	8	23
10	9	12	27	4	14
11	2	5	28	5	8
12	5	10	29	4	7
13	3	3	30	6	9
14	3	3	31	7	10
15	3	3	32	5	15
16	3	3	33	4	7
17	3	3	34	6	9
			35	9	12

DEMAND MATRIX D

90	82	60	45	75	55	75	99	50	85	70	50	70	95	80	45	65	89	70	99	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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FIGURE A4

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	50	45	65	75	50	70	90	80	55	40	65	75	85	99	70	65	80	55	80	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DEMAND MATRIX D2

*	*	*	*	*	*	75	99	50	85	70	50	70	95	80	45	65	89	70	99	0	0	*	*
*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	0	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*
*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	0	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	80	55	40	65	75	85	99	70	65	80	55	80	0	0	0	0
*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*
*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	0	0	0	0	*	*	*	*	*	*	*	*	*	*	*

FIGURE A5

REQUIREMENTS MATRIX R2

75	99	50	85	70	50	70	96	80	45	65	99	70	99	0	0
140	100	140	190	160	90	130	198	140	198	0					
50	70	95	80												
280	200	280	390												
140	190	160	90												
165	179	45	65												
50	70	95	80	45	65	99	70	99	0	0					
190	160	90	130												
140	190	160	90												
45	65	99	70												
358	140	198	0												

250 240 358 140 192 0
140
140
940
410
175
470
210
940
410
385
410
410
70
80 55 40 65 75 85 99 70 65 80 55 80 0 0 0 0
150 170 198 140 130 160 110 160 0 0 0
85 99 70 65
300 340 396 280
198 140 130 160
70 65 80 55
85 99 70 65 80 85 80 0 0 0 0
150 170 198 140
198 140 130 160
80 55 80 0

PLANIFICATION DE LA PRODUCTION A L'AIDE DE L'ORDINATEUR DANS UNE FABRIQUE D'ENVELOPPES

Pour formuler une stratégie de planning optimal de la production, il est extrêmement important de connaître rapidement, exactement et à jour les nécessités en parties composantes dépendantes ou indépendantes du temps. On y présente une nouvelle méthode pour améliorer l'efficacité de l'algorithme de Loewner pour le calcul des besoins des parties composantes. L'importance de la planification de la production à l'aide de l'ordinateur dans les grands systèmes de fabrication est illustrée au moyen d'une étude effectuée dans une fabrique d'enveloppes.

ПЛАНИРОВАНИЕ ПРОИЗВОДСТВА С ПОМОЩЬЮ ЭВМ НАЗАВОДЕ, ПРОИЗВОДЯЩЕМ ШИНЫ

Пёи определении стратегии оптимального планирования производства крайне важно узнать быстро, точно и актуализированно спрос на составные части, зависящие или независящие от времени. Дается новый метод для улучшения качества алгоритма Лёвнер, применяемого при определении нужд в составных частьях. Значение планирования производства с помощью ЭВМ в крупных производственных системах проиллюстрировано при помощи исследования, проведенного на заводе, производящем шины.

16.VIII.1978