SIMULATING MATERIAL REQUIREMENTS PLANNING ON LOTUS 1-2-3

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ABSTRACT

This paper discusses the suitability of simulating material-requirements-planning (MRP) problems on Lotus 1-2-3. It gives an example of such a simulation, suggests techniques to enhance user-friendliness, and proposes that students may be assigned to work with the template in number-entering mode or formula-entering mode. Because learning is profoundly affected by the extent to which students are motivated for performance or motivated for learning, the two modes may Induce different motivations, and consequently, lead to different effects on learning.

INTRODUCTION

Material Requirements Planning (MRP) is a computerized system for managing materials used in producing goods. Its importance in the study of manufacturing operations is well-recognized. Gaither (1986) has noted that “no course in (production and operations management] is complete today without a treatment of MRP” (p. 505).

Although MRP is covered in several simulations (Able Associates, 1983; Greenlaw & Hottenstein, 1969; Fok, Kwong, & Hiranyawasit, 1987; Pray, Strang, A Burlingame, 1984) written in languages such as Fortran, Basic, and Pascal, the fact that MRP contains, as Dilworth (198b) notes, “no complex and sophisticated mathematical models” (p. 3C9) makes the subject suitable for spreadsheet simulation. In fact, simulation by spreadsheet is uniquely appropriate to the task because spreadsheet templates may be designed to allow students to enter formulas in place of or in addition to numbers, a feature difficult to implement in rudimentary computer languages.

The difference between students entering numbers and students entering formulas into a simulation is not of trivial consequence. A student can enter numbers that work correctly while understanding little of the structure of the problem. The likelihood, however, that a formula entered without understanding will work correctly in any situation is exceedingly small, a lesson quickly learned by every beginning programmer. In essence, when students are required to enter numbers into a simulation, good performance is demanded of them, but when they are required to enter formulas, good learning is that which is demanded. Thus, motivation for performance or motivation for learning may be induced by the demands of a simulation. The qualitative difference in motivation so induced can, as Dweck (1986) has observed, have profound effects on learning.

Recognizing the value of students entering formulas, Schroeder and Gentry (1987) suggested that students be required to develop their own templates for MRP. That approach, however, is feasible only if either the MRP system is exceedingly simple or several weeks of class are allocated to the task. In the case when a complex MRP system must be covered in a week, which is usual in most introductory courses in production and operations management, that approach is infeasible.

This paper shows how a template for a complex MRP system can be created. It discusses several ways of making the template more “user-friendly,” and points out the possibility of judiciously encouraging motivation for learning by properly constructed students’ assignments.

IMPLEMENTATION

The essence of an MRP system is the proper organization of data so that material and capacity requirements can be computed readily from a production schedule. A complex MRP system consists of the following elements:

1. product-structure tree
2. routing file
3. Item master file
4. bill-of-materials file
5. work-center master file
6. master-production-schedule record
7. material-requirements-planning record
8. capacity-requirements-planning record

Examples of these elements taken from our particular implementation is shown in Figures 1 through 8 below.

FIGURE 1
PRODUCT-STRUCTURE TREE

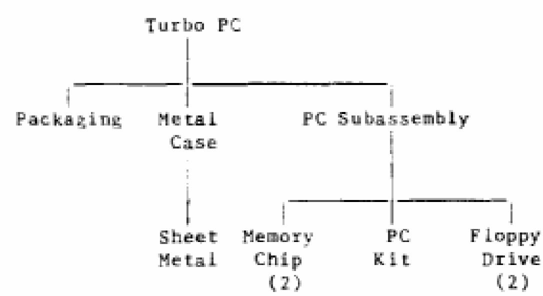

FIGURE 2
ROUTING FILE

PC Subassembly OPS No.	Operation	Setup	Run	Move	Queue	Setup+Run
		------Standard Time (hr)-------				
1	Assembling	4.00	0.05	5.00	24.00	0.090
2	Testing	3.00	0.04	5.00	24.00	0.070

FIGURE 3
ITEM MASTER FILE

Item No.	1	2	3
Description	Turbo PC	Floppy Drive	Hard Drive
Unit of Measure (U/M)	Each	Each	Each
Unit Cost	$550.00	$99.00	$288.00
Item Type	End	Part	Part
Lead Time	1	2	2
Manufactured/purchased	M	P	P
No. Of Parents	0	2	1
Low Level Code	0	2	2
Setup/order Cost	344	50	50
Carrying Rate/period	0.01	0.005	0.005
On-hand Quantity	100	50	33
Order Policy	LFL	FOQ	FOQ
Std. Lot Size		400	144

FIGURE 4
BILL-OF-MATERIALS FILE

Item No: 1 Description: Turbo PC Item Type: M

Relative Level	Item No.	Description	Item Type	Qty. Per
.1	9	Packaging Kit	P	1
.1	5	PC Metal Case	M	1
..2	13	Sheet Metal 1'x3'	P	1
.1	7	PC Subassembly	M	1
..2	10	Memory Chip	P	4
..2	11	PC Kit	P	1
..2	3	Floppy Drive	P	2

FIGURE 5
WORK-CENTER MASTER FILE

Work Center No.	1	2	3	4	5
Description	Assbly	Test	Stamp	Form	Weld
Utilization %	0.95	0.95	0.95	0.95	0.95
Efficiency %	0.99	0.98	0.91	0.91	0.93
Work Day/Week	5	5	5	5	5
Shift/Day	1	1	1	1	1
No. of Hours/Shift	8	8	8	8	6
No. of OT Hr./Shift	4	4	3	4	2
No. of Machines	4	3	2	2	3
No. of Laborers	4	3	2	2	3
Machine Rate ($/hr)	0	0	0	0	0
Labor Rate ($/hr)	6.5	10	12	12	12
OT Labr Rate ($/hr)	10	14	16	16	16
Reg Capacity/Week	150	112	69	69	106
OT Capacity/Week	75	56	26	35	27

FIGURE 6
MASTER-PRODUCTION-SCHEDULE RECORD

Turbo PC OH=100 LS=LFL LT= 1 OP=LFL

Period	1	2	3	4	5	6	7	8
Forecast	25	60	70	20	30	50	40	70
Cust. Order	12	2	15	6				
Gross Req't	25	60	70	20	30	50	40	70
Sch Receipt	0	40						
Proj OH	75	55	35	15	55	5	75	5
Net Req't	0	0	0	0	0	0	0	0
MPS Receipt	0	0	50	0	70	0	110	0
MPS Release	0	50	0	70	0	110	0	110

FIGURE 7
MATERIAL-REQUIREMENTS-PLANNING RECORD

PC Metal Case LCL= 1 OH= 0 LS=100 LT= 1 OP=FOQ

Period	1	2	3	4	5	6	7	8
Gross Req't	0	50	0	70	0	110	0	110
Sch Receipt	100							
Proj OH	100	50	50	80	80	70	70	60
Net Req't	0	0	0	-20	0	-30	0	-40
PO Receipt	0	0	0	100	0	100	0	100
PO Release	0	0	100	0	100	0	100	0

FIGURE 8
CAPACITY-REQUIREMENTS-PLANNING RECORD

Assembly Reg Cap= 150. OT Cap= 75.2

Period	1	2	3	4	5	6	7	8
Total Load	24	187	108	186	132	231	117	246
Reg Cap Hr	24	150	108	150	132	150	117	150
OT Hr	0	36	0	36	0	80	0	95
% Reg Load	16	100	72	100	88	100	78	100
% OT Load	0	48	0	47	0	106	0	126
Suf. Cap	Yes	Yes	Yes	Yes	Yes	No	Yes	No

TECHNIQUES FOR USER-FRIENDLINESS

in implementing a simulation on a spreadsheet, the user-friendliness of the Implementation is important. An unfriendly implementation irritates, and becomes a hindrance to learning. A few of the less obvious techniques for making a spreadsheet template more user-friendly are discussed below,

Use of Page-Up, Page-Down, Tab, and Shift-Tab Keys

Lotus 1-2-3 displays a screen of 20 rows and a variable number of columns. By grouping items such that they consist or a complete unit of display within the confines of a screen, users may rely upon the paging and tab keys to page across displays. This makes it unnecessary to stroll the screen, which tends to cause disorientation.

Prompt for Input

Unprotecting cells for input in a 1-2-3 spreadsheet has the effect of accenting the cells by color or intensity, depending on the monitor in use. To call for input in these cells, the cell may contain a label, such as the following:

B3: ‘ ____?____

In the first release of 1-2-3, formulas referencing labeled cells assigned the cells zero value; in the second release, however, such a reference results in error, indicated by ERR. To prevent such ERR’s from cluttering a template, reference to the labeled cell may be called through the second release’s @N function, as follows:

B4: @N(B3)

Informative Error-Trapping Messages

Perhaps nothing else is so helpful in learning than the informative trapping of errors. The second release of 1-2-3 allows labels to be printed conditional upon calculations. This enables the template to include informative error traps, such as the following:

B5: @IF(C4<0,” Not enough capacity.”,””)

STUDENT ASSIGNMENTS

Students can be assigned to work with the MRP template in two modes. In number-entering mode, the students would be told to change certain values, such as MPS Receipt on the Master-Production-Schedule Record, and observe the consequences on capacity, inventory, and cost. In formula-entering mode, the students would be told to enter formulas such as to yield the right values. In the first instance, the students would be taught to use a template; in the second, they would be taught to create one. The differential effects on motivating and learning of the two alternative modes have not yet been studied.

SUMMARY

The simplicity of the mathematics in MRP problems, and the complexity of relationships involved make such problems suitable for simulation in a spreadsheet. A unique advantage of using a spreadsheet for such simulations is the possibility of designing the spreadsheet such that students are required to enter formulas, instead of numbers.

To implement an MRP system on a spreadsheet, the MAP data base must be carefully organized. Matters of user-friendliness must be addressed. Students assigned to work with the MRP template can be directed to work in number-entering mode or formula-entering mode. The differential effects of these two modes on motivation and learning are worth investigating.

REFERENCES

Able Associates (1983), TEAM, Bethel, CT: Author.

Dilworth, James B. (1986), Production and Operations Management: Manufacturing and Nonmanufacturing (3rd ed.), New York: Random House.

Dweck, Carol 5. (1986), “Motivational Processes Affecting Learning,” American Psychologist, 41, 1040-1048.

Fok, Wing, Kern Kwong, and Chairat Hiranyawasit (1987), “Teaching Production and Inventory (PIM) Courses with PC-MAPICS” (Abstract), in E. C. Barnhart (Ed.), Conference on Computing in Undergraduate Education, Pittsburgh, PA.

Gaither, Norman (1966), Production and Operations Management: A Problem-Solving and Decision-Making Approach (3rd ed.), Hinsdale, IL: The Dryden Press, 1986.

Greenlaw, p. S. and M. P. Hottenstein (1969), PROSIM: A Production Management Simulation, New York: Harper & Row.

Pray, T. F., 0. R. Strang, S. C. Gold, and D. E. Burlingame (1984), DECIDE-P/OM: An Interactive Computer Simulation for Production/Operations Management, New York: Random House.

Schroeder, David L. and James W. Gentry (1987), “Teaching MRP Experientially Through the Use of Lotus 1-2-3,” Developments in Business Simulation and Experiential Exercises, 14, 179-182.