The MENTOR Game: Production Planning and Stock Control in Manufacturing Industry

by Nigel Hiley and Martin Wynn

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Introduction

In 1979, a new production planning and stock control computer system was introduced at Glaxo Pharmaceuticals. This system, known as MENTOR, was implemented in stages at the company's three major secondary manufacturing sites in the UK (Ware, Speke and Barnard Castle), and at the central administration site at Greenford, London. MENTOR runs a network of Hewlett-Packard HP3000 mini-computers, and processes approximately 100,000 batch transactions and 5,000 customer orders per month. The system centres on forward planning of estimated demand whereby forecast orders are placed on the system up to nine months in advance of required delivery date. There are approximately 1,000 on-line programs of which about one-half are enquiry, and the other half data update.
Between 1982 and 1985, training courses were held at Greenford for staff from all four sites, in which full-blown simulations of the live network were run on a separate "test" minicomputer. While this worked well enough in familiarising staff in the use of their critical day-to-day computer programs, it did not adequately get over the broader principles of company production planning and stock control on which MENTOR had been based. This wider awareness is essential for many staff so that they may fully appreciate the significance of data available to them, and act effectively in consequent data enquiries and update.

Consider, for example, the screen shown in Figure 1, taken from the standard stock control enquiry program (?S/CPIR) and update option (SCAN ITEM). The complex relationship between:

- planned issues (what is planned to be issued out of store);
- planned receipts (what is planned to come into store);
- projected stock level (what there will be left in the store at any one time); and
- stock class (the rules which govern when a new receipt is placed)

are difficult to explain with words and diagrams. Worked examples on the computer can illustrate that inter-relationships exist but it requires an in-depth understanding of basic concepts fully to appreciate what those inter-relationships mean, and what to do about them. The development of a computer-based training package explaining these concepts was seriously considered, but the dearth of adequate software tools running on the HP3000 suggested another approach was required. Wynn's previous work in gaming simulation [1] led to attempts to build a game to encompass the key basic concepts of stock control, factory loading, materials explosion and materials availability checking. The game, described below, was co-authored with Nigel Hiley, who has since taken over responsibility for MENTOR training on the four sites mentioned above.

V805 **Display Planned Issues and Receipts on GPOSR** ?S/CPIR

Item 12345 Pack description Store no. SS Main unit EA

Item class	EK2HWA	Opening stock	Passed	3402758	under test	0
date	Reference	issues	tot-iss	Receipts	proj. stock	
	Open stock	0		0		
31-Jul-87	FOR0605439	1110979	1110979	0		
31-Jul-87	68096G	0		250000		
31-Jul-87	68102G	0		605226	3147005	
07-Aug-87	01070020	43000	43000	0	3104005	
31-Aug-87	FOR0605439	971283	0			
31 Aug-87	68097G	0		250000		
31-Aug-87	68103G	0		1000000	3382722	
30-Sep-87	FOR0605439	975891	985891	0		
30-Sep-87	68098G	0		260000		
30-Sep-87	68104G	0		800000	3456831	

Next selection Next key

Figure 1. Stock Control Enquiry Program ?S/CPIR (Enquiry on Stock Control Planned Issues and Receipts)

Game Overview

The MENTOR game is based on two related and overlapping processes at the heart of the MENTOR system. First is the flow of information that has to be recorded as the company PLAN to meet orders required sometime in the future. This information, which starts with the placement of a customer order, cascades downwards from the finished goods store (from whence the order will be issued), through production loading, on the relevant lines of machinery, to the placement of issues of raw materials and packaging components from the respective stores and the knock-on effect to suppliers. This process concerns information only - nothing has yet been made, bought or moved specifically for that order - and represents a plan of action for how and when that order will be made in the future.

The second process is the actual manufacturing of goods, the buying and issuing of raw materials and packaging components, the production and packaging processes, the issue of goods into, out of and between stores (ultimately to the customer), and the recording of these transactions, which should (in an ideal world) match the plan of action for any one order laid down in the planning stage.

In the game, as in reality, orders will be at various stages of these two processes throughout the game, and it is essential that participants think clearly about what they are doing and why.

With so much going on (see Figure 2) current and future stock levels have to be constantly recalculated as new issues and receipts are "placed" on stores (represented by trays) and existing ones removed as issues and receipts are made. Similarly, on the "loading board", representing the production and packing lines, planned orders must be placed, and then, as they are made, taken off and forwarded to the finished goods store to be matched against the appropriate planned receipt card. It is a game of constant but well-defined activity, which attempts to bring out the broader context and underlying principles which form the back-drop to the everyday activities of those involved in planning and undertaking the manufacturing process.

Figure 2. The MENTOR game in action

Game Equipment

Equipment used in the game is as follows:

Large machine loading board - used to show which orders are being made on which machine group and hence what time is available on each machine. There are two machine groups - one of which runs twice as fast as the other.

Small stores boards - used to hold stocks of raw materials, components and finished materials for issue to the production area and for customer orders.

Stores issues/receipts boxes - used to hold details of planned stores issues and planned stores receipts which are to be made by each of the stores (see Figure 3).

Planned stores issues cards - record details of issues to be made from the store with issue date/quantity/material code/order reference.

Planned stores receipts cards - record details of receipts to be made from the store with receipt date/quantity/material code/order reference and either issue date for production materials or purchasing reference number.

Magnetic item squares/loading strips - each material is represented by a particular colour magnetic square. Orders which have been loaded on to a machine group are represented by rectangular strips of that item which is being produced.

Bill of materials cards - used to show what component/raw materials are required to make a finished item and hence to work out what planned stores issues cards need to be written out.

Machine group cards - used to show how long it takes to make one of each finished item on each of the machine groups, e.g. Group 1 takes one day to produce one green item.

Inventory cards - used to show the rules for the stock controller for each item, i.e. the minimum and maximum stocks which must be held, for example the minimum and maximum stock for green items is five and ten respectively.

Lead time cards - used to show the purchasing buyers how long it will normally take to get materials into the factory from the supplier, e.g. black items normally take ten weeks.

Role Briefs

There are 11 separate roles in the game. These can be doubled up or combined, so that between 10 and 15 people can play the game. The roles are as follows:

Finished goods storeman
Finished goods stock controller
Equipment planner
Materials planner
Production section head
Components storeman
Components stock controller
Components buyer
Raw materials storeman
Raw materials stock controller
Raw materials buyer.
In addition, a supplier is required to supply raw materials
and a customer to issue orders and receive goods.

Two examples of the role briefs given out to the participants:

(1) The *finished goods stock controller* has to generate planned stores receipts cards in order to satisfy the inventory rules for each item in the finished goods store. To do that, she/he looks at the current stock in the store and calculates the projected stock based on the planned stores issues to be made.
(2) The *materials planner* generates planned stores issues cards based on the planned stores receipts cards which the finished goods stock controller has created for each material used to make up the finished item. Those planned issue quantities are based on the bill of materials cards referred to earlier.

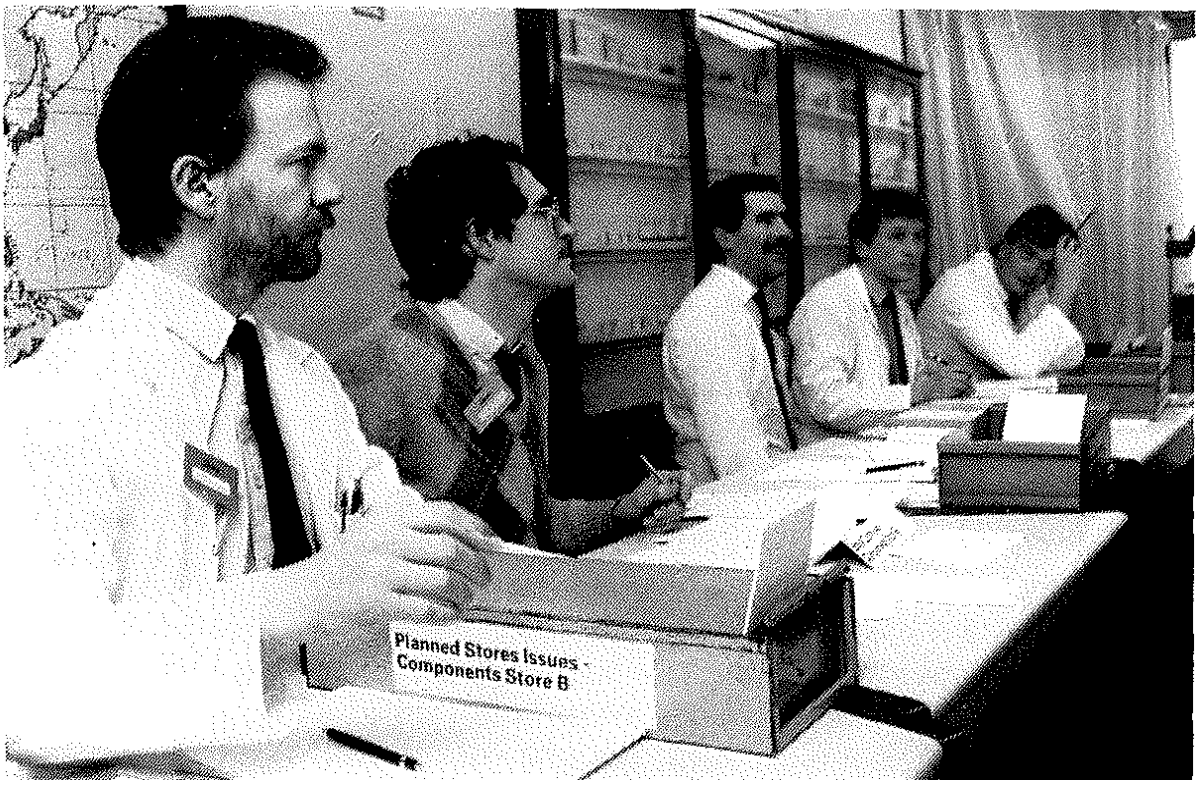

Figure 3. Storeman Undertaking Stock Control with Planned Issue and Receipt Cards

Stages of Play

The game is initially set up with some production orders fully or partly loaded on to the game boards and customer orders waiting to be processed. The game proceeds in rounds of one month, further divided into one-week slots. In essence, all issues and receipts to be made during a week must be completed where possible and all production completed for a week. Future actions such as generating planned stores issues/receipts should also be carried out as soon as the information on which they are based is available.

At the start of the cycle, the finished goods storeman issues the goods from his store to satisfy the customers' orders for that week. He notifies the stock controller of any stock shortages or failure to supply. The stock controller generates planned stores receipts to satisfy the inventory parameters and liaises with the equipment planner to ensure that these will be met.

The equipment planner loads these planned stores receipts on to the equipment board and marks them up with the order reference. The materials planner then looks at these loaded orders and creates planned stores issue cards for the materials required to make these orders and places them in the appropriate raw material/components stores boxes.

The production section head may move around the loaded orders on the equipment board and is also responsible for sending finished goods to the store and making sure that materials issues to production are made correctly. The raw materials/component storeman/stock controller then carry out the same actions for their stores as were detailed for the finished goods stores.
The purchasing buyers are responsible for negotiating with the supplier to ensure that materials are available for issue as required. If the materials are required within the lead time then the supplier makes the decision on whether the supply, based on the throw of a dice. If the material cannot be supplied as required the buyer then informs the stock controller of the fact.

As the game progresses, it becomes clear that some orders cannot be met and decisions must then be made as to which are the more important orders. All the players in the game are kept fully informed of such decisions and the cards and board are amended accordingly. The end of the game is arbitrary but could in theory occur when all the customers' orders have been met.

Concluding Remarks

The MENTOR game is now used systematically and periodically to clarify the macro-context within which production and materials management staff carry out their daily duties and transactions, many of which involve the use of on-line computer programs. Debriefing sessions suggest that the simulation provides an insight into the complexities of production planning and the manufacturing process in general not easily achieved by other teaching methods. Although the game itself is a gross simplification of reality, it does enable participants to see *their* real-life role in the broader context of the company's manufacturing process; and through further discussion and worked examples, specific on-line computer programs are linked to key activities and processes highlighted in the game.

Participants see in the game the sequence of events that follow the placing of a customer order, and realise just how important it is for deadlines to be met at *all* levels in the production chain, if the customer is not to be kept waiting. If running the MENTOR game only serves to bring home this business truth, then it will be time well spent.

Reference

1. Wynn, M.G., *Planning Games,* E & F N Span, London and New York, 1985.