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The Lego Truck Game - A game of production control

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The Lego Truck Game demonstrates the relationship between material and production control through a number of departments in a total supply- and production chain. The game illustrates the use of different production control principles and organizations and in particular the connection between production- and information lead time, and the importance of synchronizing the material flow. Furthermore, the game is excellent to illustrate the concept of dynamics and uncertainty in production and production control. In the game the effects of using different production control principles can be calculated as well in economic terms as in terms of delivery accuracy.

The game is first and foremost an educational game aimed at students, but it can also be used in industry training foremen, purchasing- and production control staff. The duration of a game run varies from 3 to 6 hours. A game team may be between 4 and 6 persons. An experienced game director can handle 4 - 5 game teams simultaneously.

Keyword Codes:
Keywords: Teaching, Production Control, Production Systems, Logistics

1. THE GAME SET UP

The Lego Truck Game consists of three departments in a supply chain. The functions in questions are Delivery/Assembly, Manufacturing, and Supply. The products manufactured and sold are trucks in two variants: Pick-up (PUT) and fully enclosed trucks (FET). Table 1 shows the BOM of the Put variant and table 2 the FET variant.

J. O. Riis (ed.), *Simulation Games and Learning in Production Management*

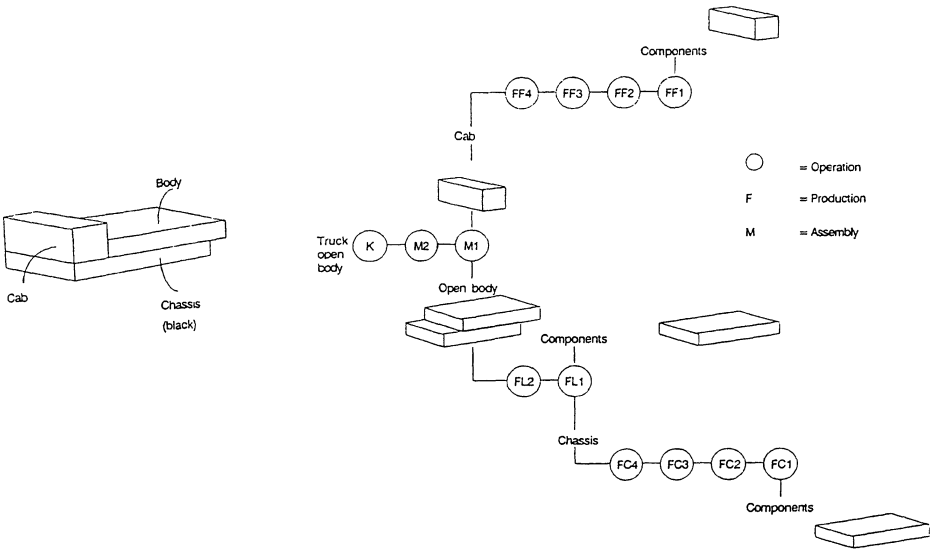

Table 1: BOM of the PUT truck variant.

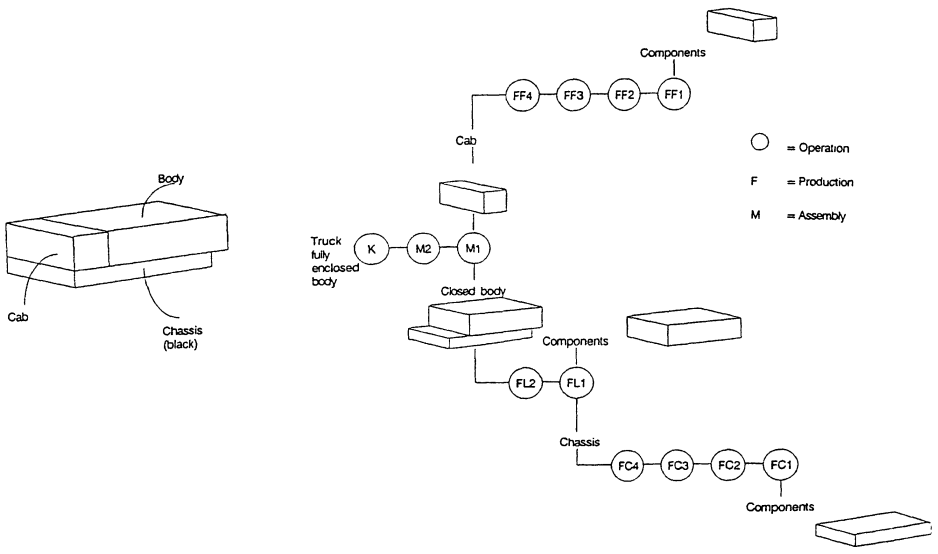

Table 2: BOM of the FET truck variant.

Table 1 and 2 shows that the chassis and cab are common parts, and form part both in the PUT and FET variant of the truck.

Table 3 shows the material flow from right to left. The suppliers deliver raw material for the cab and body directly into production. The supplier also delivers chassis with engine fitted. The chassis undergoes 4 operations before being delivered (FC1, FC2, FC3, and FC4). The COS and the CHS inventory are managed by the Purchasing Department.

In the Manufacturing Department the cab is built up in 4 stages (FF1 to FF4). The body is assembled to the chassis in the body manufacturing area. The PUT version has 2 stages (FL1, FL2) and the FET version 4 stages (FL1 to FL4). The pick-up versions (PUT) are built to stock whereas the closed version (FET) is made to custom orders. Consequently, cabs and open bodies can be stored as intermediate parts (WIPS).

The Delivery/Assembly Department assembles the cab to the body. This assembly operation takes place in two stages and one inspection stage (M1, M2, and final inspection). The PUT version of the truck is stored at FGS, and the FET version is dispatched directly to customer.

Table 3 also shows the information flow of the game. Customer orders are given to the Delivery/Assembly Departments. PUTs are delivered directly to customer from stock (FGS) - if possible, whereas FET's are ordered to the Manufacturing Departments and produced to order.

The Delivery/Assembly Department does not know the exact demand for trucks, but they are provided with a forecast revealing the pattern of the demand and the approximate sales volume of each of the truck variants. In the light of this information the department estimates the expected sales for the coming periods, and plans the PUT inventory and assembly accordingly.

Based on the inventory status of intermediate parts (body and cabs) and the expected assembly needs (not necessarily equal to sales) in the coming periods, the Manufacturing Department launches a production plan for cabs and bodies every fourth period. In the production plan the department decides for the next four time periods how many units to produce each time period. The schedule cannot be exceeded, but the department can decide not to use the capacity at the expense of a penalty.

The production plan goes to the Purchasing Department for information. Based on this plan and the explications for future sales the Purchasing Department plans for the next four time periods. The plan is fixed and cannot be exceeded, but as in manufacturing the department can decide not to use the capacity at the expense of a penalty. The Purchasing Department re-schedules every fourth time period.

Assembly capacity, body and chassis production can only be decreased/increased by one unit per time period.

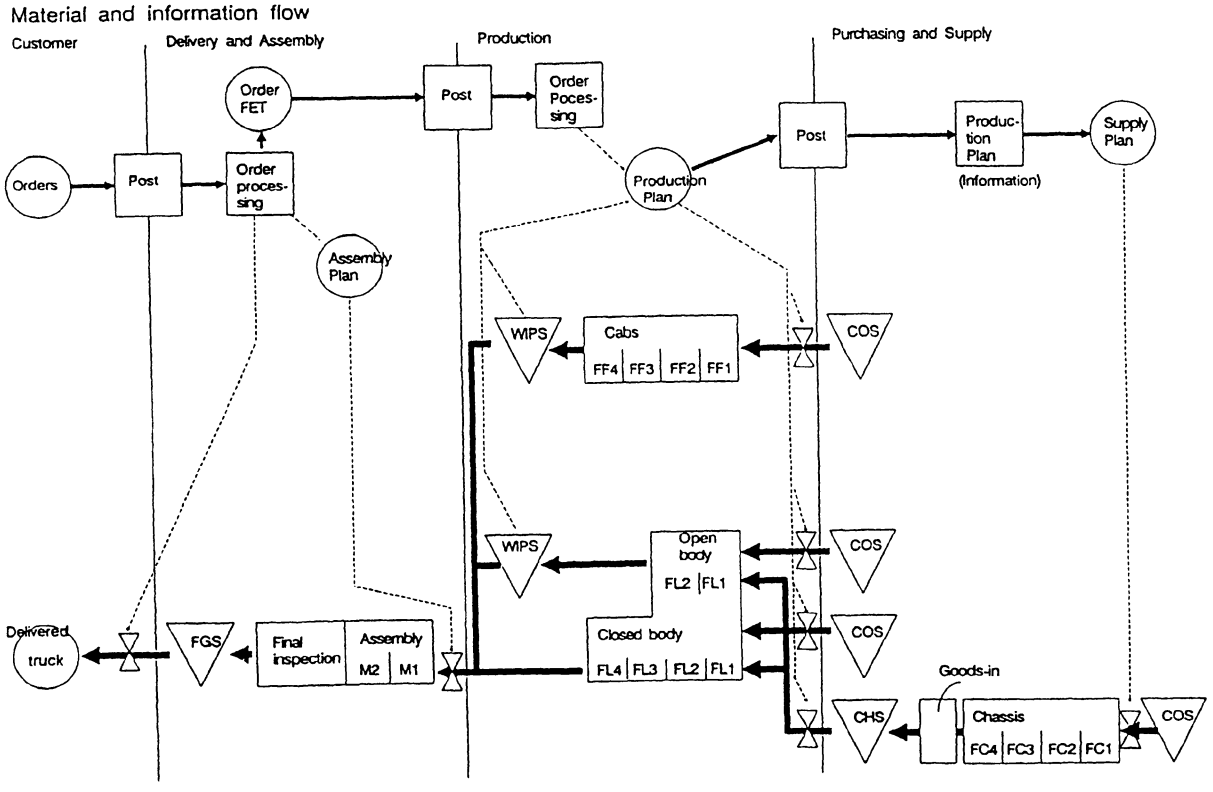

Table 3: The material flow in the game

2. THE GAME DYNAMIC

The Lego Truck Game is driven by customer orders, supplied by the game director. Each time period the Delivery/Assembly Department is provided with a set of orders, PUT is delivered from stock and PET is ordered directly in the Manufacturing Department. If the Delivery/Assembly Department is not able to meet the demand of PUTs orders are recorded as back orders, and must be delivered as soon as possible.

The game runs over approximately 25 time periods. Each time period simulates a day or week. Time is controlled by the game director on a visible clock board. Every time period all functions in sequence carry out order processing, supply and production respectively, planning and order placing. There is an instruction for each function. It is important that all players follow the timescale of the game.

Orders are placed and planned in the following manner:

- The customer places an order at the Delivery/Assembly Department - for one period at a time.
- The Delivery/Assembly Department starts every time period with the assembly of trucks. The number of trucks assembled is calculated partly on the basis of the inventory status partly on the expected and actual demand. New orders for FETs are placed directly at the Manufacturing Department.
- The Manufacturing Department makes a new production schedule every fourth time period. The schedule covers four time periods, and the first schedule is made in period one.
- The Purchasing Department makes a new delivery schedule every fourth time period. Also this schedule covers four time periods, but the first plan is made in period two. The plan for the first time period is given by the game director.

Plans and orders placed cannot be changed.

The physical production of the lego trucks takes place on a game board by advancing the lego bricks one operation each time period. This also simulates the lead time in supply, manufacturing and assembly. Similarly, information is sent from department to department to be available in the next time period, this simulates the information lead time.

After each time period each function records inventory level, capacity utilization, production and deliveries, and back-orders. At the end of the game results are accumulated and the final result of the game is calculated. Table 4 shows the values taken into account.

If several game teams are competing against each other, the game team with the lowest total cost has won the game.

	$ pr. time periods
Back orders (PUT)/time period	200
Unused capacity/time period, Assembly	200
Unused capacity/time period, Manufacturing	200
Unused capacity/time period, Supply	200
Inventory (FGS)/time period	100
Inventory (Chassis - WIPS)/time period	60
Inventory (Cab - WIPS)/time period	40
Inventory (Chassis - CHS)/time period	40

Table 4: The Lego Truck Game values.

3. PLAYING THE GAME

The Lego Truck Game can be played in different ways. Usually the game is played two times with two different game set ups. In the first game a standard game set up is used. In this game the game team has little influence on the planning procedures and the principles of production, including the production- and information lead time. Each function has to do its own planning, based on available information - which at start is rather scarce. The individual function must plan capacity for a number of periods and order their supplies considering the given lead time. Usually the first game will reveal a cascade effect due to variation in sales, and poor synchronizing of the material- and information flow.

In the second game the players are allowed to change the game set up. They can change the organization, establish a logistical planning function, speed up planning e.i. by synchronizing information flow, shorten production lead time e.i. by introducing group technology and cellular manufacturing, etc. In the game players also are allowed to change the principles of production e.i. from a push to a pull principle, or introduce the principles of TQM and consequently reduce the time used on quality inspections. After the changes have been carried out the game is played a second time to see the effects of the changes.

A game course can be organized as follows:

1) Introduction to the Lego Truck Game (Purpose, game set up, rules, etc) - Approximately 30 minutes
2) Playing the game (20 - 25 time periods) - Approximately 60 minutes
3) Compute game results and game debrief - 30 minutes
4) Reorganizing/-designing the game - Minimum 120 minutes
5) Presentation of new solutions (plenum) - (5 - 10 minutes pr. team)
6) Playing the game (20 - 25 time periods) - Approximately 60 minutes
7) Compute game results and game debrief - 30 minutes

The duration of a game can vary from 3 to 6 hours depending on whether the game is played one or two times.

A game team may be between 4 and 6 persons. An experienced game director can handle 4 - 5 game teams simultaneously.

4. GAME EXPERIENCE

The game has primarily been used as an educational tool in an introductory course of production management, and in this connection the game especially has been used to illustrate the complexity of production control. The game has also served as an excellent opportunity to introduce and train the students in selected production management modelling and design techniques. Especially, the game has been used to introduce the students to the Production Management Concept. The students have been pleased and motivated when playing the game, and using the game in classes has been very cost-effective.

The Lego Truck Game has been used in industry, but the experiences are relatively sparse. The game, also from an industrial point of view, has a complexity and relevance which makes it relevant also for industry people. The game has for instance been used in team building processes and for introduction of the Production Management Concept.