A High Rate of Stock Turnover Discipline

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In this paper a high rate of stock turnover discipline postulated by Burbidge & Duckworth in *Opl. Res. Q.* will be verified by the Japanese manufacturers' data of recent ten years gained in the author's sample survey and case study. This discipline involves small batches and rapid turnover as the aim of production control in multi-product firms. The shortening of production periods and contributions to it are figured. Making the batch size small cuts both ways. It shortens the production period, but may exert a harmful influence on labour productivity, In the sample survey the reciprocal of labour productivity, however, shows a decrease at the rate of 7.37 % per annum. In case study, figures of the following sectors are presented : passenger cars, lorries, washing machines, colour televisions, cameras and duplicators.

INTRODUCTION

Synchronisation of all complicated processes where multi-products are manufactured has a double function to perform : (1) minimising materials and supplies, work in process, and finished stock, which result in low capital tie-up and a high rate of stock turnover and (2) shortening delivery time in hours to customers through keeping constant the product of batch frequency × set-up time in

hours per batch. The economic batck quantity theory[1] and the objections[2,3] to it resolve themselves into whether synchronisation can in practice be realised or not.

In *Opl. Res. Q.* Burbidge and Duckworth emphasised small batches and rapid turnover as the aim of production control in multi-product firms. As long as this is called a discipline, the same emphasis has to apply not only to the British economy but also to other economies. Moreover, Duckworth lays stress on the shortening of delivery times.

Since the "oil-shock" in 1973, Japanese manufacturing firms are in a position to apply the discipline of synchronisation to production control along with a shortening of delivery time.

THE SHORTENING OF PRODUCTION PERIODS IN THE JAPANESE ECONOMY

Production period is defined as follows : the length of time of a given batch of a single kind of manufactured product from input as materials to output as finished product. This author's sample survey of fifty companies involving personal interviews shows that the production periods in manufacturing firms are shortened from 21.41±6.85 running days in the early part of the 1970s to 12.32±4.23 running days in 1980 (95% confidence limits). The population in this survey consisted of 153 companies which own sales subsidiaries in such industrial sectors as passenger cars, electrical apparatus for home use — specifically, washing machines, refrigerators, colour televisions —, cameras and duplicators. In particular, the production period has been rapidly shortened since 1975. The principal aims of such a shortening are : (1) the shortening of

delivery time and (2) small batches and rapid turnover.[3,4] One running day has a 2.12±0.44 average shift (one shift falls somewhat below eight hours).

TABLE 1. THE SHORTENING OF PRODUCTION PERIODS AND CONTRIBUTIONS TO IT

	weighted by sales
period observed	8.42±0.59 (years)
production period (8.42±0.59 (years ago)	21.41±6.85 (running days)
production period (1980)	12.32±4.23 (running days)
contribution of	%
method (a)	72.37±19.62
method (b)	6.24± 3.50
method (c)	0.36± 0.93
method (d)	0.28± 0.48

Notes :
Method (a) : improvements in the methods of production control (the discipline mentioned br Burbidge and Duckworth)
Method (b) : investments in machinery and equipment
Method (c) : modified specifications of products
Method (d) : reorganisation of factories designated for subcontract

To accomplish these aims, the population of our research improved in the methods of their production control. As regards the shortening of the production periods, method (a), improvements in the methods of production control, made a contribution of 72.37± 19.62%, while method (b), investments in machinery and equipment, contributed 6.24±3.50%, method (c), modified specifications of products, was responsible for 0.36±0.93%, and method (d), reorganisation of factories designated for subcontract, produced 0.28±0.48 %. These contributions do not add up to 100%.

Improvements in the methods of production control consist of the following factors :

(1) making the batch size of work in process small (and also making the time needed for 'set-up ' short),

(2) improvements in transfer,

(3) layout of machinery and equipment to facilitate the flow of work.

These are necessary and sufficient conditions for synchronisation.

Method (1) cuts both ways. It shortens the production period, but may exert a harmful influence on the labour productivity defined by ASME. The required discipline must keep constant the product of a much larger batch frequency × set-up time in hours per batch,,

Method (2) is represented by the Japanese saying "the final line does pull the previous lines (processes)". The final line determines the operation and the kind of product of the next line (process) ahead, and the latter determines the previous process in its turn. Such a transfer enables workmen to operate machines with minimum stocks in hand as demands vary, The discussion concerning cyclic planning is reduced in extent and importance.

As an instance about method (3), the following may be mentioned. Various types of work are carried out by a workman at the "work centre" where a lathe, a mill and a drilling machine are combined in the flow of materials. Suppose he is going to work up a material into some part. He loads the material in the lathe and operates the machine and then unloads the lathed material. Then he loads it in the mill, operates the machine and then unloads the lathed and milled material. After that he loads it in the drilling machine, operates the machine and finally unloads the material. In a few minutes the material is worked up into some

part.

The total set-up time in hours for using a lathe, a mill and a drilling machine does not raise the cost of the part if the following conditions are met:

(1) the lathe works and stops automatically and the working time in hours on the lathe is equal to or above the set-up time in hours of the mill,

(2) the mill automatically works and stops also, and the working time in hours on the machine is epual to or above the set-up time in hours of the drillng machine,

(3) the drilling machine works and stops automaticaly and the working time in hours on the machine is equal to or above the set-up time in hours of the lathe.

The reciprocal of labour productivity, however, shows a decrease at the rate of 7.37% per annum. Method (a) adds the contribution of 56.12±16.24%, method (b) 21.57±0.82%, method (c) 0.20±7.97% and method (d) 1.29±1.05%.

TABLE 2. THE RECIPROCAL OF LABOUR PRODUCTIVITY AND CONTRIBUTIONS

	weighted by sales
period observed	9.32±0.42(years)
reciprocal of labour productivity(9.32±0.42 years ago)	100
reciprocal of labour productivity (1980)	49.68±8.05
contribution of	%
method (a)	56.12±16.24
method (b)	21.57± 0.82
method (c)	0.20± 7.97
method (d)	1.29± 1.05

Note:

Refer to Table 1 about method (a)~(d).

CASE STUDY

Let us turn from the sample to the sample points.

It is observed from the values in Table 3 that the production periods of several industries adopting synchronisation in these ten years are shortened by two-thirds to one-third, In particular, we can give the batch sizes in terms of shifts in both 1975 and 1980.

"run batch"

12 shifts in 1975 are shortened to 1 shift in 1980 (the pressing process in a passenger manufacturer), 1/2 a thift or more is reduced to 1/6 or more (a series of processes in lens manufacture

TABLE 3. THE PRODUCTION PERIODS

days

	(1)	(2)	(3)	(4)	(5)	(6)
1971	16.7	32.2	1/2～10	11.3	30	11.5
1980	6.9	24.7	1/4～ 6	6.7	13.8	4

Notes :

(1) passenger cars of compact sizes (the average of four companies, Toyota, Nissan, Mitsubishi and Daihatsu) coiled steel plate cold milled・pressing・body metal ass'y・painting・final ass'y

(2) lorries of 8 tons (a company) steel・pressing・frame ass'y・chassis ass'y・final ass'y

(3) household washing machines, semiautomatically driven, 2 kilogramme washable volume (two companies) coiled steel plate cold milled・pressing・painting・ass'y

(4) colour televisions of 14 inches (a company) inserting integrated circuits・chassis・ass'y

(5) cameras (the average of two companies) processing of main body, front plate and prism・painting・machining・units of parts ass'y・final ass'y

(6) duplicators (a company) die-casting・machining・painting・units of parts ass'y・final ass'y

for cameras), and 5 shifts become one shift (the machining and painting process in a duplicator manufacturer).

"transfer batch" in 1980

1/4 shift is gained in the case of four passenger car manufacturers, a washing machine manugacturer and a duplicator manufacturer. In these industries, parts are transfered from subcontractor-suppliers, whose production processes are synchronised with the parent-firms' internal processes.

1/6 of a shift is gained with the above camera manufacturer among internal processes, and the figure is unknown for the colour television manufacturers.

For instance, the above lorry manufacturer attained a decrease of work in process valued at twenty thousand million yen (£38 million, IMF, IFS, Oct. 1980) in two years, while maintaining the same level of production.

Table 4 shows that the contribution of method (a) is the greatest and the most important.

TABLE 4. CONTRIBUTIONS TO THE SHORTENING OF THE PRODUCTION PERODS

%

	(1)	(2)	(3)	(4)	(5)	(6)
method (a)	95	100	80	50	100	100
method (b)	5	0	0	25	0	0
method (c)	minus	0	20	25	0	0
method (d)	0	0	0	0	0	0

Note :

Refer to Table 1 about method (a)~(d), Table 3 about (1)~(6).

It is observed from the valuet in Table 5 that the reciprocals of the values of labour productivity are relatively widely distributed

between eighty three and twenty seven. Table 6 shows how methods (a), (b) and (c) each contribute effectively to this result.

TABLE 5. THE RECIPROCALS OF LABOUR PRODUCTIVITY

	(1)	(2)	(3)	(4)	(5)	(6)
1971	100	100	100	100	100	100
1980	42.1*	83.4	30	27**	45	70

Notes :

Each value is on a standard basise except for(1) ((1) on a actual basis—total man hours/total productions in physical term).

* Ministry of Labour *Statistics of Labour Productivity*

** The integrated circuits are not included.

Refer to Table 3 about (1)～(6).

TABLE 6. CONTRIBUTIONS TO THE DECREASE OF THE RECIPROCALS OF LABOUR PRODUCTIVITY

%

	(1)	(2)	(3)	(4)	(5)	(6)
method (a)	70	83	0	10	12.5	95
method (b)	17.5	10	50	30	60	0
method (c)	minus	−49	50	60	12.5	0
method (d)	0	7	0	0	5	5

Note :

Refer to Table 1 about method (a)～(d), Table 3 about (1)～(6).

According to the batch size of work in process, the production period of the washing machines in 1980 varies between a quarter of a day and six days. In 1970, it varied between one half and ten days.

CONCLUSION

Production control performs a double function for rationalisation of the production process : high labour productivity and low capital

tie-up. Both of these factors are actually realised by synchronisation. Making the batch size of work in process small as well as improvements in transfer and layout of machinery and equipment to facilitate the flow of work are necessary and sufficient conditions. In the decade of the seventies (in particular, the fiye years from 1975), Japanese manufacturers have shortened production periods by forty three per cent.

Making the batch size small cuts both ways. It shortens production periods, but may exert a harmful influence on labour productivity. The repuired discipline must keep constant the product of a much larger batch frequency × set-up time in hours per batch. In the same decade the the reciprocal of labour productivity shows a decrease at the rate of 7.37% per annum.

It is proved by the data that the economic batch quantity theory and the objections to it resolve themselves into whether synchronisation can in practice be realised or not.

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