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# THE DIFFUSION OF AN INNOVATION IN COTTON SPINNING<sup>1</sup>

by ALISTER SUTHERLAND

SCHUMPETER has accustomed us to thinking of innovations as spectacular alterations to the range of products or processes found in an economy, and has linked them to the rise of new firms led by new men. Yet an interview study undertaken in the summer of 1957 as a means of illuminating the economic background to the spread of the methods generically known as 'shortened processing' suggests that there are cases where uncertainty about the future of an industry may make the adoption of an apparently well-proved innovation almost as bold a step for the imitator as for the initiator.

The invention of high-draft spinning on which the innovation is based was made in 1904 by Fernando Casablanças. Since the 1920s it has been widely applied in the United States, and is now said to be universal there. In Lancashire, some firms have been using it successfully since before the war, though it is still disputed in the industry whether it should be adopted by the remaining 50 per cent of firms for whom it would be technically feasible. At the beginning of the inquiry it seemed that the dispute would turn out to be based on the difficulty of comparing the effects of a reduction in processing costs with those of a deterioration in the quality of the product. It is argued here that the question cannot be separated from a consideration of the history of the investment policy of the firms over a period of years; and that their behaviour during these years has differed as the result of the way management has reacted to a situation in which there is a strict minimum price agreement, and a high degree of technical complementarity between what has been done at the spinning stage and what can be done now at the earlier processes.

A non-technical account of the changes in processing involved precedes a summary of the interview data. An attempt is then made to elucidate the reasons for thinking that it is in principle desirable to adopt the innovation, and to explain why some firms have taken it further than others.

<sup>1</sup> The factual data on which this article is based were collected in the course of a pilot survey concerned with the economics of shortened processing in the card room. This survey was partially financed by the Department of Scientific and Industrial Research, whose assistance I gratefully acknowledge. The Department is of course in no way responsible for the opinions expressed here.

I should also like to thank the necessarily anonymous people in the industry who made the inquiry possible.

I am indebted to Mr. P. W. S. Andrews, Mr. N. H. Leyland and Dr. I. M. D. Little for their helpful comments on the earlier and longer report of the survey. They are not responsible for the way their advice has been used.

It should be emphasized that the generalizations which occur in the paper are meant to apply only to the small sample of firms interviewed. Before one could contemplate generalizing about this diverse industry far more data would be needed than have so far been published.

#### I. WHAT TECHNICAL CHANGES ARE INVOLVED?

It is fortunately not necessary to describe in any detail the process of converting a compressed bale of cotton into yarn. There are three main stages. At the first of these, the bale goes through the opening ranges and blow-room, from which it emerges as a 'lap' or roll. This inquiry was mainly concerned with the second stage, the card room. Here the cotton lap is put through three types of machines: cards, draw frames and speed frames. The card converts the wide roll of fibres into a 'sliver', or loose rope. The draw frames and speed frames (and the spinning frames at the third stage) are in detail very different, but they operate on the same general principle. They 'draft' a thicker sliver into a thinner one. The drafting systems by which this attenuation is accomplished consist basically of two sets of rollers, the second set pulling the cotton away more rapidly than it is being delivered by the first set. From the last speed frame the cotton, now fine enough to be wound round a bobbin, goes to the third stage, the spinning room. Here it is finally spun into yarn, either on a mule or on a more modern ring frame.

Thus, after the cards, all the machines are at least partly concerned with drafting the cotton. If there could be an increase in the amount of attenuation carried out at each machine, the number of machines could be reduced. Casablancas showed how this could be done by improving the drafting system on the spinning frame; similar improvements have since been made earlier in the process at the speed frame. On the traditional system, the cotton from the card goes through three sets of draw frames and three sets of speed frames in the card room, and then through a spinning frame, usually a mule. With improved drafting systems in the card room at least one of the sets of speed frames may be eliminated. If shortened processing is to be more complete than this, that is if more machines are to be dropped, it seems that an improved drafting system is also needed at the spinning frame. If this is installed, as it would be on a modern ring frame, a further set of speed frames may be dropped; possibly one of the three sets of draw frames may also be eliminated. Thus, with a high degree of shortened processing, four sets of machines instead of the traditional seven may be needed to spin the carded cotton into yarn.

The main results of making such a change to shortened processing seem to be a reduction in the number of workers required to produce a given output of yarn; a reduction in the labour costs per pound of yarn;<sup>1</sup> a change in capital costs which may be more or less considerable depending on whether or not capital costs on the old system are assessed on a replacement cost basis; and, if more than one set of speed frames is to be dropped, a probable deterioration in the quality of the yarn produced unless ring frames replace mules in the spinning room.

## II. THE CONDUCT AND RESULTS OF THE INTERVIEWS

Visits were made to sixteen firms. The representative of the company, usually a director, had been given in advance an outline of the questions to which an answer was being sought. In the course of the interview, which took up to two hours, he was encouraged to give what in effect was a history of the firm since the war. Most of the questions on technical matters as well as on the motives behind the nature, extent and timing of the firm's re-equipment programme were answered naturally in the course of this account, and could be given the emphasis desired by the management rather than that implied in a questionnaire. Indeed if the inquiry had made use of a written questionnaire or check-list it would have been almost impossible to pick out the main motives from the lesser ones; as will be seen shortly, almost all the firms with some degree of shortened processing could appear to have been influenced by the same motives, but in the interviews it was made clear that the various motives had by no means the same weight. In the course of the interview reference was often made to the firm's accountant, the inside manager and the overlookers; and the visit ended with a period on the mill floor watching the actual operation of the processes which had been described and discussed.

In deciding which firms to approach, the object was to choose a sample of firms all of which might have been expected to find some measure of shortened processing a technical possibility. Within this area, a possibly unrepresentative selection was made to include examples of firms with processes ranging from traditional methods to very much shortened ones. The selection of the sample was further biased because of complications due to annual holidays; and possibly by the fact that firms amenable to change would be the most willing to co-operate.

<sup>1</sup> By agreement with the trade unions, higher wages will have to be paid on the high-draft speed frames. The average increase in output per worker in the mill as a whole more than offsets this, even allowing for an increase in the number of ancillary workers.

The sixteen firms visited controlled thirty mills. In March 1955 there were 174 firms engaged predominantly in spinning or in spinning and weaving<sup>3</sup> so about a tenth of the firms in the industry was visited. The size of the sample is also indicated by the fact that the firms owned 7 per cent of the total spindles installed in running mills in the first quarter of 1957.

The firms fell into two broad size classes: eleven of them controlled 80,000 mule equivalent spindles<sup>4</sup> or less; five controlled 130,000 or more. The latter class was made up of two firms completely integrated vertically, which carried out the full range of activities from buying the raw cotton to selling the finished garment; and three combines of spinners integrated horizontally. The former class was made up of seven single-mill spinners, three spinner-weavers and a small spinning combine. Only one private company was included, but the single mill spinners could be classed as 'family' firms, public companies whose shares are mainly held by a small, unchanging and integrated group.

There is no accepted definition of what is to count as 'shortened processing'. Using what seems to be a reasonable one,<sup>5</sup> the sixteen firms have been grouped as follows: four are said to have adopted complete shortened processing (abbreviated to 'S.P.');

five are said to have adopted shortened methods for at least a half but less than a whole of their output ('s.p.');

four have adopted shortened methods for some but less than half of their output ('f.p.');

and three have traditional full processing ('F.P.').

Any kind of correlation analysis is impossible with the data available, but there do seem to be interesting connections in the sample

<sup>3</sup> Derived from the table given by Dr. R. Robson on p. 353 of *The Cotton Industry in Britain*, Macmillan, 1957.

<sup>4</sup> Because of its higher output, one ring spindle is usually reckoned to be 'equivalent' to 1½ mule spindles.

<sup>5</sup> The basic criterion for saying that a firm has adopted some degree of shortened processing is that it should have eliminated two passages of speed frames; the proportion by weight that the output produced in this way bears to the total production of the firm then decides how the firm is to be classified (S.P., s.p., etc.).

Three firms had done something to reduce the number of processes, but not in such a way that they would be included in the original definition. To prevent them being grouped with the firms which had done nothing to shorten processes, a second criterion has been adopted. If for the *whole* of its output the firm had eliminated one speed frame only but had also introduced a split-silver device on the draw frames, it was classed as 's.p.'. If it had dropped one speed frame only, it was counted as 'f.p.'. The groups of firms resulting from the modified definition do seem to accord better with the common-sense view of the extent to which their members have shortened their processes. It seemed better to modify the definition in this *ad hoc* way than to adopt a more easily satisfied criterion, such as the elimination of one speed frame only.

Alternatively, it would have been possible to keep the common-sense groupings on the original definition if production of counts above, say, 20s had been ignored in calculating the extent to which processes had been shortened. As some firms had found it possible to drop two speed frames even on these finer counts, it seemed better to avoid a decision on a technical matter by adopting the other compromise.

between the degree to which processes have been shortened and other factors.

It appears from the following table that, in the sample, the vertical firms have done slightly more towards shortening processes than the horizontals, that the horizontals have done more than the spinner-weavers, and that the single-mill spinners have the greatest variety of processes; but the extent to which shortened processing has been taken in those single mills which have done some is greater than in any other section except that of the verticals (Table I).

TABLE I

Type of Firm	Degree of Shortened Processing			
	S.P.	s.p.	f.p.	F.P.
Single-Mill Spinner	2	2	—	3
Vertically Integrated	1	1	—	—
Spinner-Weaver	—	1	2	—
Horizontally Integrated	1	1	2	—

In addition, such evidence as there is suggests that the single-mill spinners were quicker off the mark than the rest; and that the firms which started earlier have done more in the direction of shorter processing (Table II).

TABLE II

Date of Change	Firms Changing at this Date				Degree of Shortened Processing adopted		
	S	V	S-W	H*	S.P.	s.p.	f.p.
Pre-war	2	—	—	—	2	—	—
During War	—	1	—	—	—	1	—
1945-48	2	—	2	2	1	3	2
1949-51	—	—	1	1	—	1	1
1952-54	—	—	—	—	—	—	—
After 1954	—	1	—	1	1	—	1

The dates refer to the time at which work was started in the mill; plans would have been made up to three years before this date. Between 1951 and 1952 the industry suffered a recession.

\* Types of firms in the order given in Table I.

The most striking feature of the sample, however, is the extent to which firms with some degree of shortened processing in the card room either already had new equipment at the next stage, the spinning room, or decided to acquire it before going very far with shortened processing. Of the thirteen firms with some degree of shortened processing four were already equipped with modern ring frames when the innovation was adopted, and eight either installed new ring frames or converted their existing frames to one of the modern high-draft systems as a prior part of the re-equipment programme. The remaining firm was able to shorten processes to some extent

before it put in ring frames, though not sufficiently to come within the definition, by making changes at the draw frame. This very high degree of technical complementarity may of course not hold for the industry as a whole. But in dealing below with the question of the motives of the firms in the sample it seems to be impossible to explain why shortened processing has been adopted, and even more why it has not, without considering the question of ring frames.

Evidence for the statements in the previous paragraph can conveniently be given as part of a much abbreviated account of the reasons mentioned by the firms for adopting, or not adopting, shortened processing.

Of the S.P. firms, three already had ring frames before the war. Two of these took up shortened processing to increase production despite a labour shortage when there was a great demand for yarn shortly after the war; the third started to think in 1951 that it would be left behind on costs if it did not replace its machinery. The fourth firm had found it hard to get labour (especially slubber tenters) *before* the war, and had introduced a patented system which cut down the number of draw frames required. The old ring frames were later converted to a modern high-draft system for technical reasons, and because of the reduction in labour costs when a further speed frame was dropped.

One of the s.p. firms already had ring frames; during the war, shortened processing was adopted to maintain production despite the labour shortage. Between 1946 and 1948 three firms started re-equipment schemes in which ring frames were to replace mules; one put in the ring frames on quality grounds in 1946 and did not find it necessary to adopt shortened processing in the card room until faced with a prospective shortage of labour in 1950; one had put in the ring frames and simultaneously adopted shortened processing, giving as its reasons a wish to increase production in the face of shortages of labour and space; the other was mainly influenced by the availability of the subsidy\* and the need to save labour. The remaining firm did some shortened processing without ring frames at first. It had started the shortening at the draw frame in 1947, to maintain output despite the labour shortage; in 1951 it started to put in new ring frames because of the demand for ring yarn, and the saving in labour.

\* The Cotton Spinning (Re-Equipment Subsidy) Act of 1948 provided that up to 25 per cent of the expenditure on modernization of a kind approved by the Board of Trade and carried out between August 1945 and April 1952 for which contracts had been entered into before April 30th, 1949, would be reimbursed, if the work was done by a group of a minimum size of 400,000 m.e. spindles and three mills (or a smaller group if the Board of Trade allowed); one of the usual conditions for approval was that not all the mills in the group should be re-equipped.

Of the four f.p. firms, two started their partial re-equipment by installing ring frames in 1948; their reasons were the demand for ring yarn, the improved drafting system, and the subsidy. In 1956 the shortage of labour and the result of experiments which had a satisfactory effect on yarn quality led one of them to adopt some measure of shortened processing; the other firm, which had already dropped one speed frame, now dropped another because of the labour shortage. The remaining two had started to adopt shortened processing as soon as they had installed ring frames; their reasons were the shortage of labour, the demand for yarn spun on a ring package, and the technical improvement in the drafting system.

One of the three firms which still had full processing had considered replacing its spinning spindles at the end of the war; it had decided not to because the change would be very expensive and would not reduce the average total cost below that with old machinery which had already been largely written off; in addition, the improvement in quality would be negligible, and the new frames would not fit easily into the space available. More recently some experiments with shortened processing had been tried, following the retirement of a manager, but had met with mechanical and labour difficulties. Another firm had no difficulty in getting labour because a near-by mill had closed; the layout of the mill would in any case have made it difficult to adopt shortened processing, while the need for a strong yarn suitable for the rope trade made it essential to keep full processing. The final firm had a well-established connection with a weaver who wanted mule-spun yarn; the buildings were unsuitable for ring frames; and it was said that shortened processing would lead to a great deterioration in quality.

From the data it appears that only one firm would disagree that the possibility of reducing a shortage of labour had some influence in deciding it to adopt shortened processing. From impressions gained at the interviews the following conclusions are ventured about the *main* motives of the firms. Seven firms adopted some measure of shortened processing mainly because there was a shortage of labour. A desire to improve the quality of the yarn was the main factor in three cases. The subsidy was the main factor in two cases. A desire to reduce costs was the main factor in one case. The three firms which had kept the full range of processes said that they had done so partly because they had no physical or financial alternative; and partly because they had no desire to do so in view of the adverse effects of shortened processing on quality and on costs.<sup>7</sup>

<sup>7</sup> The firms with full processing did not seem to be faced by the difficulty of deciding whether they should adopt the present techniques of shortened processing or rather wait



## III. AN ANALYSIS OF THE PROBLEM

In attempting to elucidate the reasons in principle for adopting or not adopting shortened processing, the first point to be accounted for is the disagreement about the effects of the change on yarn quality.

The firms with full processing argue that the best way to get a good quality yarn is to keep as many 'doublings' as possible. When there is a large number of machines in series, each machine combines, or 'doubles', cotton elements from the earlier machines, so that any faults in the yarn are more likely to be compensated for. With shortened processing, the number of machines is reduced and faults are more likely to be carried through to the final product. The firms which gave improved quality as a reason for adopting shortened processing were arguing that the improved drafting systems on the machines in the card room, when combined with modern ring frames in the spinning room, produce a more consistent yarn than that obtained from the older drafting systems, so that there are fewer initial faults to be removed. That is, the firms arguing that shortened processing would impair quality are thinking of it being carried out in the absence of that installation of ring frames which the firms taking the other side regard as usual and necessary. It may be tentatively concluded that it is technically possible to produce at least as good a yarn using shortened methods; and that there may be an improvement. This improvement may lead to a small reduction in costs, if the better yarn breaks less easily at later stages; or it may make it slightly easier to sell the yarn, a point which may be of great importance since competition on price is ruled out.<sup>8</sup>

Since it is the case that competition on price is ruled out, so that large changes in revenue are unlikely, it is perhaps surprising that only one firm gave a reduction in average costs as the main reason for adopting shortened processing. On the other hand it might be said that the argument in terms of the labour position was merely a disguised cost argument. We must therefore consider in more detail the implications of 'a shortage of labour'.

As stated above, the most frequent reason given for adopting some measure of shortened processing was that the change would relieve a shortage of labour. It might have been expected that in an indus-

<sup>8</sup> Cf. p. 128, *infra*.

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for the development of something even better. Further improvements in ring frames and speed frames will surely be made, but they are unlikely to be so radical that it would be sensible to delay the change to shortened processing solely for this reason. Deciding just when to install new equipment is always a problem, but the pace of technical progress is not the main difficulty in this industry.

try where this opinion was widely held earnings would tend to rise rapidly above the agreed wage rates. That this has not happened to any great extent may be partly explained by the opposition of the employers' associations. A firm could still, of course, increase real earnings indirectly by providing such amenities as canteen meals and transport on a more lavish scale. However, it is fairly clear that the main reason why earnings have not been pushed upwards rapidly is that firms do not think it would be profitable for them to pay more. If this is so, it could be argued that the firms adopting shortened processing because of 'a shortage of labour' are doing so after a more or less implicit argument in terms of cost streams. Their statements could be interpreted to mean that they thought some increase in outlay to keep the mill at full capacity would be justified by the reduction in overheads; and that it would be more profitable to make the expenditure on machinery than it would be to increase wages while keeping the old methods, given their ideas about what the economist would call the elasticity of supply of labour and its marginal productivity. There seem to be a number of reasons why firms nevertheless put this part of the case in terms of reducing a physical shortage of labour and not in terms of increasing profits, or of reducing a shortage of sufficiently productive machines.

In the first place, there seems to be a strong feeling that the level of working to be regarded as 'normal' is that of maximum physical output, whether or not this output can be sold. Hence to say that labour is short often seems to imply merely that the machines could not be worked to full capacity unless more labour was recruited; it need not imply that the firms would be prepared to pay even a little more to obtain the labour. Thus several firms complained both that a shortage of labour prevented their mills from running at full capacity, and that they would not be able to sell their full capacity output. Secondly, since the time of the Platt Report<sup>9</sup> there has been persistent emphasis on *labour* productivity. If this is taken as a reminder that economies can often be made by a more careful redistribution of existing factors then it is most welcome. But the danger is that firms might come to think in terms of maximizing the rate of profit per unit of labour, rather than the maximization of total profit.<sup>10</sup> It would be fallacious to argue that shortened processing should be adopted solely on the grounds that this would increase output per head. Finally, the main reason seems to be the difficulty of making a reasonable estimate of the capital costs per unit of output

<sup>9</sup> Report of the Cotton Textile Mission to the United States, 1944.

<sup>10</sup> The policies are equivalent only if the supply of labour to the firm is absolutely fixed, and if labour is the only factor of production limiting the growth of the firm.

before and after the change to shortened processing. The usual arguments about the most suitable way of assessing depreciation are complicated here by knowledge that the market is contracting, and by the fact that the capital costs to be estimated include expenditure on the next stage, the spinning room, as well as in the card room. As already shown, the firms interviewed found that if they were to adopt any considerable degree of shortened processing they had to have ring frames. The technical complementarity seems to be a major factor in explaining the absence of cost arguments even where the obvious capital costs of making the change to shortened processing are low, as they are when the change can be made by converting existing card-room machines rather than purchasing new ones. There are of course other factors involved here.

Three firms had carried out the change to shortened processing before the new machines became available in 1947, and so had no option but to convert existing machines. Of the other ten firms, half had bought new machines, and half had converted old ones at approximately one-fifth the cost. Three of the firms buying new machines said that their existing ones were too worn out to stand conversion; age may not always be a compelling reason though, for one firm had successfully converted machines built before World War I. One firm said it needed a machine which could be supplied with a larger number of spindles, because of space requirements. One firm felt that quality on a converted machine would not be good enough. In view of the very large difference in cost, it is not obvious why firms chose to buy new machines for the card room instead of spending any available finance elsewhere, unless the machines were in very bad mechanical condition indeed. It may be that more care is needed to produce a reasonable yarn on converted machines; certainly more careful maintenance in earlier years is a necessary condition. In either case it appears that the difficulties associated with conversion are more likely to be overcome by some managements than by others. But the practical difficulty of allowing for the capital expenditure in the spinning room still prevents the argument from being put in cost terms.

So far it appears that shortened processing is regarded as desirable in principle mainly because of its effects on the labour position; and that the changes in the card room cannot be considered separately from changes in the spinning room. In the rest of this section we must attempt to answer the further question of why more shortened processing has been done by some firms than by others. Here it seems to be vital to sketch in the effects on re-equipment policy of the Yarn Spinners' Association. The following sentences have this

limited object in view. They are not meant as an overall appraisal of the case for and against the existence of the Association.

The Yarn Spinners' Association was formed in 1947; when price control was removed in 1949, the existing costing margins were continued and recognized as minimum margins.<sup>11</sup> The Agreement of the Association, as it stood on February 1st, 1957, when it was registered at the office of the Registrar of Restrictive Trading Agreements, lists among its objects the representation and elucidation of the industry's views and interests, the promotion of research, and the co-ordination of action. In addition, it is a function of the Association to establish minimum margins on the various types of yarn. The minimum prices that may be charged by members are to be arrived at by taking the replacement cost of the raw cotton, as calculated by the Association for each mark, and increasing it by 10 per cent; then the appropriate spinning cost margin as determined for each range of count, type of spinning frame (mule or ring) and size of mule cop is to be added; and finally the margin allowed for special forms of make-up. A resolution of January 16th, 1957, laid down the principles to be followed in arriving at the spinning margins. They should not allow a return greater than that recommended by the Board of Trade Committee on Cotton Yarn Margins appointed in 1948. The spinning costs should be based on the actual cost figures supplied by members in 1953, plus an allowance for interest and depreciation; the costs of the dearest one-third of the producers of each count of yarn should be ignored and the median of the remaining two-thirds used as a basis.<sup>12</sup> The depreciation and interest allowances were calculated on the cost of *new* machinery in September 1955. For buildings, 1948 costs were used. These allowances would amount to 3.26 per cent per annum on machinery, and 0.946 per cent on buildings, if full capacity working was maintained. In fact depreciation was recovered at the average rate of activity, and interest recovered at 92 per cent activity. The interest allowed on working capital was 5 per cent.

To speak briefly, leaving out the possible qualifications which would have to be considered in a more extended analysis, it seems to me that this Agreement provides the firms with full processing no inducement to re-equip; it also seems to prevent any pressure being put on them. On the first point, it seems that the overhead charges allowed in calculating the spinning cost margins are meant to allow for the eventual replacement of existing equipment. Now if the

<sup>11</sup> Robson, *op. cit.*, p. 226.

<sup>12</sup> Thus if there were ninety-nine firms in all, arranged in order of costs starting with the lowest, the mean of the costs of firms numbers 33 and 34 would form the basis.

members assume that they will eventually replace, the margins could not reasonably be based on any other assumption (leaving aside the question whether any fixed margins can be fair). But it is notorious that a large percentage of the members make no such supposition. Hence a margin which is designed to enable a modern and efficient firm to make allowance for replacement permits the survival of a firm which does not mean to replace; for the fixed margin allows it a reasonable profit after meeting its variable costs. Moreover, by staying in business the firm may be able to realize some of its capital as the result of a take-over bid.<sup>13</sup> On the second point, the absence of price competition prevents the mills with shortened processing from trying to enlarge their share of the market in the most obvious way. In addition, there is no direct competitive advantage from producing better quality yarn from any particular grade of cotton. The Agreement is so framed that the average replacement costs of the cotton, and not either the actual cost of the cotton to the individual spinner, or the merits of the spinning process actually used, determine the quality for which a price may be charged.<sup>14</sup>

Firms which have re-equipped are prevented by the absence of price competition from using any cost advantage they may have to get to full capacity working. Despite numerous statements that the demand for yarn is very price inelastic, there seemed to be no doubt in the minds of some of the spinners interviewed that the restriction on price competition was a great handicap to their sales. In addition, if the firms are working at full capacity they are prevented on normal single-shift working from making the cost advantage as great as it might be; and they are discouraged from working double shifts. On single shifts it would be foolish of them to sacrifice flexibility for the sake of trying to make the most of the economies of scale since it would be hard to be sure of selling the whole of a large batch of one quality of yarn unless a low price could be quoted. Instead it becomes vital to maintain the goodwill of buyers by being prepared to supply almost any kind of yarn within a wide range of counts. Encouraging bulk runs is one of the stated objects of the Association, but it appears that the fixed margins may work in the other direction.

<sup>13</sup> Dr. Robson cites the basis given for take-over bids leading to reconstruction as a merit of the minimum price regime (*op. cit.*, p. 244). But if the buyer is a weaver who intends not to break up the mill, but to use it to provide his own yarn needs at a lower price than he has to pay the members of the Association, the margins allowed by the Agreement must be thought to be very generous. For they must be great enough to offset the risk of his being left with an uneconomic mill if the margins are ever revised downwards.

<sup>14</sup> Dr. Robson, writing in October 1956 of the 'present practice' of the Association, gives a different version (*op. cit.*, p. 227).

The increased emphasis on goodwill encourages sellers not to exploit the economies of scale. Further, the size of the margins encourages integrated or partially integrated firms to spin for themselves the large number of qualities they need and not to exploit the economies of scale by spinning a limited number of qualities and buying the rest on the market.

Double-shift working is discussed again below; the Agreement discourages firms from trying to strengthen their position by working shifts because of the difficulty of selling the greatly increased output.

Against this background, what other factors are likely to affect the extent to which shortened processing is taken, and the rate at which it is carried out? The following consideration of the other factors suggests that the most important question to be answered is why some firms have ring frames and others have not.

It could of course be argued that almost all those firms which had begun to shorten the number of processes would in the long run change over completely, and that any delay in this programme was due to technical factors, such as the rate at which the new equipment, or the necessary materials for conversion, could be obtained;<sup>15</sup> the rate at which they could be installed; the rate at which the adjustments made necessary by the shortening of processes in the card room could be carried out in the other parts of the mill; and the rate at which the change-over was slowed down to allow other changes in the card room to be made simultaneously (humidification, electric drive, etc.).

It could also be argued by several firms that the range of counts suitable for spinning on shortened methods was restricted, and that they could not shorten processes where counts were higher than, say, 20s.<sup>16</sup> But firms with an average count higher than 20s have succeeded in shortening processes even on the finer counts, so that technical reasons may not be compelling unless the firm has other reasons for wishing them to be so.

Until a direct question was asked, not very much was said about the availability of finance as a limiting factor on the rate of investment in shortened processing. It was taken for granted that all but a small amount of any profit made would have to be ploughed back. Firms also said they would not wish to borrow from outside sources even if they thought they could find a lender. It is perhaps odd for a firm to plough back its profits because it thinks it the best long-run policy,

<sup>15</sup> The supply side of the question is still under consideration.

<sup>16</sup> The higher the 'count', the thinner the yarn. The unweighted average count of yarn produced using shortened methods was 15s as compared with an average of 20s for the whole output of the firms with some shortened processing, and 22s for the firms with full processing.

and at the same time to refuse to borrow because cotton is a contracting industry. Even if the market for funds is imperfect on the supply side, this attitude on the demand side remains curious, unless the controlling groups of almost all the firms have simultaneously found themselves in a position where any further borrowing would lead to a loss of control. A more likely explanation is perhaps the natural unwillingness of firms to admit that they would find difficulty in borrowing if they tried.

No attempt was made to deal systematically with the attitude of labour, but most firms made some kind of reference to it. It would seem to be fair to say that the only firms to complain seriously about the quality and co-operativeness of labour as a limiting factor were those which had not done much in the way of shortening processes; and that they were ready to explain the latter state of affairs as the result of the former. But in at least one case the labour difficulties would seem to be due to the way in which the attempt was made to introduce a very limited amount of shortened processing. Other firms certainly mentioned the importance of consulting the trade unions before introducing changes, and of arranging for proper instruction; and several mentioned temporary difficulties during the change. But only one firm, apart from those with full processing, seems to have been deterred by labour opposition from making the kind of changes it wished. The conclusion would seem to be that labour difficulties may be a reason for not going ahead too quickly with shortened processing; but that if there are difficulties which are given as a reason for not trying to shorten processes at all, they are more likely to be a result of not making the change.

The attitude of management has already been mentioned as a factor perhaps explaining the extent to which existing machines have been converted. Technical factors may have been equally important there, but in explaining differences in the amount of shortened processing this attitude plays a vital part, both directly in ironing out the difficulties of transition, and indirectly in determining the rate at which the necessary changes are, or have been, made in the spinning room. For the percentage of ring spindles seems to be the essential factor limiting the extent to which the profitable policy of shortened processing is taken.

It appears that the decision in principle to install ring frames may be taken either because the firms want to install them or because they feel they have to. They may feel they have to because of the weavers' demand for the larger ring packages. They may feel compelled to replace mules because of the fact that mule spinners are a gradually disappearing race. They may even be compelled to replace mules

because they have worn out, though this is unusual; the life of a mule is almost infinitely extendable. On the other hand they may go over to rings because they want to. The quality of the yarn spun may be better, in the sense that it is more even than could be spun on the mule. The output may be increased if the capacity of the earlier machines in the flow line can be expanded to match the increased output of the ring frames. They may wish to install ring frames because they desire to feel up to date. But to explain the absence of any forcible argument based on the increased profits to be made by re-equipping the spinning and card rooms we must look at the problem of capital costs.

If the demand situation is not expected to alter, and in addition no great technical obsolescence is expected, firms which are to argue confidently that it pays to scrap machinery which is still yielding some profit after deducting variable costs must be prepared to say that the average total cost with the new methods is less than the present average variable cost. If the demand situation is expected to deteriorate over time, they would have to argue that the new average total cost was *very* much less than the old average variable cost. But the furthest that many of the firms with shortened processing would commit themselves was to say that re-equipment had reduced their average *labour* costs, usually by about a fifth. In view of the general stress on matters connected with labour it might have been expected that a reduction of this size could by itself be the basis of a strong cost argument for making the change. If the very few cases in which detailed figures were obtained are typical of the industry, it seems that, in a re-equipped mill, labour costs make up about three-quarters of variable *processing* costs; but the variable processing costs are only about three-eighths of total processing costs, the other five-eighths being fixed processing costs. Processing costs in turn account for about one-third of the selling price of the yarn, the rest being made up of raw material costs. Without figures for the level of processing costs in a mill with full processing, and of their distribution between variable and fixed costs, the most useful comparison cannot be made. But it is interesting that a further reduction of one-fifth in labour costs in a mill with shortened processing could make a difference of only about 2 per cent in the selling price of the yarn (i.e.  $\frac{1}{5} \times \frac{3}{4} \times \frac{3}{8} \times \frac{1}{3}$ ). Any scope at all for increasing earnings is of course useful, but much more spectacular increases would be needed when the market outlook for the industry is so unfavourable. These could only come from large reductions in average total cost, which are not in evidence, or from slight reductions in average total cost on a greatly increased volume of output.



Some increase in output might be obtained by replacing mule spindles with an equal number of ring spindles and increasing the capacity of the earlier processes; or by working nearer full capacity. To do even this it is argued above that a restoration of price competition would be needed. To increase output greatly the firm would have to become one of the very few working double shifts; in accordance with a recent agreement, payment for a shift week of  $38\frac{3}{4}$  hours is the same as that for a 45-hour single-day shift, so there would, in the absence of other factors, be an immediate increase of 16 per cent in labour costs. To increase profits while working shifts there would therefore have to be a reasonable price elasticity of demand for yarn, and/or a reduction in average fixed cost. However, most of the firms showed little enthusiasm for working double shifts within the agreed arrangements.<sup>17</sup> They seemed to be mainly conscious of the increase in labour costs that the change would bring, and to be thinking in terms of the profit per pound of yarn produced rather than the total profit. This is surely an instance of the results of working with fixed costing margins. In addition, there seemed to be a tendency to think that depreciation was most sensibly to be regarded as a result of wear and tear, and not of obsolescence. In this case there would of course be increases in capital costs of double shifts were worked, and not the necessary reductions; but the life of spinning equipment is surely more likely to be terminated by obsolescence induced by demand changes than by physical old age?

It may be concluded from this examination of capital costs that the firms which had adopted shortened processing, and which had therefore taken the other steps necessary in the spinning room, did not seem anxious to press forward with plans for double-shift working, although they could have argued that this step would have reduced their average total costs below the level they reached working single shifts with new machinery. As their re-equipment policy did not enable them to increase their output very greatly, and also did not improve their market opportunities in any way that could be readily estimated, it appears that the firms adopting the innovation could hardly be said to argue in terms of the maximization of calculable profits. They proceed instead by feel. Their attitude was neatly summed up in two statements: 'If we looked at the capital costs we would never put in anything.' 'If a thing is good technically, it's bound to pay. For it will always reduce *some* items of cost.'

<sup>17</sup> The Factory Act of 1936 lays down that double-day shift working is permissible if the factory inspector is satisfied with the mess-room, transport facilities and ventilation within the mill; and if a majority vote of the workers supports the change. The agreement reached in 1956 between the employers and the trade unions in addition postulates detailed improvements in working conditions; and lays down the definition of a 'shift week' given here.

## IV. CONCLUSIONS

From this pilot survey it appears that the firms in the sample which have not adopted shortened processing are on the whole what might be called more 'defensive' than those which have done some. All the firms concerned are organized horizontally and are small. They are pessimistic about the industry and about their own place in it. They tend to think in terms of the short run only; this limit may be fixed by the date of retirement of the managing director or by the possibility of a weaving firm which is a principal customer modernizing its looms and thereafter requiring its yarn in a different form. They may well be right in arguing that their best policy is to hang on while investing as little as possible; and they can often point to a feature of the existing buildings or machinery which in any event prevents them from following any other policy. It also seems that their arguments, which could be based on estimates of their present variable costs compared with the total cost after re-equipment, are not so based. It is suggested that the minimum price agreement prevents readjustment from being carried out quickly; for the full process firms seem to have no inducement to leave, and their presence prevents the other firms from expanding output and then being willing to reduce prices. It appears, however, that the arguments of the full process firms about the future of the industry are likely to be self-justifying; if it does contract they will be the firms to leave, either because they are eventually undercut on costs, or because they are not concerned to fight.

The firms which have done some shortened processing, and which have therefore also carried out what is argued to be the necessary replacement of mules by ring frames, are in general more 'aggressive' than the firms with the full range of processes. In the sample the verticals have on the whole gone further than the rest. In making the case for shortened processing, the firms tend to stress the less tangible benefits. The effects on the availability and need for labour, the effect of quality improvement, and, above all, the effect on the morale of the firm seem to be more important than the calculable effect on costs or profits. In deciding that it is worth while to stay in the industry, and to improve their chances of survival by carrying through the general programme summed up in 'shortened processing', the firms were deciding to lengthen their horizon; it could be said that they were still fitting into the model of profit maximization, in the sense that they were interested in maximizing profit over the whole lifetime of the firm. But at this level the theory ceases to be helpful as a way of predicting how the firms are likely to behave, for

their policy seems to be based on the very vaguest of impressions about the future of the industry and about their own firm's share in it, rather than on reasonably precise estimates of revenues and costs. How are animal spirits to be made an objective correlate in an economic model?

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