The Technology of Cotton Spinning*

By DR. W. LAWRENCE BALLS, F.R.S

My object is to indicate changes which have already taken place in the cotton world during the present century, and to risk some guesswork concerning the future trend of those changes in the remainder of the century. Such changes are partly due to world-wide economic causes, but—in so far as the industry shows signs of surviving the impact of those causes—they are largely due to the application of modern scientific methods. These methods have succeeded in making discoveries of things within the industry which the industry itself unaided had failed to find during a hundred years of experience.

At the present day the industry may be described as having too many machines, which machines are individually too simple, with one exception, the mule; that it could utilize more complex machines satisfactorily is demonstrated by that exception. The next salient feature is that no two cotton hairs are exactly alike, even when they have grown on one and the same seed. Although uniform cotton is very desirable, it is quite impossible to obtain it, and the most uniform cotton which the best grower can supply is a complex mixture of hairs which differ enormously in their length, diameter, wall thickness, strength and slipperiness. We shall see later how this situation may be dealt with in the future, but at the present day it is met by using a technique of blending, or mixing in order to obtain a raw material of constant average properties; the other textile industries are able to employ the converse process of sorting, whether in silk, wool, or flax, simply because their raw material is big enough to be handled.

The Advance of Cotton

These two characteristics taken together seem to me to differentiate the cotton industry very clearly from most other forms of industrial endeavour, and thereby to define the lines along which it may be expected to develop or shrink, in the future. They may be summarily described as a state of dependence upon unskilled labor, and upon unclassified raw material. Cotton was initially a raw material for making a cheap substitute textile, in the early stages of the industrial revolution. It passed onwards to produce textile fabrics with virtues of their own in strength and fineness; indeed, it thereby reverted to its previous use in the native industries of cotton growing countries. At the present day its use as a textile pure and simple, for covering purposes only, is rapidly becoming less important, and the center of gravity of cotton uses is shifting towards purposes which may be described as those of engineering. It is not a despicable engineering material; its tensile strength is comparable with that of mild steel, and no steel would endure the everlasting flexure undergone by the cords of a motor car tire.

The status of the artificial fibers in relation to cotton is merely another aspect of this salient. It is often stated today that artificial silk has reached its limit of usefulness, that further improvements in it are unlikely, and that it will serve cotton for the future as an em-

*In the Annual Mather Lecture of the Textile Institute of Manchester Eng. at Institute's 21 Anniversary, April 23.

bellishment, not as a competitor. I am sorry that I cannot subscribe to this comfortable belief; it has been held throughout the twenty odd years during which I have been keenly interested in the possibilities of artificial fibers, and it has so far proved itself erroneous to such an extent that the world's output of artificial silk is now bigger than the whole Egyptian cotton crop. The past few years of competition between artificial silks and the fine cotton textiles has been a temporary phase, and the prospective victims of the artificial fibers are the inferior kinds of cotton and yarn.

What of the Future ?

But if cotton will continue to desert its proper textile employment in favor of engineering uses, this antagonism will not matter much. The cotton spinning industry of the future might be largely divorced from weaving; concentrating on the production of cords; it will be a fine spinning industry, working with fine cottons, but usually spinning them into coarse counts. My guess is—that the artificial fibers will be successful in their rivalry to the wrong kind of cotton spinning, but that the world demand for the best kind of cotton yarn will keep this modified form of cotton industry occupied for an indefinitely long future.

I am inclined to select two ideas and to give them pride of place among extensions of knowledge in the cotton industry. One is the late Prof. Johannsen's idea of "pure lines," the other is the idea of translating all cotton problems into terms of single cotton hairs. I put the work of the late Prof. Johannsen of Copenhagen in the first rank of discoveries affecting the cotton industry because of the certainty which it has given to the seed supply whereby our raw material is grown . . . . . Any modern variety of cotton which has once been reduced to the state of a Johannsen pure line is a permanent possession of the industry which need never be lost, and can be withdrawn from supply or reintroduced, as the demand may require. The change in outlook brought about by the pure line concept is well exemplified by the wonderful set of statistics obtained in the working of the seed control law in Egypt. These figures cover every sack of seed sown in the country, and entail the examination of representative samples from about a quarter of a million tons of seed annually.

I hope my listeners will forgive me the egotism of claiming that our modern method of formulating cotton problems in terms of the single cotton hair is also important, seeing that it is my own contribution. The single hair is the fundamental unit, and the properties of a bale of cotton are those of its constituent hairs—although the number of these in an Egyptian bale is about fifty thousand million. . . . Among many curious consequences of this attention to the individual hair I may specify our realization of the relative lack of importance which can be attached to length of staple, in comparison with other hair properties.

Lacking in Technique

In the past there had been no technique for measuring any other property than length, which is the only one appreciable by the naked eye, and an altogether disproportionate importance has been attached to it in consequence; length is an advantage when other things are equal, but we are now completely familiar with many cases where marked inferiority in length is accompanied by marked superiority in spinning, because the other things are not equal.

The results which have so far been achieved in the central problem of cotton spinning are somewhat disappointing; I refer to the prediction of the properties of the yarn from knowledge of the properties of the cotton. Much progress has been made but we are still far short of the broad generalizations which will eventually be obtained. Indeed, it has taken the technologists a surprisingly long while to realize the centrality of this problem; I had been working on it myself for five years when I ventured to offer it as such in a committee which was discussing programmes of research work ten years ago; it was intimated to be that there was no such problem, so—somewhat crushed—I said no more, and returned to work on it. Five years later it began to attract notice, and last year I heard it described as the fundamental subject for cotton spinning research. . . . It is not without significance that during this period we have seen substantial practical advances in the construction of yarn.

The possibilities of cotton breeding for quality have scarcely been surveyed as yet, while even now it has been found possible to breed for increased yield in such a specialized cotton producing area as Egypt . . . The better understanding of the physiology of the crop is leading to increases of yield from the same variety on the same land, again in Egypt, which—as we have already seen—implies that other cotton-producing countries must either follow suit to an extent comparable with the intensity of their food production demand, or abandon the growing of cotton in order to feed their increasing populations. In the case of Egypt, where the available area is strictly limited, and can only be increased by about one quarter at the most, I estimate that the present eight million kantar crop might eventually reach fifteen millions by such increase combined with intensification of culture, under the limitations imposed by agricultural, economic, and social requirements. The possibilities of other countries must vary with their local conditions, but among these I place very high the stability of their climate from year to year leading to a reasonable certainty of an even-running product from season to season. . . . Failing the development of extensive applications of the sorting technique, I can see no future for miscellaneous and unstable cotton crops.

The absence of any technique for bulk sorting of cotton into classes characterized by different lengths and fineness was mentioned at an earlier stage of this lecture. To a slight extent the card and comber may be regarded as sorting appliances, though only secondarily to their other functions, but there is no such prior separation into classes as the other textile industries can effect. I have demonstrated experimentally that such sorting is mechanically possible for length differences, but the practical result of spinning such sorted cotton was to show that the long-cherished distinction of length was relatively unimportant; speaking roughly, a cotton which is twice as long makes twice as strong a yarn, which is insignificant in comparison with the effects predictable as the result of sorting for fineness, if and when that is accomplished. The everyday achievement of length sorting can therefore afford to wait until fineness-sorting can take place concurrently with it.

Less remote than these possibilities of sorting are the possibilities of employing super-drafts, so that the transition from the finishing draw-frame to the yarn may avoid the successive passages of flyframes, with their concomitant labor costs. In collaboration with Mr. F. Hutchins I have demonstrated the possibility of satisfactory spinning direct from the draw-frame sliver into 100's count with a single super-draft of two hundred; there is a ring-spinning machine actually on the market which uses two stages of high draft on the same frame to achieve the same result; there are possibilities in physical research on the hair which might give us super-drafts by other means than mechanism. That super-draft machines would be complex and expensive is self-evident; some of their moving parts would have to be built to far higher standards of accuracy; more specialized operatives would be required to supervize them. But in order to pay for the machines and the labor, we can draw on the money which at present we pay not only for the spinning machines but also for three sets of flyframes and for the labor which attends to them.

Still nearer to actual realization within a very few years is the advent of a satisfactory continuous spinning machine. In this case not only is the theory adequately worked out, but the simple practical means of accomplishing it only wait commercial development. I refer to the arrangement which I designated as the "Rule" frame, it being a ring frame with nearly all the good points of the mule. A frame built on these lines, namely, with a long stretch of freely vibrating yarn between the drafting rollers and the spindle, is already on the market as the result of quite independent investigations in Germany; curiously enough, this Hartmann machine misses an essential characteristic of my rule frame, in that it retains the unnecessary and disadvantageous constraint of a thread-guide. I have a strong belief in the possibilities of this type of spinning machine.