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QUALITY CONTROL IN THE FINISHING OF WOOL AND WOOL BLENDED WOVEN AND KNITTED FABRICS 1/

by

C. Duckworth

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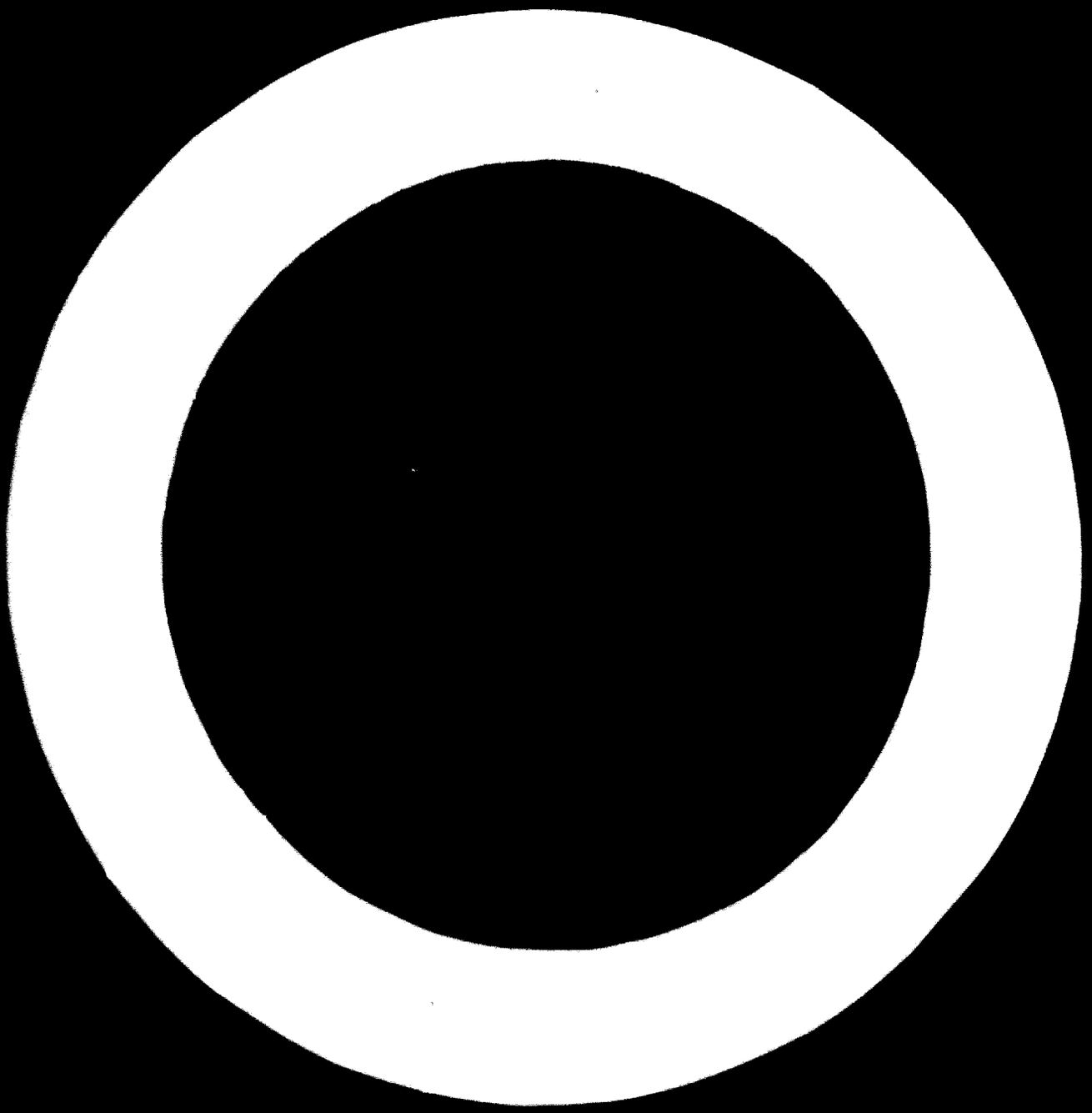

PREFACE

This document was prepared at the request of THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION. It is concerned essentially with the more practical aspects of Quality Control in textile finishing and embodies the experience of the author over several years in practice. The extent to which Quality Control is adopted, especially as a separate functional responsibility, is determined largely by purely commercial considerations, and in the following account practical and economic factors have continually been borne in mind.

The author wishes especially to acknowledge the assistance and advice given by Professor C.S. Whewell, The Department of Textile Industries, The University of Leeds, in the preparation of this report.

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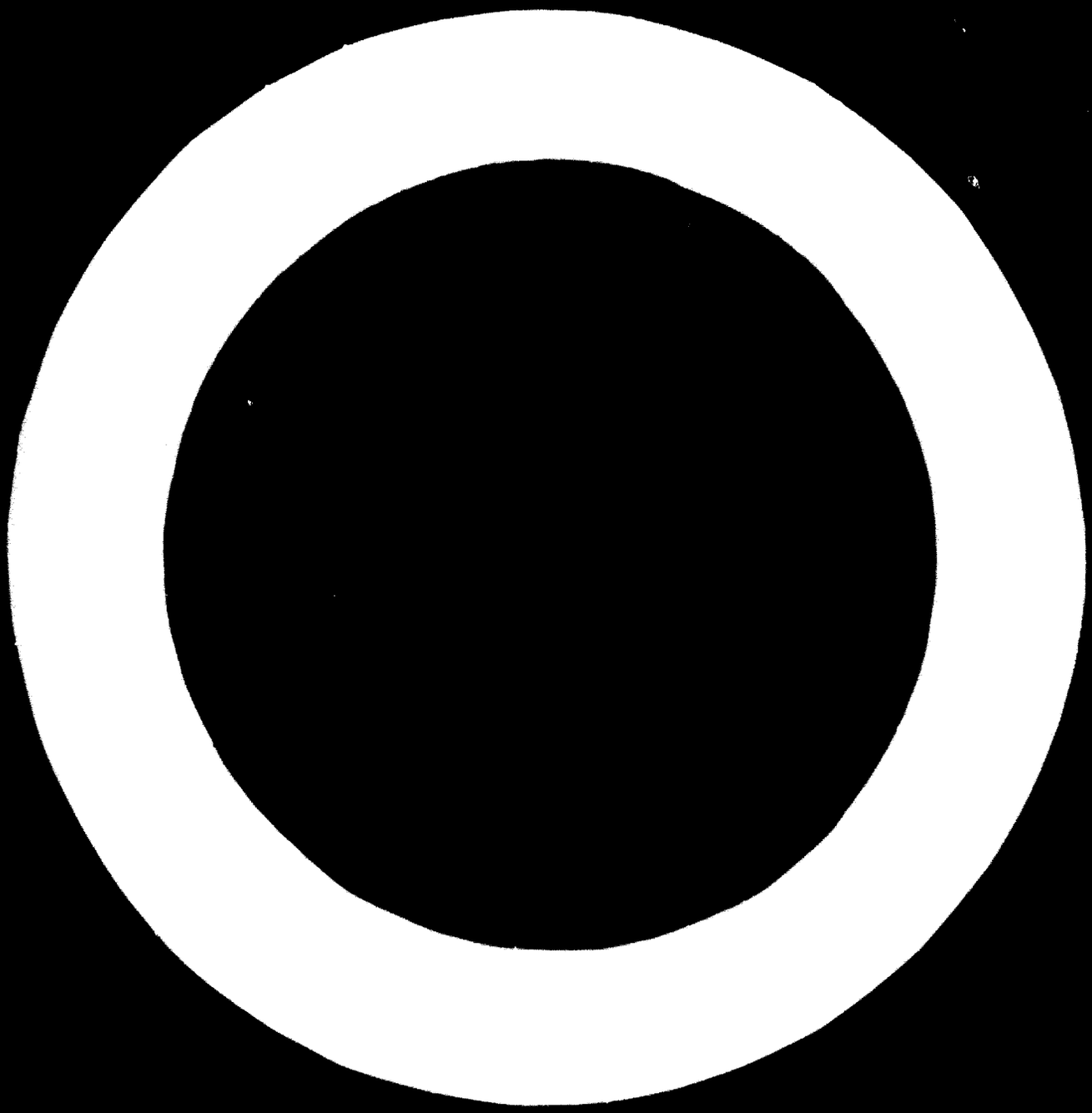

QUALITY CONTROL IN THE FINISHING OF WOOL AND WOOL-BLENDED WOVEN & KNITTED FABRICS

Introduction and Outline of the paper.

The object of this paper is to indicate the principles underlying Quality Control procedures in a textile finishing factory and to give an outline of the methods which may be employed.

The paper is divided into two parts.

1. The principles and philosophy of Quality Control.
2. Practical application of Quality Control by reference to control in
   a) a vertical textile organisation, and
   b) a commission finishing company.

1. The Principles and philosophy of Quality Control.

It is fitting at the outset to emphasise the essential practical nature of Quality Control and the cost of the operation, and then to provide some definitions of the frequently used terms. Whatever the political economy of a country any commercial undertaking must make "profits" in order to survive and prosper. That is, there must be a surplus of gross income over gross expenditure however these quantities are calculated. To achieve this a company must consistently satisfy its customers in terms of price, quality, and type of article, as well as in general terms of trade including speed and reliability of delivery.

This is indeed basic business economics, but forgotten or ignored often and so readily in various specialist departments of a company, not least in many current examples of Quality Control departments in which professionalism and empire building illustrate the now famous "Parkinson's Laws".

It is customary to classify many service departments of a business including a variety of laboratory services under overhead charges, in that the

cost of providing the service does not materially vary with the activity or turnover of the business and that the department does not have a directly saleable product.

Nevertheless, from a commercial point of view, a Quality Control service, however large or small, should be considered as a production unit and not as an overhead. The cost of providing this service should be regarded as a production cost.

Price, quality and delivery are indeed hackneyed terms, but the long term regulation of a company probably depends more upon quality of product and service than price, although obviously all three are interrelated.

Quality Control then in its broadest and more enduring sense is an attitude of mind by managementm which must be communicated to all levels of departmental management and operative labour.

The term "quality control" is liable to misinterpretation in respect of finished cloths because of the popular meaning of "quality". Often in the cloth trade "quality" is associated with a high price due to the use of expensive raw materials and sophisticated designing and finishing. This paper is not concerned with this aspect of "quality", and attention is focussed almost entirely on the maintenance of uniformity and of standards of fabrics, over a period of time, at any price level and for any type of fabric. This must be attained at the lowest possible cost.

Uniformity can be judged only by the existence of a standard with which samples of articles produced can be compared.

Standards for textiles may be conveniently classified as

1. Subjective, and
2. Objective.

Subjective standards include those relating to such properties as handle, drape, softness, firmness, lustre, cover, solidity of shade. Objective standards would include an increasing variety of properties which can be more

or less accurately measured or evaluated.

It should be stressed that a considerable degree of error is possible in some so-called objective measurements either because the instruments themselves are not yet capable of yielding reproducible results or because the results are obtained by inter-laboratory studies of some particular standard. Such variations arise from the design of the instrument and the efficiency of the operator.

Shade matching and uniformity of shade throughout the area of a piece of fabric or repeat batches of fabric presents several problems if a satisfactory degree of standardisation is to be obtained. By custom this is still largely a matter of subjective agreement within a factory and between a factory and its customers, but increasingly scientific methods of measuring and defining colour values are being used.

Some basic properties of textiles are however capable of being accurately measured; for example, weight per unit area, picks, ends, width and length, and tensile strength. Consideration of these properties begins at the manufacturing stage of textile production. Ways in which such design and structural properties can be affected by finishing processes will be covered later.

Textile finishing is still to some extent an art, but it is increasingly being regulated and controlled by scientific methods. In the nature of things, however, if only by the influence of the fashion element which dictates so many changes in style, the craft or traditional approach must long survive. Scientific discovery itself does much to preserve the artistry and craft instincts in the textile industry. For example, the host of new man-made fibres produced in the last 20 years owe as much success to the craft manipulations of the designer and the finisher as to their basic fundamental properties.

Whilst the recommendations of the Fibre maker's Manuals become the

starting point for the production of new fabrics and finished effects it is those companies who have appreciated the scope of the new fibres, understood their novel properties and applied their traditional craft techniques to the basic information, who have prospered most. From time immemorial textile producers who have achieved repute and success have had an ingrained instinct for the quality and uniformity of their production, but until recently, say the last 20 years, even the largest firms had no Quality Control Department as such.

The achievement of a good reputation for quality and its preservation rested entirely on the attitude of mind throughout the company, the acquisition of mental standards by which to judge variation, which, coupled with keen observation and prompt action, yielded the desired results.

Whether all staff concerned operated in such a way because of a sincere and personal interest in such matters or because of "force majeur" is beside the point. Control of quality in textiles, now and in the future, must depend largely upon an attitude of mind by all concerned with production, which is devoted to the achievement of special skills, observation and action in controlling output; no system of organisation as such or automatic instrumental controls by themselves can be substituted; these scientific aids can only achieve their full promise if the human foundation is soundly based.

In general the lowest costs of production for any given product are achieved by large scale production; it is equally clear that the larger the undertaking and the more numerous the staff and operatives, the more difficult it is to maintain adequate channels of communication between top management and the production floor.

This is perhaps one reason why relatively small firms abound and prosper in the textile industry especially in specialised finishing, and where it is then relatively easy for the skilled owner to select appropriate staff and operatives, and to maintain personal contact with them daily, and thereby jointly maintain close supervision over every aspect of production and control.

2 (a). Practical application of Quality Control in a vertical textile organisation.

a.1. General.

Some definitions have already been given in the introduction, part 1, but it is considered important to repeat those in a different form, as any company which is to establish a Quality Control function must be quite clear what is involved. "Quality Control" is not an academic exercise, but a vital production function concerned with profits and reputation. It is not solely the collection and recording of data based upon statistical analysis.

Quality Control must consider all those aspects of producing an acceptable finished fabric, that is, one which meet the demands of the customer. In a vertical company this means control of all the fabric manufacturing stages along with the activities of the Finishing Department itself, the latter being the prime concern of this paper.

To facilitate the consideration of principles and problems it is proposed to describe an imaginary vertical textile company, its size, styles produced, types of plant employed and then to discuss one of the practical ways in which a Quality Control unit could be made to operate.

a.2. Production.

3,000,000 linear yards per annum based upon 50 weeks of 5 working days on a 3 shift basis 24 hours,

equivalent to :	60,000 yds per week	: 3 shifts	at 100% production efficiency
	20,000 yds per week	: 1 shift	
	4,000 yds per day	: 1 shift	
	500 yds per hour		
	8 yds per min.		

Styles of fabric produced.

Woollen spun and Worsted spun fabric, Woven and Knitted, and intended as suitings, dress fabrics, coatings and blankets.

Manufacturing equipment.

It would be out of context to describe all the equipment necessary to operate such a factory.

Clearly for each type of yarn plant will be installed which deals progressively with the basic stages of sorting and blending, scouring, preparing, carding, combing, drawing, spinning, twisting, winding. Yarn may be "dry spun" or "oil spun", and plant may be based on traditional multi-stage sequences or on very modern short sequence high draft-techniques.

The types of faults to be met at each stage are fairly well classified and are in general independent of the make and design of a machine itself. For example, neps and fibre breakage in carding are more likely to be due to incorrect settings and badly scoured wool, than machine deficiencies whatever the specific design or make.

Similarly, yarn irregularity, slubs, knots, reflect either processing or machine deficiencies.

Refere ce will be made later t the influence of "Quality Control" on raw material purchases and the consequent effect on uniformity of standard re-eat qualities of fabric.

So far as weaving is concerned it is sufficient to appreciate that apart from warping and weft winding, the types of looms would be mainly plain and dobby, with some Jacquards, whilst knitting would almost certainly be confined to double jersey circular knit.

8.3. Finishing machinery equipment

No attempt is made to be specific about the type of machine or the number of units required to meet the assumed production output. The main point to be observed is that whereas the factory as a whole is a very substantial capital investment, and yields a high turnover, the hourly production and optimum machine speeds through the finishing department are small by commission finishing standards.

As will be seen by comparison with plant referred to in the section on Commission finishing it is likely to be much less flexible in operation, more limited in the variety of finishes or effects that can be produced, and should be more highly loaded in respect of machine operating efficiency.

Nevertheless as fancy coloured yarns must be available, it is assumed that a factory of this size would have its own top and yarn dyeing equipment.

For fabric processing, the minimum requirements would be

Crabbing/steaming or
Wet decating/steaming.

Rope scouring - and open width scouring
Milling - carbonising
Centrifugal hydro extractor
Winch Dyeing machines
Hot air drying machine and high temperature setting
Damping or Conditioning machine
Card wire raising
Shearing
Steam decatising, semi-decating machine
Rotary press or hydraulic flat bed press
London Shrinking
Making up machines
Perch or Inspection machines

4.4. Management structure.

This is included in order to highlight two particular aspects of Quality Control.

Firstly, whatever the top management or Board structure, the company is likely to be strongly departmentalised so far as production management is concerned.

This is inevitable in that spinning, weaving, and finishing differ so fundamentally from each other that a good head of department becomes a specialist in his own sphere, often with many years of experience to support his position.

Each of the 3 heads of department or Managers may "live well" with each other, respecting each other's talents, but sensitive if one blames the other for faults arising. Criticism must be accepted from a director or general manager but the Quality Control function which covers the whole undertaking probably has its biggest problem in establishing a working relationship with the specialist department managers, greater in fact than administering its own function.

The specialist accountants or sales managers already have their particular functions and importance well established, and enjoy substantial seniority.

The Quality Control manager on the other hand is relatively new as a separate functional responsibility, and his job tends to be interpreted by production managers as a lack of trust by top management in the execution of their departmental duties, and in that the Quality Control job does largely consist in looking for faults, analysing them and allocating responsibility for their occurrence, such an attitude is not surprising - at least when a Quality Control function is first set up.

This problem will be dealt with in greater detail in the following section.

A vertical company of this type is almost certain to be based upon a production programme, built upon Sales budgets for certain qualities and quantities of fabric already established from past production, and from samples produced for the future.

Compared with commission processing, this means a great deal of repetitio and the opportunity by Quality Control staff to analyse faults more accurately and to recommend remedies and standard procedures with greater confidence.

Also, all fabric is initially the property of the company, unlike the situation in commission finishing, and the usual policy when faulty fabric is found during processing is to pass this forward for grading in the making-up department, and subsequent selling as "seconds",

In other words, it is not usual to re-process faulty fabric, unless there is an obvious cure such as re-dyeing into a dark shade or black.

Thus in a vertical organisation this simplifies the problems of production scheduling and deliveries and makes it easier for the Quality Control staff to analyse the occurrence and prevention of faults.

2.5. Organisation of the Quality Control function.

Position of Quality Control in Management Structure.

Some reference has already been made to the delicate position of this function, and in that Board Management must initially decide to establish Quality Control as a separate function, in place of that attention given by each Specialist Manager within his own department, then the Board through its General Manager is recommended to act on the following lines:-
It should advise the department managers of its proposal and make clear that Quality Control personnel:-

(a) are responsible to the General Manager,

(b) have authority and responsibility only for their function,

(c) do not give instructions outside their own department,

(d) must justify their existence to general management in terms of a better quality product at lower cost,

(e) recommend changes in factory procedures considered desirable by Quality Control directly to each Specialist Manager, whose responsibilit it is to implement them,

(f) appreciate that the Quality Control department is a tool of management and a service to production, and depends upon mutual co-operation for the company's benefit,

(g) accept that the unit should not be seen as a policing activity for general management, but should equally be used by Specialist departments.

Staffing.

It must be assumed that an existing vertical company has already at least two persons whose main tasks are to collect and analyse data on the Spinning and Weaving departments, probably on the basis of charts constructed on statistical analysis principles, and that final inspection in the Finishing and Making-up department is the responsibility of that department.

The object being now formally to establish a Quality Control section, then the absolute minimum staff would be three, one of each dealing with spinning, weaving and finishing.

This may well form the nucleus, but as much of the nature of Quality Control lies in the calibre of its works staff and their observations and deductions on works procedures, then it follows that separate clerical staff should be employed to deal with the paper work. Paper records are the only way in which progress can be charted, but continuous efforts must be made to ensure that paper work is at a minimum, and that files and records made are of use and seen to be used. The ultimate size of the department must eventually be decided by the circumstances of a particular firm and by top management.

Scope of the Department.

Its oversight should include all production activities from raw material to finished product, and in due course can include observations and recommendations concerning the uniformity of raw material in the shape of fibre, purchased tops or special yarns and of certain dyes and chemicals.

This paper is however mainly concerned with work in the Finishing section, but in a vertical company there is little point in having separate Quality Control departments for each phase of production.

Much of the work in Spinning and Weaving is purely of the objective type

as discussed at the outset, whereas the subjective approach becomes important as finishing proceeds.

The heart of Quality Control in a vertical company should be at the Grey of "greasy" mending stage; that is, immediately before finishing begins.

In spite of the variety and complexity of faults which can occur in finishing, it is nevertheless usually found that the bulk of "strings" which are placed in finished pieces to indicate faults are those showing physical blemishes due to yarn or weave imperfections. These are, for example

Knots

Slubs

Broken threads

Mended places

Bars and stripes

The grey mending room is therefore a main control point and guide as to the standard of quality which may ultimately be expected.

The mending staff and foremen will be production personnel, often responsible to the weaving Manager.

One of the benefits of a separate Quality Control department is to provide staff who are free from production problems such as wage rates, differing operative skills, production programmes and so on and who therefore have time and opportunity to observe what is being produced and how it is being produced and liaison with Grey mending is the starting point of Quality Control in finishing.

<u>The relation between Quality Control in finishing and Quality Control in other sections.</u>

It has been remarked that a form of quality control may already be in existence in spinning and weaving, but in addition, the existence of laboratories and their staff must be taken into account, and all these activities should be integrated.

It is certain that for a large company some facility must be provided whereby fuels, water, effluent, dyes and chemicals are tested, and in which physical and chemical tests can be carried out to establish the standards of performance of yarn and fabric.

Depending on the country, location and circumstances of the textile company the laboratory can be quite a large and justifiable asset, but it is preferred that this be regarded as separate from a Quality Control function as such. It is true, that in the absence of a defined Quality Control function, then the laboratory performs some of those functions. However, the staff of a laboratory tend to be concerned with methods of test and performance standards and to be laboratory based, carrying out a good deal of routine work.

Quality Control is concerned with the daily work of production as it is carried out on the "shop floor" and therefore the central laboratory should be maintained separate from Quality Control as discussed in this paper.

It should be the means of carrying out tests and analyses as required either by Production Departments or by Quality Control. In addition it is common to find that a central laboratory is too remote from the shop floor and lacks practical experience in many matters as they affect the finishing department itself.

The Dyer therefore frequently has a small works laboratory staffed by themselves as "dyer-chemists" and a laboratory assistant, with the main objects of carrying out sample dyeings to produce recipes and on the spot "trouble shooting" for a variety of wet processes.

This aspect again should remain the province of the dyer and emphasises once more the importance of human relations if Quality Control is to establish good liaison with so many other important functions.

Qualifications of staff.

It may reasonably be assumed that the Quality Control persons responsible

mainly for spinning and weaving should have a basic knowledge of these departments and be familiar with the statistical basis of such work, but in many cases a specially trained high grade clerk with leaning towards production performs the work very satisfactorily. It is suggested that the senior of the assumed minimum staff of three, must be the person who takes over from the grey mending onwards, as he not only has to deal with manufacturing faults as they ultimately appear in finished fabric, along with the potential hazards in finishing as such, but primarily he has to justify the existence of the department and yet achieve its ends, without direct authority in production matters.

Subject to his personal qualities and an assessment as to how well he can perform his "diplomatic" tasks it is of course preferred that the Quality Control person for each main section should be an "engineer" (in the broadest sense of one who is well qualified and with sound knowledge) and the new head of the Quality Control unit as a whole, has to cope in addition with a different type of textile technology based largely on the chemist's language.

He cannot be an expert in spinning, weaving and all aspects of wet and dry finishing, but he should understand the basic principles and be sympathetic to the difficulties encountered in each section.

Whatever his academic or practical qualifications, ultimately it is his personality and method of approach to running the Quality Control department which will determine its value and his reputation.

He must be capable of convincing his senior colleagues in production of the need for more care or control, or changes in procedure and yet retain their respect and ready co-operation. Failure to do so sufficiently often is not necessar ily his fault: human nature being what it is, a production department manager with a strong personality and a "no interference in my domain" attitude can prevent an independent Quality Control section from functioning correctly.

It follows that in requesting changes in techniques, Quality Control staff must check and double check when a case is of crucial importance, yet, being right every time can be a thorny crown to wear !

A case must be presented on accurate reporting of facts, reasonable conclusions, and be conducted at all times dispassionately and without malice or temper. Only if a case is important and progress unacceptable should the factory manager be brought in to make a decision. At the same time, a good factory manager will be aware of all these points and can almost anticipate trouble by giving potential areas of conflict the more personal attention.

Co-operation, leadership, logic, communications, industrial democracy, and so forth are words which frequently occur in text books and lectures on the science of modern management, but one well known leader of industry had his own pungent phrase which summed up many managerial problems: "Co-operation must be enforced".

Procedure, Records and Reports.

The basic procedure is based upon key fabric inspection points. The main points are - (1) Grey or greasy mending. (2) Final finished fabric inspection. These of course must exist in any vertical organisation, and data from these two key inspection points provide Quality Control with a basis for analysis and action. A third inspection point is that following upon wet processing and dyeing.

The first two points necessarily cover 100% inspection; that is, every piece must be examined.

Quality Control in finishing, so far as inspection for uniformity of product is concerned usually involves examining each piece of fabric which is produced. This is very different from Control of Quality in spinning, where it is obviously impossible to examine each yard of yarn. Inspection of yarn must be on a sampling basis, in which the "count" and uniformity of a length of yarn selected from the bulk material is examined. This has led to the widespread adoption of statistical quality control techniques which depend upon the collection of data from the examination of a relatively large number of samples. The data are used to construct control charts, from which it can be seen that a particular spinning frame or collection of frames is regularly producing yarn within the required tolerances.

These techniques are possible only because the manufacture of yarn is a mass production operation in which very large weights of fibre are converted into yarns of a restricted count range.

Production becomes much more varied during weaving, by virtue of the differing fabric designs and colours, and during wool finishing itself the batch system predominates, and in which it is unusual to process batches much greater than 1000 yards of precisely the same quality.

Even in processes such as continuous open width scouring or in drying, whilst the machine itself may be operated continuously, the batches differing considerably in weight, design of fabric and colour, follow upon each other.

Under such conditions it is difficult except in exceptional cases to operate a statistical Quality Control system, and as will be seen later in the section on Process Control, the main endeavour is to control the many process variables at each stage of production in order that a uniform product is obtained.

This is based on 100% inspection of each piece of fabric at two key points at least.

The intermediate inspection is usually limited to fabrics which have been piece dyed, and where irregularities can be such that grading as seconds is not possible. Such pieces must either be redyed or reprocessed, or redyed to some other more suitable shade or in dire circumstances written off as a loss. The percentage of production which is to be inspected at the middle stage is therefore quite variable.

It should be kept as small as possible consistent with the standards required and those being achieved.

The production work ticket should state which lots of fabric are to be inspected at the middle stage and when any particular quality no longer merits such inspection the order or progress clerks who prepare instruction tickets will note accordingly.

At all three points, operatives will already complete some type of individual work sheet, if only for the two needs of wage assessment and progress chasing.

Mending of faulty places will have taken place in Grey mending, and strings inserted to indicate gross faults which remain visible. (See Appendix A - Faults detected at Grossy mending).

Stringing will also take place at intermediate inspection and on final inspection, and custom often dictates that dyer's or wet processing faults are indicated by a different colour or type of string from physical blemishes from spinning or weaving.

Quality Control staff should prepare analyses based upon daily invoice or delivery records in terms of

1. total output
2. percentage graded as seconds
3. percentage not fit for normal sale (disposal as rents)
4. yardage cut from pieces and sent to rent room
5. total strings per 1000 yds delivered.

This minimum analysis should be aggregated to weekly and monthly totals and summarised quarterly and yearly if required.

These records and analyses provide a factual basis upon which progress in achieving a better control of the quality of production may be measured. Inspection of these records and the results obtained at the finished pieces inspection point will indicate what further analysis under these headings is required, either against a particular customer, or for specific fabric qualities.

At the Grey Mending stage the spinning and weaving departments will already be concerned to see what standard of workmanship is being achieved.

This may be by regular personal contact and/or by occasional special reports on specific qualities.

As indicated earlier, Quality Control must be equally active at this first stage of fabric inspection.

Operative work sheets will show time spent on mending, again if only for wage and progress purposes, but it will be necessary from time to time to record the number of strings being inserted.

This can be done on the operative work sheet or on a special sheet provided for the purpose, but it must be remembered that the operatives daily work sheet is required immediately at the end of a shift by Progress and by Wages sections, and therefore any sheets required for Quality Control for more detailed analysis will inevitably mean producing a copy sheet or a special card for specific lots or qualities upon which the required details are entered.

Thus, Quality Control staff must be in the position of being able to produce an analysis of hours per piece spent in mending and the number of strings per piece for specific customers or qualities.

This should be compared with the overall average of total mending hours against total yardage.

Likewise at the intermediate inspection point, the percentage of pieces returned for additional reprocessing should be recorded, and the type of fault which gives rise to a "substandard" rating should be recorded.

It is not the purpose of this paper to attempt to give a list of all the faults which can occur in wet and dry finishing, nor in particular to assign causes to such faults. Identical faults tend to have different names in different factories or localities, and the cause of such faults can in any event arise in different stages of processing. Nevertheless, Appendix A indicates types of faults which may occur at different stages of processing.

For example, "Rope marks" and "streaky" are both used alike to describe warp-way colour imperfections, usually running at a slight angle to the warp threads, but some finishers reserve the term rope marks to those cases in which there is a mechanical deformation in addition to colour differences.

In both cases the fault can be caused either during piece dyeing or during rope scouring.

Similarly, uneven or cloudy dyeings where the colour is generally uneven or blotchy, but without any definite pattern, can be due to the dyeing stage or to inadequate scouring or faulty carbonising. Good scouring is essential to ensure satisfactory piece dyeing.

Due to the complexity of faults arising in finishing it is all the more important that careful analysis of their occurrence be made. Fortunately the percentage of rejections is not usually high, but trouble at this late stage in the complete chain of manufacture can nevertheless be costly and can seriously interfere with deliveries on schedule.

Process Control.

Whereas it is clear from the preceding pages that the detection, examination and analysis of faults is highly important, it must also be evident that many faults occur because the process conditions themselves are not being uniformly observed.

Where a Quality Control department has grown beyond the minimum three man basis referred to, a reasonable proportion of the time of such staff should be made available to work with production staff to monitor just what is being done at some particular stage of the processing. Process Control is one of the responsibilities of Production; they should retain the responsibility and authority for seeing that the conditions of processing laid down are indeed maintained.

Some enthusiasts for an all embracing Quality Control department have recommended that Process Control should be supervised and regulated by that Department. Whatever advantages may be put forward, in our opinion this is bad management practice, in that the chain of production management authority should be as logical and continuous as possible, with all concerned being quite certain to whom they are responsible.

Assuming therefore that Quality Control staff are required to provide a service to improve process control this should be done in two steps or stages which are illustrated by the following detailed consideration of scouring, one of the most important processes in wool finishing. First there should be general agreement as to the optimum method of processing and this can be set out precisely on the basis of experience within the factory. Secondly there must be a procedure for ensuring that the agreed method is followed.

1. The Method.

In the past skilled operatives have frequently been allowed to determine processing conditions themselves, using only their judgement to decide if a batch was indeed well scoured. In present day circumstances this approach cannot be justified and there should be a schedule of procedures or code of operations in which the following are outlines:

Basic information: Machine type and load
Cloth speed
Weight on top roller
Concentration of alkali
Concentration of soap
Temperature of liquor in machine
Sequence and times of operations
— Wet out say 5 minutes
Scour 1 say 45 "
Run-up or let down
Wash
Scour 2 say 45 minutes
Run-up or let down
Wash

Exactly what is to be done may be indicated by an appropriate code and this will have been recorded on the work ticket from which the operator takes his instructions.

2. Checking the operation.

It is self evident, that provision of a system is not sufficient to

ensure uniformity of results, and whilst it is indeed the responsibility of the Production staff to regulate its Department, Quality Control staff can and should be called upon to assist in Process Control.

A typical survey or monitoring operation would include the following:-

(a) Check machine serviceability

(b) Check availability of thermometers or temperature indicating instruments and that they are in good order.

(c) If machine types differ significantly from each other, check that the batch is allocated to the stated machine type.

(d) Check bulk chemical supply concentrations and quantities being used.

(e) Check operating temperatures.

(f) Observe the process sequence and check times allowed.

(g) Query any other observed peculiarities.

(h) Arrange for samples to be taken when scouring is completed, measure and compare dimensional changes with past records and arrange for analyses of residual grease and soap content.

(i) Arrange to inspect the batch after piece dyeing and after final finishing and prepare a brief report on the findings.

A great many of the other finishing processes are also batch operations and the foregoing should serve as a guide to checking that a Method exists and that it is being carried out correctly.

The same principle applies to continuous processes. The Method should be stated briefly or in code on the work ticket, and it should be seen to be carried out.

Nevertheless, it will be found that occasionally the finished results are not exactly what is desired, and a change of Method is advocated. This usually means a special trial or experiment at some particular stage of the full sequence of operations which a batch of fabric undergoes throughout the finishing department.

This is a further opportunity to use Quality Control staff to assist in supervision, but only as skilled observers and as a service to Production. See Appendix A for some comments on finishing faults.

Apart from a record of faults, one of the most useful possessions is a large sample book or filing system showing actual cuttings of specific faults with a summary of action taken, and some form of index to facilitate a search for information at some later date. Similarly, a record will almost certainly be kept by Production of samples of fabric from delivered orders. The usefulness of these cannot be overestimated, and many firms also file with such cuttings a swatch taken from loomstate fabric.

Quality Control staff should constantly make use of these references for comparison purposes and urge that the system be kept complete and tidily and cleanly filed.

2.6. Standards of Performance.

It used to be a common occurrence for a customer to state his requirements to the Finisher in the simple phrase - "Dye and Finish exactly as pattern".

Whilst a pattern or sample is either still supplied by the customer or a "scaled" or standard pattern referred to, this is usually intended to show the shade or colour required and illustrate those characteristics which defy precise physical description or measurement; for example, handle, drape, cover, and lustre.

The other properties of the fabric which are required, are more precisely described in a specification.

Such a Specification will list the level of standard of performance which is to be achieved, this level being ascertained according to a stated or agreed Method of Test.

A typical specification would cover the following properties of a fabric:

Width,

weight per unit area,

dimensional stability,

tensile strength,

colour fastness (to various conditions e.g. light

perspiration

dry cleaning

laundering),

and conformity to pattern.

This would state only the bare minimum of all the possible requirements. Specifications and Standards of Performance are prepared and issued by a vast number of organisations on a more or less confidential basis. That is, they are supplied to and for the use of the Finisher who is to process fabric to their requirements.

Government Agencies usually prepare the most thorough and detailed specifications for Defence and Services use. In the United Kingdom a great number of these are freely available from H.M. Stationery Office.

The next largest source of such Standards of Performance would include the Tailoring combines and Retail Stores.

Another important group is that including organisations which have a vested interest arising from the use of Registered Trade marks and Brand names. Some examples would include

The use of the "Wool Mark"	(IWS)
"Terylene"/Wool	(ICI)
"St. Michael"	(Marks & Spencer)

In a number of cases the Standards of Performance and related Method of Test are exclusive to the organisation which issues them. For example

Fastness to rubbing (crocking)

and Seam slippage of garments

are both available as standard Methods of Test, but at least one Retail Store sets its own private standard and Method of Testing for both properties.

In many cases a minimum performance standard is specified, for example:

"Tests to determine the breaking load will be performed on a machine having a constant rate of traverse of 18 inches per minute, the size of the test pieces being 6" x 6" between clamps. The values thus determined shall not be less than those specified in Schedule A".

Extract from Defence Specification DEF-100-B.

Wool fabrics, barathea, gabardines, serges etc."

H.M. Stationery Office, London.

In other cases, the Standard of Performance is quoted in several grades. These apply especially to colour fastness requirements where the grades are 1-5, and 1-8 in the case of Fastness to Light.

However, fastness to washing for example, quoted only as Grade or Scale 4 is meaningless unless coupled with the precise Method of Test which has been used which in this case would be

ISO	Colour	Fastness	to	Wash	ng No.1 Scale 1-5
"	"	"	"	No.2	"
"	"	"	"	No.3	"
"	"	"	"	No.4	"
"	"	"	"	No.5	"

It then remains for the customer to specify which level of performance is required for his purpose. These must vary according to the end-use.

It is clear for example that the demand in terms of fastness to light for furnishing wool repp will be considerably higher than that for a wool blanket.

Similarly a coating fabric (mens heavy top coating) would not require a specification in terms of wash fastness but rather in fastness to cold water and to perspiration, whereas a fabric used for men's trousering and sold with a washable label must certainly be specified in terms of appropriate fastness to

washing, and processed and dyed accordingly.

It should therefore be clear from the foregoing that innumerable standards exist, and the Quality Control staff must be familiar with them, and the reasons for the differences.

They should ensure that appropriate samples are taken, tested and reported upon. For export orders especially, they should check that the export customers requirements in this respect are quite clear at the outset: misunderstandings as to which standards are required can be very costly.
See Appendix B for reference to Performance Standards.

9.7. Methods of Test.

As indicated earlier the main laboratory or any small department laboratories will not be under the direct control of the Quality Control unit. Nevertheless, Quality Control staff should be familiar with the types of equipment available and the various Methods of Testing which are used, along with the Standards of Performance likely to be required and which are either set internally within the factory or which are to be met to satisfy customer's requirements.

The Methods of Test may be divided into two categories - Physical and Chemical, although in a number of cases the distinction may not be perfectly clear. The two broad categories may be subdivided as follows and with some examples as quoted below.

Physical Methods of Test.

Tensile Strength and elongation

Tear Strength

Resistance to abrasion

Resistance to pilling

The majority of physical Methods of Test are listed in various Handbooks. (See Appendix C).

Chemical Methods of Test

These may be subdivided as follows:

(a) Chemical Analysis

This is essentially the speciality of the professional chemist supported by his additional training in the textile chemistry field.

Under this subheading would be included for example:

(i) The determination of metals or their salts, such as Calcium, Magnesium, Iron, Copper, and Lead which frequently are a cause of stains or uneven dyeing.

(ii) The use of a number of Methods of Test to assist in Process Control, such as Determination of pH value of a water extract of a fabric.

(iii) Determination of the "grease" content of wool.

(iv) Determination of the solubility of wool in urea/bisulphite solution.

(b) The Identification of Dyestuffs.

(c) The Analysis of Chemical finishes applied to fabrics.

(d) "Fastness" to various agencies or treatments.

The various Methods of Test employed may be scheduled as "Standards", that is, accepted as approved methods by such bodies as the International Wool Secretariat; International Wool Textile Organisation; British Standards Institution.

(See Appendix C for reference and comments).

With regard to identifying the nature of a fault with special reference to stains, unevenly dyed places, and all those which might be called visual blemishes, it is virtually impossible to produce a systematic and detailed analysis of their occurrence and treatment, on the classic lines of chemical analysis, and which would apply to any factory. This is due to the enormous number of variables present.

What should be done, in any one factory, as is mentioned in several places in this paper, is to collect systematically all the data within that factory,

from which logical steps may be taken to deal with faults as they appear.

To some extent this dilemma occurs in selecting a Method of Test by which to determine the level of performance of a fabric, with regard to a particular property.

Different countries use different Handbooks on Methods of Test, which may vary substantially from each other, and furthermore all Methods of Test are continually being improved and revised.

The International Standards Organisation exists to try and eliminate these anomalies and a great deal of progress has been made.

When any Method of Test has become an approved ISO standard it will be so listed in the Sponsoring Institution's publication.

Appendix C also refers to a number of Methods of Test which have not yet been scheduled as "standards" but which are widely used in the finishing industry.

2.8. Control of Raw Materials.

There are three main divisions -

1. Raw fibre
2. Dye wares and chemicals
3. Process water supplies.

For the first two, Purchasing Department will already have its organisation but dealing mainly with specifications obtained from Production, and price.

Once top management is satisfied that the infant Quality Control section is working well, its activities can be extended into the Raw Material field, but again on the basis of a service. Uniformity of raw material is obviously the first requisite for uniform production, but it is sometimes taken for granted especially when other problems seem more pressing.

The task of the Quality Control unit would then be to ensure that raw wool

tops and yarn specifications are adequate and correctly quoted to Purchasing Department, and to ensure that a system of sampling of deliveries is in being and is being used. They would then keep a central file and record of samples and results of tests upon them, acting at all times on behalf of Production.

Good water supplies are highly important for quality production. Depending on the main source of supply there may be many grades of water quality: for example,

(a) Untreated - for hydrants and general hose work.

(b) Process water.

(c) Boiler feed water.

(d) Drinking water.

Regulation of these is the job of a Water Works section, often allied to effluent plant and usually under the management of the Works Engineer, with the Chemist's laboratory as Control point.

It is nevertheless worthwhile for Quality Control personnel to be interested in the process water supply position and regularly to inspect the test records and discuss these with the Finishing Department Manager.

2. Practical application of Quality Control to a commission dyeing and finishing company.

2.1. General

A Commission Works differs from a Vertical organisation in the following main ways:

(1) It does not own any of the textile raw material it processes for customers.

(2) The variety of types of fabric in terms of fibre used, yarn and fabric construction is much greater.

(3) The number of customers and end-uses for the fabrics will be far greater for an equal output.

(4) On average, the total yardage output for such a Works will be considerably greater than for a Vertical Company.

(5) Orders will be smaller in size and split into relatively small batches per shade required.

(6) Income is based solely on the cost of conversion of loomstate or knitted fabric to finished fabric; bad quality may result in claims by the customer which include the cost of the basic fabric.

(7) A production programme based on foreknowledge of what is to be processed months ahead is impossible, and invariably such a Works suffers alternatively from a glut of orders and shortage of orders.

(8) Deliveries are expected to be on schedule and the assortment complete.

All these pose quite different problems of detail execution to production management, but the basic principles remain unchanged, and the philosophy previously expounded is equally applicable.

h.2. Production.

Commission finishing works vary enormously in size, and the imaginary one selected is of the larger type, where some splitting of the various forms of production management can be justified.

Production - 10,000,000 yards per annum, based upon 50 weeks of 5 working days on a 2 shift basis of 8 hours each, equivalent to:

200,000 yds per week 2 shifts	at 100% production efficiency
100,000 yds per week 1 shift	
20,000 yds per day 1 shift	
2,500 yds per hour	
42 yds per min.	

Styles of fabrics produced.

Woollen Spun and Worsted Spun fabric, Woven and Knitted and intended for suitings, dress fabrics, coatings, upholstery and furnishing fabrics, pile fabrics.

Finishing Machinery for the following processes:

Singeing

Setting - Crabbing/Steam

Wet decating/Steaming

Rope Scouring

Width Scouring (batch)

Width Scouring (continuous)

Milling - Carbonising

Centrifugal hydro extraction

Water Mangling

Cylinder Drying

Winch Dyeing

Hot Air drying

Hot Air drying and high temperature setting

Card Wire Raising

Teasle Jig Raising

Tigar raising

Brushing, Damping and conditioning

Shearing

Steam Decating

Torpedo Setting (Paul Klug type)

and/or Automatic High Pressure beam setting

Rotary Press

Hydraulic flat bed Press

London Shrinking

Making up machines

Perch or Inspection machines.

A feature of the above plant will be the variety of sizes and differing makes of machines for each process.

These will often differ significantly from each other in detail design,

sufficiently to affect the appearance and behaviour of resultant fabric.

No common process routine will be followed - in fact fabrics of identical construction but for different customers will frequently undergo a quite different sequence of processing in order to produce the desired finished result.

b.3. Management Structure.

The usual hierarchy is a Works Manager, dealing with all production matters, to whom are responsible the

Preparation Manager, the

Dyehouse Manager, and the

Dry Finishing Manager,

with a Works Chemist(s) attached to a Works laboratory and directly responsible to the Works Manager.

All the foregoing are dealing with wet and dry Finishing problems; they are not directly concerned with any manufacturing stage.

They are thus closer knit in outlook than their counterparts in a vertical group where the three main production functions of spinning, weaving and finishing differ so much from each other.

Traditionally all the functions of control of quality are vested in the above team, each department head being responsible for all aspects of the quality of output from his section. Increasingly, however, it is becoming the custom in medium and large firms to establish a separate Quality Control function or unit. This arises mainly because of the increasing complexity of modern finishing processes, a greater variety of fibre and fabrics, new dyes and chemicals, allied to multi-shift systems of operation and incentive bonus methods of payment, but with a demand for speedier deliveries and to tighter standards of performance.

b.4. Production Organisation.

Before describing the organisation of a Quality Control unit it is thought fitting to describe a typic l method of organising production.

In a vertical company there is a logic and sequence of operations which is described in various textbooks, and combined with the relative slowness of machine speeds in finishing and restriction to selected fabric styles on a budgetted programme, these do permit efficient planning.

Little has been written about production techniques in commission processing, but it is a constant tussle with apparently conflicting forces, for the following reasons -

1. Great variation in size of order book.
2. Maximum output of installed machine capacity is in conflict with selection of suitable classes of work for each machine from available orders.
3. Fluctuations in order book and machine staffing pose labour problems regarding transfers between departments and retention of skilled labour.
4. Planning for the optimum flow of orders is in conflict with long and short process routines and demands of special deliveries by customers.
5. There will be some section which controls the total output which is possible. This may be drying capacity or dyehouse capacity, but either of these can vary widely according to fabric weight.
   Other sections of plant may have a higher or lower capacity than the control point and consequently "bottlenecks" frequently occur or statistically there is a "queueing" problem.

The Works Manager tries, along with Progress department to issue a set of orders daily, which in quantity meets the target production, and which in assortment of styles and routines to be followed provides balanced work for the plant as a whole. In a complex Works with varied plant and fabric styles, allied to urgent delivery demands from special customers efficient planning of production can rarely be visualised beyond the preparation stage.

Special investigations have indeed shown that computer planning can cope with all the permutations and combinations required in issuing balanced orders daily, but it cannot at the same time produce plans for maximum machine utilisation along with commercial needs of special deliveries, orders for which must frequently be issued purely as a matter of urgent necessity. Also the cost of computer planning is a significant item of cost in what, in most countries, is a highly price conscious industry.

The general conclusion is that good management alone can cope with the problems; and if computerisation were the only means of dealing with a complex situation then the remedy is to rationalise that situation by discarding many styles of fabric, cutting down the number of customers and simplifying process routines.

Inevitably, however, the Commission processor has a host of production problems which require daily solution, and as earlier remarked mean frequent transfers of operative labour and a spare shift in order to be able to employ overtime to balance production.

Transfers of labour mean skills are never quite adequate, and with a large proportion of completely new fabric styles always coming forward, the proportion of internal rejections for quality is far higher than in the relatively streamlined finishing section of a Vertical Works.

This complexity has grown with the influence of fashion which demands variety, but the advent and present importance of synthetic fibres of all types used in blends, and the growth of fabric structures such as knitted material brings problems for which past experience is only a slight guide, and "trial and error" is the rule.

Any "error", or rejected lot or piece, means reprocessing in an attempt to attain the required standard. From earlier comments in that part of the paper respecting a Vertical company, it will be realised that the Commission finishers' customer only sends an order for that yardage which he requires

finishing. There may indeed be other pieces of the same quality in the Grey Room stock, but they cannot be issued to replace some faulty batch without the customer's agreement, and the crucial issue becomes the disposal of the fault, batch.

If a faulty batch is not acceptable to the customer, even at a discount, then the Commission finisher is debited, at least, with the loomstate cost of the fabric involved. In any style of fabric this far exceeds the price per yard charged for finishing, and in wool type fabrics the ratio of these two costs - loom state to finisher's process charge, is exceptionally high. It also follows that rejected pieces returned for reprocessing interfere with optimum works output and complicate delivery promises made when an order is taken.

Thus adequate control of quality is a first essential in Commission finishing, and the establishment of a separate Quality Control function is increasingly necessary.

b.5. Organisation of the Quality Control function.

Even in a large works, however, it is unlikely that the "Department" is larger than one man, with such clerical assistance as paper records, files and reports may eventually determine.

This statement is purely a personal opinion based upon experience, and the various comments which follow in this section are related to one person as a quality control technologist along with clerical assistance.

Differing circumstances can certainly justify a larger staff, but one important qualification must constantly be borne in mind
Any successful commission finishing works must be managed upon principles discussed at the beginning of this paper, (i.e.) an instinctive and continued interest in quality of production through all stages of management and operative personnel.

This of course is also a requirement for a vertical organisation, but the variety of fabrics, dyes and finishes handled by the commission finisher along with very short production runs place a premium on this aspect of quality - the attitude of mind. Therefore in introducing a separate management function under Quality Control nothing must be said or implied that control of quality is now entirely vested in the new functional responsibility. If this were so, no quality control staff could be large enough to maintain previous standards or improve upon them.

It is therefore hoped that the succeeding paragraphs present a clear picture of the type of liaison and assistance to production which a quality control section should be capable of providing.

Essentially the function is carried out by delegating to this specialist much of the analysis and routine portions of checking quality carried out by the department heads, and especially by providing someone free from the daily production problems who can bring keen observation and initiative into full play.

The best results have been obtained when the Quality Control head is a man with technical training and works experience. He may be a Works Chemist with an especially practical outlook or an ex department manager who is keen to make better use of his detective instincts.

All the earlier lengthy remarks on his delicate position as a man without authority to give direct instructions in the works apply with equal force, as do those concerning his ability to make his position in the company of value and of respect.

Procedures, Records and Reports.

Grey or greasy mending is not usually or extensively carried out by the Finisher. He works on the principle that fabric delivered to him is in a reasonable condition for finishing. However, he must constantly check that this is so, guided by past records, the knowledge of a particular weaver's reputation and so forth.

He should therefore be inspecting a proportion of loom state fabric received, and it also follows that length of time and condition of storage and transport will influence the type of inspection.

Full width samples should be retained from every lot received for any quality and duly filed, for a period of at least 6 months, because in many cases examination of such references can show that a particular fault arising during finishing had its origin before finishing.

All this is in fact carried out as part of the Preparation Manager's job, but Quality Control oversight begins at this stage.

Perching or inspection is usually carried out on all fabrics after dyeing or after drying if "secured and finished" only.

This section is the key to all enquiries and investigations because the proportion of fabric found faulty at the last inspection stage in making up must be small, and is in effect limited to final stringing of occasional faults.

It is at this middle stage that the decision is made to "pass" or return for re-processing, and if the latter, then fresh work tickets must be issued carrying instructions respecting the new process sequence and conditions of treatment.

A daily statement of the types of faults and their percentage occurrence must be prepared and summarised weekly, monthly and yearly.

The Works Manager should hold a weekly meeting at which the three department heads and the Quality Control manager are present. This is the opportunity for the Quality Control manager to excel in logic and analysis of faults, and he would be advised to keep a short diary note of these meetings which records the main items of action which are agreed.

The problem of faulty pieces is so vital to a Commission works that nothing should be too much trouble. Charts and graphs which show the trend in certain faults should be constructed.

Discussions with the cost accountant will enable clear statements to be prepared which indicate the benefits or penalties of certain steps which have been taken or are contemplated.

Similarly, a customer expects orders to be delivered as complete assortment and on schedule, and statements showing the percentage of orders which are delivered on time and complete, will set standards by which progress can be measured.

Other indications of the standard of quality being achieved are the number of strings per 1000 yards, the proportion of D & K, that is yardage which is "damaged and kept" and which is charged by the customer to the finisher.

In short, the Quality Control manager should become the indispensable assistant to the works manager. He is the one man who has the time to assist in supervising on behalf of any of the production department managers any of those stages which are under trial, having previously agreed on the techniques or changes to be made with that manager and the works chemist.

<u>b.6. Standards of Performance</u> - see a.6.

<u>b.7. Methods of Test</u> - see a.7.

<u>b.8. Control of Raw Materials</u> - see a.8.

All the comments made earlier in sections a.6., a.7., a.8. are applicable in commission finishing but with even greater force, and it is hoped it is clear that the Commission Finisher has a more complex task than his counterpart in a vertical company.

The Quality Control Manager has the same personal problems of working with specialists, but in a more narrow and detailed field.

APPENDIX A. VISUAL FAULTS.

1. Common faults seen at Grey mending,

a. Broken warp or weft threads.

b. Faulty interlacing and "trailers-in".

Such defects may arise from wrongly slayed ends, bent reeds, wrong lifting harness, or a moving thread catching a stationery thread when weaving with multiple shuttles.

c. Slubs or thick threads.

These arise from uneven sliver, defective spinning or bad piecening.

d. Slack threads.

In the warp these may be due to careless piecing or slack beaming and when in the weft there may be a number of causes such as weft running loose from the pirn and shuttle rebound.

e. Tight threads.

When in the warp these may arise by reason of faulty piecing, the catching of thread or knots in the healds, uneven let-off or take-up motions, and when in the weft mainly due to uneven pirning causing threads to drag as it runs from the shuttle.

f. Warp stripeyness, arising from uneven yarns, defective warping or sizing, defective reeds or wrongly dented.

g. Weft stripes.

These may be caused by uneven or wrong yarn, faulty let-off or take-up motions, wrong picking resulting in threads being over or under picked.

Short bars may occur on starting up especially overnight or over a weekend.

Longer bars may coincide with a full pirn of weft indicating change of yarn quality or change in pirn winding tensions.

h. Piece edge faults.

There are a variety of these, arising from bad warping causing cramming of threads near the selvedge, defective temples and inadequate selvedge construction.

i. Miscellaneous.

These include stains of various kinds, usually oil and metal residues due to careless oiling of loom mechanisms. Overhead jacquard mechanisms are a source of oily flock which drops on to the shed and becomes trapped in the fabric. Mildew and bacterial stains occur owing to storing under damp conditions.

Damages, holes and tears may be caused by shuttle traps and in general rough handling of beams, pirns or fabric in the loom.

Many of the foregoing faults require attention by the mender, except when the fabric is to be heavily milled or raised. Warp and weft bars and stripes caused by faulty warping cannot be mended, but many blemishes can be skilfully mended, the degree of care and attention depending largely on the clarity of the design and finish which is required and the intrinsic value of the fabric. Knots should be drawn to the back of the fabric.

2. Faults seen at inspection or perching stages during finishing.

The faults now referred to exclude those arising from spinning and weaving and are primarily visual blemishes due to deformation of the fabric structure or a multitude of possible variations in colour.

A fabric may also be classed as sub-standard due to failure to meet some particular part of a specification. This cannot be assessed at the perch as these properties are determined by standardised test methods, rather than assessed visually. The cause of such faults is, as may be expected, often due to lack of process control.

Details of the more important Methods of Test and Performance Standards are set out in the Appendices.

In Section a.5. on Procedures in Process Control, reference was made to the difficulty of producing a universal schematic analysis of the occurrence and treatment of faults. The following comments are therefore based upon the more common faults which can arise at the various stages of processing from grey to finished state. They are described in the order in which the finishing machinery has been previously listed, firstly for a vertical company and secondly for the additional plant to be expected in a commission finishing company.

Crabbing/Steaming.

The chief faults are inadequate setting, giving rise to cockling or design distortion during rope scouring or piece dyeing. Inadequate setting is also liable to cause rope marking during subsequent scouring and dyeing. Finished pieces may also be found to be ended or listed. Fabric may also be weakened due to excessive tension and/or the pH of the water may be too high. pH control is very important as wool cannot be adequately set if the pH is much less than 6.0 but there is a serious risk of damage if the pH is above 8.5. Coloured woven fabric may "bleed" during crabbing and reference is made in Appendix C to a Method of Test to fastness of coloured yarns in fabrics to be crabbed, scoured or milled.

Wet decating/Steaming.

All the comments under crabbing are equally applicable, but the system which employs forced circulation of liquor through a perforated beam seems more prone to such faults than crabbing or steaming. It is difficult to pump water at temperatures near the boiling point, this causes inadequate setting and on many fabrics a pattern of the beam perforation may show on the inner layers of the fabric wound on to the beam.

Rope Scouring.

Rope marks, design distortion and excessive shrinking can occur even on well set pieces due to excessive mechanical load on the dolly nip or too high

a scouring temperature.

Inadequate scouring results in dirty pieces, or pieces which fail to dye uniformly, and the residual fat, soap or alkali in the piece should be carefully controlled. Residual alkali can cause migration effects whilst pieces lie in the wet state, or cause yellowing or weakening at a drying stage. Residual soap can cause an unpleasant odour to develop in the fabric and affect the handle. Synthetic detergents are widely used instead of soap to avoid scum formations and colour bleeding, as synthetic detergents are effective in relatively hard water and scour more efficiently at lower pH values and temperatures than soap.

See Appendix C on Methods of Test, for further comment on soap, fat and alkali content.

Milling.

The main visual faults are mill rigs or length way streaks. Once formed these are more or less permanent. They can usually be avoided by refraining from excessive pressure on the rollers and by not over-filling the machine. "Bagging" may help to reduce such a fault and also prevent selvedge curling.

Carbonising.

The major faults are uneven and over-carbonising, which are reflected in dyeing. Uneven carbonising may be due to imperfect saturation with the acid or drainage/migration whilst the pieces are subsequently lying in the wet state. The latter is the cause of local high concentrations of acid which reduce the dye affinity or even cause serious weakening.

Winch Dyeing.

The many reasons why fabric may become unevenly dyed are too long to list but inadequate preparation is a very common fault. Attention to dye selection and the use of the correct application method however are probably more important points. The dyestuff manufacturer's recommended methods must be carefully followed.

Dye winches should not be overfilled; too much bulk, too much weight, too little liquor lead to uneven dyeing. Control of temperature should be accurate and in many cases the rate of rise of temperature is equally important.

Centrifugal Hydro Extraction

The main danger at this stage arises on fine face fabrics where overpacking or too prolonged an extraction may cause fine creases or "crow's-foot" marks which can be difficult to remove.

Hot Air Drying and High Temperature Setting.

The chief hazards are under or over drying and damage while the cloth is on the pins or has become detached from the pins during tentering.

Raising.

Like so many finishing operations this is inherently a dangerous operation from the point of view of fabric damage.

Over raising will weaken a fabric and any creases in the fabric during raising will cause local under and over-raising which cannot subsequently be rectified. Patchy raising may be due to uneven moisture content or the presence of residual chemical compounds which affect the response of the fabric to raising.

Selvedges may be badly damaged if they curl during passage through the machine. A patchy or uneven pile effect may also be produced if the raising treatment is carried out too intensively. Card rollers should be regularly re-ground and maintained in good condition.

Shearing.

It is essential that the cutting cylinder be sharp and set exactly parallel to the bed, and that the ledger blade be correctly positioned. "Beds" may be of several types - solid, hollow, rubber, spring. The closest cut for fine face fabrics is obtained against a solid bed, but the risk of fabric damage is also greatest and many finishers avoid a solid bed for this reason.

It is clear that cuts and holes can be all too readily produced, and it is essential to shear the back first to deal with knots, so that these have less chance of forming a hump on the face which may then be sheared off to make a hole.

Steam Decatising.

The most common faults arise from the use of wet steam, too short wrappers and uneven treatment resulting in ended results. Decating machines installed at the end of a long run of steam piping, with inadequate condensate trapping and draining can be a source of many stained pieces. Wrappers should be wound evenly without creasing and under constant tension and the tension of the wool fabric fed to the machine should also be kept constant. Unless the cylinder diameter is over 24" it is wise to reverse all pieces for a second "end".

Rotary Pressing.

The main precautions necessary are to ensure that fabric is preconditioned uniformly, that fabric is presented flat to the nip of the pressing roller and the bed, and that the fabric is not unduly extended.

Hydraulic Flat Bed Press.

Uniform conditioning is essential for uniform pressing. Most faults in the past have occurred owing to careless papering when this was carried out manually. Automatic papering machines ensure that the fabric lies flat between papers.

Additional stages in Commission Finishing.

Singeing.

The main dangers in singeing arising from using a flame that is too hot or badly adjusted. This may cause undue yellowing of the fabric, or in open weave fabrics threads may be burnt. An uneven flame may be a cause of warp streaks on subsequent dyeing.

Open width scouring (Continuous).

The main objection to this process is that fabric so processed lacks the cover which is produced by rope scouring, and width and length shrinkage which may be required to meet weight per unit area and dimensional stability is inadequate. Re-design of the fabric may allow these requirements to be met. Care should be taken to ensure that creases are not allowed to pass through the multiple nip rollers.

Control of chemical feed and wash water must be carefully supervised in order to ensure that constant scouring and washing conditions are maintained throughout a working day.

Water Mangles.

As a very heavy nip loading with hard bowls is used the chief precaution is to ensure that fabric creases do not pass into the nip.

Cylinder drying.

As in hot air drying, over- and under-drying must be avoided. Too much fabric tension will cause glazing.

Water drops from steam condensing on overhead structures are a familiar source of stains and spot marks. "Doll-head" splashes likewise cause spots or oil spots. Dents in the cylinders and leaking seams are causes of dyeing variations due to uneven drying.

Tenale, Jig and Tiger Raising.

See earlier comments on card wise raising.

Tornado setting (Paul Klug).

The faults to be expected here are almost identical with those from steam decatising, except that defects such as creases, ending and listing and water spotting are certainly permanent blemishes. Most of these are caused by defective winding, and timing the sequences of steaming and vacuum cooling.

Automatic high pressure beam setting.

As this is a highly automated and sophisticated version of the torpedo machine fewer faults occur and these arise largely from malfunctioning of the machine and not lack of skill or attention on the part of the operative. Careful attention to winding on is still essential.

Miscellaneous.

In any finishing department stains and damages to fabric are ever present. Some reference has already been made to damage hazards during singeing, tentering, raising and shearing, but rubbed places, chafe marks with or without holes, can occur at almost any stage of processing where undue friction occurs locally.

This may be due to a seized roller which fails to rotate, rough places in scouring or dyeing machines, tangled pieces in scouring and dyeing. Damages which show as regular repeats in a straight line invariably originate in faulty roller nips, for example, trapped metal, defective rollers, and it is useful to have a list of all roller circumferences in use as nips, in order that a faulty one may be speedily located.

Faults in knitted fabrics.

Visual faults in knitted fabrics reflect precisely those same hazards encountered at the various stages of processing previously listed for woven fabrics. Two faults are however peculiar to knitted fabrics.

The first is "snagging" of the loops during wear. This is usually a matter of correct design, but unduly slack finishing can throw loops into prominence on the surface. With a fabric prone to snagging the loops must be drawn back by finishing at a greater width without however permitting much further lengthwise shrinkage.

This problem highlights all the other major difficulty in finishing knitting fabrics, that of obtaining adequate dimensional stability. The loop nature of fabric construction prevents the potential shrinkage being reduced to

the level of equivalent woven fabrics, and manipulation to avoid snagging may seriously interfere with dimensional stability.

Appendix C refers to Methods of Test.

Stains.

Stainless steel constructions have removed the risks arising in earlier years when wood rollers, bobbins and trucks or carts were a common source of marking-off. Scum, oil and dye spots are readily recognisable, but most of the others require laboratory examination to determine the nature of the stain, the probable source of the trouble and the method of correction by retreatment.

The only certain way to reduce the incidence of stains is to insist on good engineering maintenance whereby oil stains are rare (and the better use of splash guards and drip trays where machine design is inadequate), along with rigorous "housekeeping", which means cleanliness in every activity and orderly marshalling and systematic use of all loose plant and equipment such as scrays, pallets, bobbins, trucks, mixers, buckets. Any untidy and disorderly department is a breeding ground for careless workmanship.

APPENDIX B. REFERENCES TO PERFORMANCE STANDARDS.

Unlike standard Methods of Test on which there is ample literature, Standard Performances of finished fabric requirements tend to be issued on a semi confidential basis as explained in the body of this paper.

Most performance standards are classified as minimum requirements based upon consumer experience and the various end-uses are classified as follows. Apparel fabrics : (1) dress, coatings, suitings, skirts, and slacks for Women's Wear, (2) trousers, suitings and coatings for Men's wear. Furnishings, upholstery and blankets for household fabrics.

Such standards are applicable irrespective of [illegible]

The most comprehensive, non-confidential standards are probably those published by The American Standards Association

10 East 40th Street,

New York 16. N.Y.

under the schedule L22. Volume I.

An accompanying Volume II, details the "Test methods to be used with L22 Standards".

Much more specific standards of performance for military and public service fabrics are published by H.M. Stationery Office,

Atlantic House,

Holborn Viaduct, E.C.1.

The specifications are schedules under Ministry of Defence requirements. For example DEF 1001 B lists 145 separate pattern numbers of widely varying weights and constructions in woollen and worsted fabrics, for which appropriate tensile strengths are given in "Schedule A". However, apart from tensile behaviour most other requirements are quoted as "Piece dyed as pattern", "Waterproofed". In the latter case, "Schedule B" outlines the performance and method of test.

The most recent schedule is that published under the "Woolmark" certification scheme of The International Wool Secretariat

Technical Division,

Ilkley, Yorkshire.

The specifications are listed under 12 categories of product and each is subdivided according to particular consumer usage. For example - "Schedule of Specifications applicable to woven apparel" is divided into Category 1. Men's woven apparel. Category 2. Women's woven apparel. Category 3. Accessories. Men major garments (ties, scarves, headquarters etc.)

All the Acts -

Useful Journal references on the subject of specifications are as follows -

"Cloth Specifications in relation to consumer requirements". A.D. Ferguson.
The Textile Institute and Industry. February 1963. Pages 15 - 21.

"Performance Specifications for textiles and garments". H.W. Bost-Gordon.
The Textile Institute and Industry. March 1963. Pages 16-22.

APPENDIX C. REFERENCES TO METHODS OF TEST.

Methods of Test may be classified under three headings.

1. "Standards" published by a national body or professional Institution.
2. "Recommended standards" - a preliminary stage, prior to acceptance as standards.
3. Trade or industry methods. Newly developed techniques, either as improvements on older methods, or new techniques to measure a novel property, or factory methods for internal use only.

In the first two groups the following sponsoring institutions and publications are among the most widely known -

a. American Standards Association
10 East 40th Street,
New York 16. N.Y.
"Test Methods to be used with L22 Standards".

b. American Society for testing and materials.
1916 Race Street,
Philadelphia, Pa.
19103.
"Textile materials, yarns, fabrics General Methods. 1958. Part [illegible]

[illegible]

d. British Standards Institution.

British Standards House,

2 Park Street, London W.1.

"Methods of Test for Textiles". P Handbook No.11. 1963.

e. The Society of Dyers & Colourists

P.O. Box 244,

Bradford 1. Yorkshire.

"Standard Methods for the determination of the colour fastness of textiles".

(Copy enclosed with this paper).

f. International Wool Secretariat

Technical Division,

Ilkley, Yorkshire.

"Wool Mark Standards Manual".

g. The International Wool Textile Organisation.

Commerce House,

Bradford 1. Yorkshire.

"Methods of Test".

h. DNA.

Deutscher Normenausschuss,

4-7 Burggrafenstrasse,

1 Berlin 30.

Revisions to German standards are published in the

Deutsche Farben Kalender

Editor Dr. F. W.

2. Colour fastness to scouring.

Boil small cuttings of fabric, along with an equivalent cutting of white wool fabric for 20 seconds in

a. 1% soap solution

b. (0.5% soap solution
   (1.0% sodium carbonate solution

If distinct bleeding or staining occurs in (a) the fabric should be secured in absence of sodium carbonate, and only with a non-ionic detergent.
If distinct bleeding or staining occurs in (b) the fabric should be secured in absence of alkali, i.e. with soap or with a non-ionic detergent.

3. Examination of secured fabric.

At least one sample per day should be examined as follows -

(a) Residual grease content

British Standards No. 3582. Pages 379-381. BS. Handbook No.11, or the Rapid Grease Extraction Method, due to the Wool Industries Research Association and published in BS. Handbook No.11. 1963. Pages 386-390. "Methods of Test for Textiles".

(b) Residual alkalinity.

Several methods are given in the book by J.W. Bell. "Practical Textile Chemistry", published by The National Trade Press Ltd. but an adequate and simple works test is as follows:
"Immerse the sample in pyridine solution to which a [illegible] to which [illegible]

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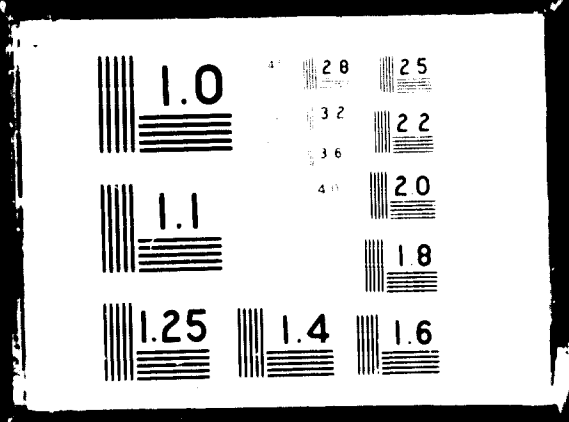


(d) Testing for alkali damage to wool.

The alkali solubility test has been largely replaced by the solubility in urea-bisulphite test. This is described in BS 3584, and the IWTO Manual - Code 11-65(E).

The test has been adapted so that virgin wool gives a solubility of 50%. Wool treated in alkali has a lower solubility and figures less than 15% indicate considerable alkali damage.

(Acid damaged wool has a solubility above 50% and over-carbonised wool can show figures of 60-70%).

Tests on dyed or finished fabric.

(a) **Residual Acid.**

Mainly for reasons of possible dermatitis it is inadvisable to leave more than 1% acid in the fabric. This may arise from the carbonising process or when large amounts of acid are used in dyeing with 1:2 metal complex dyes.

Suitable Methods of Test are

the IWTO - Method 3-65(E) or

BS LL Handbook - pages 548-549.

(b) **Showerproofing.**

Bundesman Hydrostatic and Methods of Test (B.S.11 Handbook) are not generally regarded as suitable for wool fabrics for civilian use although they may be specified for Service fabrics. It is usual to employ a Spray Rating test as described in the [illegible] or [illegible] Handbook pages 330-333. Recently, a new [illegible] test has been developed.

(c) **Dimensional Stability.**

All the [illegible] and [illegible], but [illegible] covered in the [illegible] especially [illegible] fabrics containing [illegible]

The [illegible]

IWS Test Method No.

8. (Spec. 7A Sched. 1.)
9. (Spec. 8. Sched. 1.)
10. (Spec. 8. Sched. 2.)

Codes in brackets refer to the old Test Method numbers.

(d) Mothproofing.

An acceptable method is given in IWTO. Code 9-62(E) or IWS. Test Method No.12.

(e) Pilling.

Pilling is more common on fabrics composed of wool and synthetic fibres. The ICI Technical Manual Section C3 describes the apparatus and Method of Test based upon the ICI Tumbler Tester. However, the Atlas Random Tumbler Pilling Tester is now the more widely used, and the Method of Test is described in the ASTM Manual Volume (or Part) No.24.

Random Tumbler procedure Pages 289-293.

Text Books.

Recommended books on Test Methods are listed below.

Practical Textile Chemistry, by

J.W. Bell.

The National Trade Press Ltd. London.

The Textile Laboratory Manual. (6 Volumes).

by W. Garner.

Iliffe Books Ltd.

Dorset House, Stamford Street,

London S.E.1.

The Principles of Textile Testing. 3rd Ed. 1968.

by J.E. Booth.

Heywood, London.

Textile Progress Vol.1. No.4. Dec. 1969.

Part 1. Physical Testing and Quality Control.

Part 2. Chemical Testing and Analysis.

Published by The Textile Institute.

APPENDIX D. STATISTICAL QUALITY CONTROL.

Reference has been made in the body of the paper to the fact that whilst statistical quality control is widely used in the form of contr l charts at the spinning stage, they are infrequently used in the finishing departments because it is rarely possible to collect the requisite number of fabric samples for examination.

Nevertheless, some of the techniques and principles of investigation are of considerable value, and the staff of a quality control unit should be familiar with the background to statistical analysis.

Two books especially written for the Textile industry are:

"Statistical Methods for Textile Technologists"

by T. Murphy
K.P. Morris
L.H.C. Tippett

107 pages.

(Textile Institute)
10 Blackfriars Street,
Manchester 3.

and

"An outline of Statistical Methods for use in the Textile industry".

by A. Brearley
and D.R. Cox

47 pages

and published by Wool Industries Research Association
Headingley Lane,
Leeds 6.

General publications include

"Facts from figures"

by M.. . Moronay. (Pelican E oks).

Introduction to Theory of Statistics.

by G.D. Yule and M.G. Kendall. (Griffin).

A number of terms are widely used, and some of the more common are set out below.

Average, or arithmetic mean.

The sum of a set of observations divided by the number of observations.

Variability or Dispersion.

The variation of test results about a central value.

Deviation.

The difference between an observation and the mean of all the observations.

Mean deviation.

"The sum of all the differences o. the values from their mean, taken without regard to sign, divided by the number of values".

Variance.

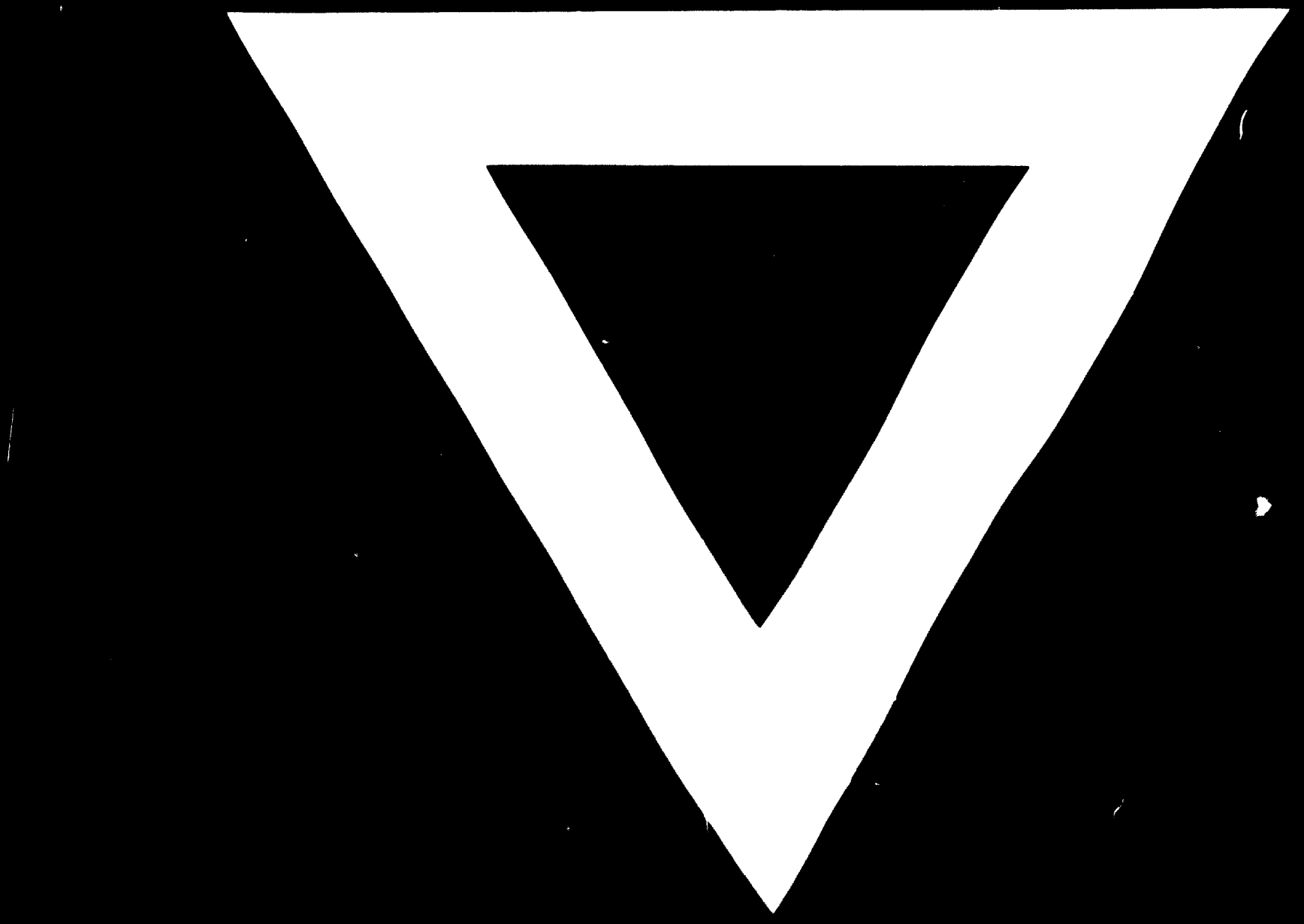
"The sum of the squares of the deviation divided by one less than the number of individuals".

Standard Deviation.

"The square root of the Variance".

Standard Error. (of a statistical measure)

"Standard Error measures the extent to which an estimate arrived at from a random sample is liable to differ from the average value".



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