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QUALITY CONTROL IN THE FINISHING OF MAN-MADE FIBRE PRODUCTS 1/

by

C. Duckworth

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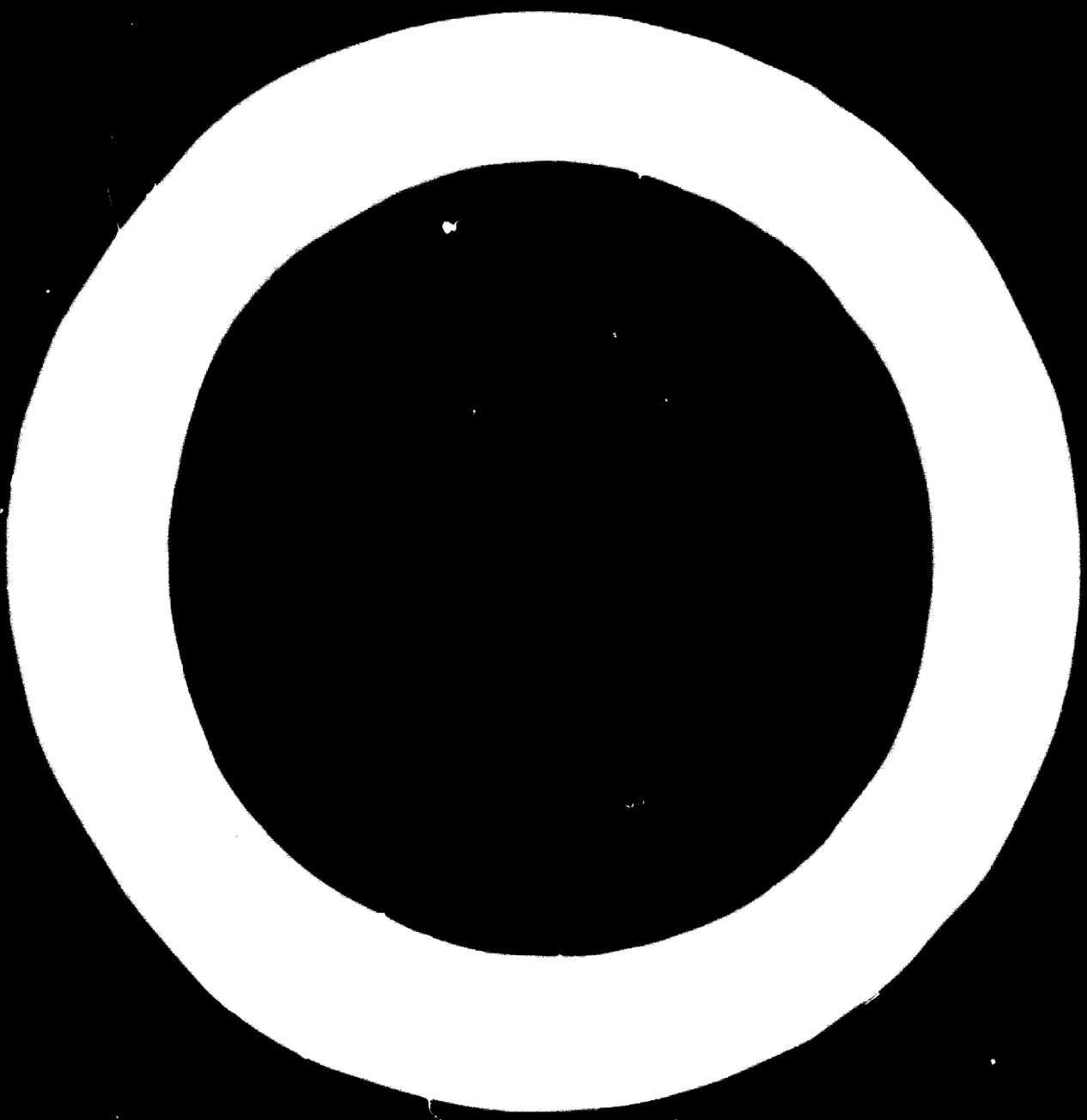

PREFACE

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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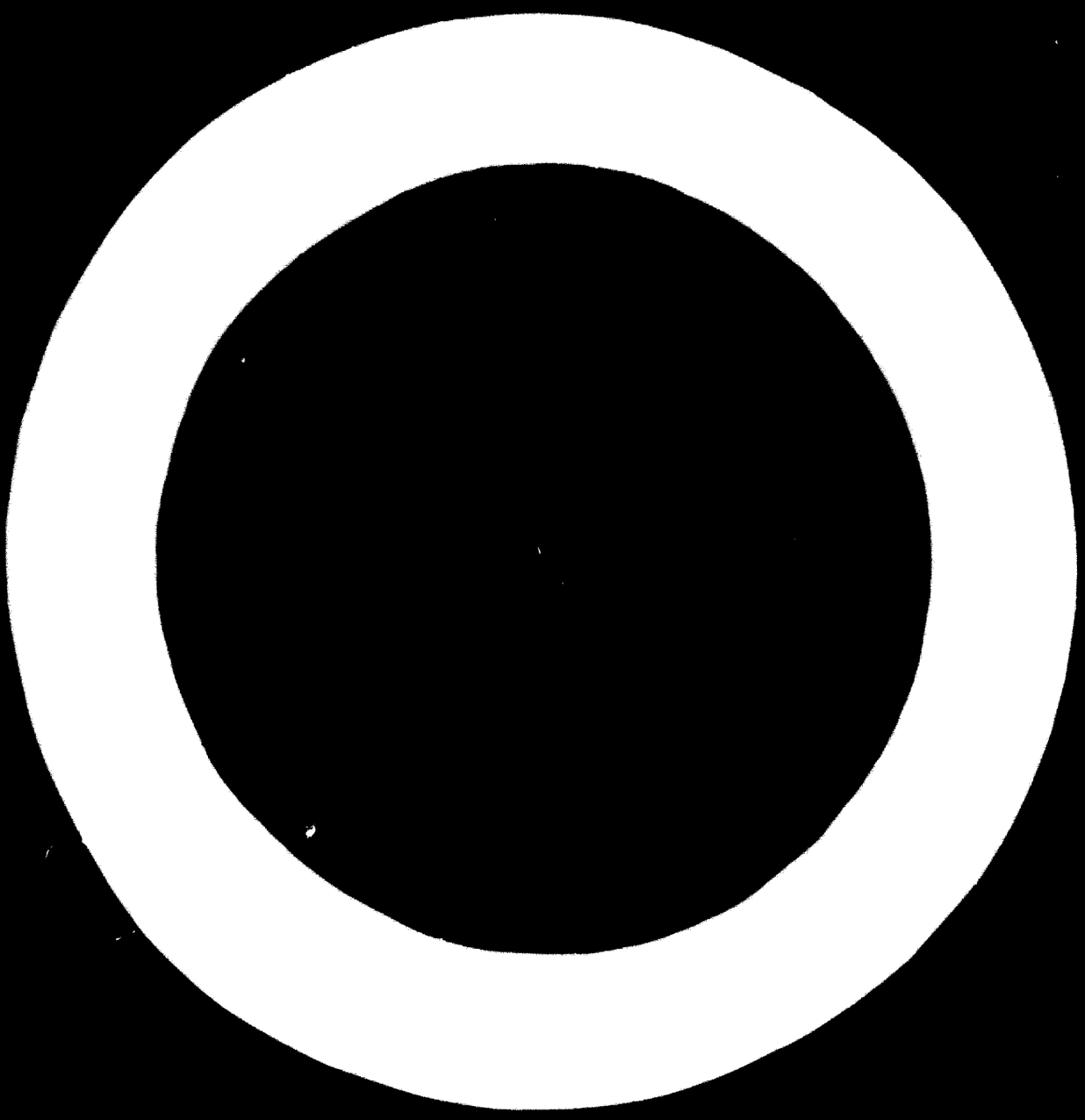


QUALITY CONTROL IN THE FINISHING OF MAN-MADE FIBRE PRODUCTS.

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 management, 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 fabrics because of the popular meaning of "quality". Often in the textile 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 fully capable of yielding reproducible results or because the results are obtained by interlaboratory 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 the 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; and that 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 these 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 these 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.

30,000,000 linear yards per annum based upon 50 weeks of 5 working days on a 3 shift basis 24 hrs.

equivalent to:-

600,000 yds per week	3 shifts	at 100% production efficiency
200,000 yds per week	1 shift	
40,000 yds per day	1 shift	
5,000 yds per hour 84 yds per minute.		

Styles of fabric produced.

Whilst the title of the paper refers to man-made fibre products, the scope has been broadened to include cotton or cotton blends along with fabrics wholly composed of man-made fibres.

This is because man-made fibres have made their greatest impact on those styles of fabric which were or still are associated with cotton.

Thus a great number of companies originally devoted entirely to cotton have added plant or whole sections to the factory which will then deal with filament yarn fabrics in weaving and in finishing, and have modified spinning to cater for important blends such as acrylic/cotton, polyester/cotton and also made significant changes in the Finishing section to cope with the different process requirements for polyester/cotton.

Likewise a factory of this size, based upon an original cotton type outlet would include printing in the Finishing section. This is mainly because the styles such as dress and furnishings demand these decorative effects, although there are subsidiary advantages of such a policy, to be discussed later.

Cotton and synthetic fibre/cotton blend fabrics.

Drills for overalls

Shirtings and dress

Plains and poplins for dress prints

Furnishing repps & plains dyed and/or printed.

Light weight suitings and trouserings.

Filament man-made fibre fabrics.

100% Viscose rayon (garment linings)

100% Di-acetate rayon (" ")

100% Nylon — overalls
dress
industrial uses

100% Polyester — overalls
dress
industrial uses

Geography, markets and competition would influence the precise selection of styles to be produced. There is a good case for example, for including very short staple spinning which would make the best use of very short or waste fibre from cotton preparation processes.

Such yarn is used extensively for raised fabrics such as flannelettes and as condenser yarn in a variety of heavier furnishing fabrics. Sheetings raise questions of loom widths from weaving onwards.

Therefore whilst such types of fabric are frequently produced in this type of factory they are not specifically referred to again in this paper as their omission does not affect the principles or practice of Quality Control.

Manufacturing equipment.

This is not itemised, as being out of context of the paper, but would essentially contain standard spinning and weaving equipment.

It is important that manufacturing departments for processing filament type fabrics should be quite separate from those producing staple yarn fabrics in order to eliminate short fibre "fly" problems and the respective air conditioning equipment should be on separate circuits.

Manufacturing faults in general are fairly well classified and documented, and are characteristic of a particular stage of manufacture rather than of any make of machine itself.

The Fibre Makers' Manuals bring the more recent technology of man-made fibres up to date, and recommend specific techniques, points to watch and types of faults encountered.

Reference will be made later to the influence of Quality Control on new material purchases and to liaison between the Finishing Department and the preceding stages of production. After weaving, all fabrics will pass to an inspection room in which staple yarn fabrics will be "cut" or sheared as required

by the type of yarn or fabric quality and lapped for storage or rolled into large diameter rolls. Filament type fabrics will be inspected roll to roll and stored in roll form.

8.3. Finishing machinery equipment.

The equipment listed is by type, rather than in units and sizes related to the assumed output. Unlike the wool fabric industry, a vertical unit in cotton and man-made fibre fabric production is usually large enough to produce a relatively high output when translated into Finishing terms of yards per minute, and the output of the Finishing Department of a vertical organisation may not differ significantly from that of a typical commission finishing company, except that the commission finisher is called upon to deal with a much greater variety of fabric constructions, varying greatly in types of fibres used, and differing widely in weight and in width.

The vertical organisation will almost certainly use coloured yarns and there will be a small section devoted to the scouring, blenching and dyeing of yarns on cone, cheese and maybe beam packages.

Invariably, such a section comes under the wing of "Finishing" by virtue of the chemical and coloristic techniques employed.

For fabric processing the plant would include -

Preparation

Cotton and synthetic fibre/cotton blends

Singeing

Rope Scour and Bleach (Kier or J box)

Cylinder dryer

Mercerising (chain and/or chainless)

Open width scour and bleach (continuous range or pad-roll)

Heat setting stenter

Dyehouse.

Staple yarn fabrics and filament yarn fabrics.

Pad Steam Continuous dye range, combined with a Pad-Thermosol range.

Dye pads

Dye jigs

Pressure beam dye machines

Open width hydro extractors

Water mangles

Cylinder dryers

Inspection (Perching) machines

Printing Shop.

All fabrics.

Clip stretcher and batching

Roller printing machines

Screen printing machines

Steamers

Soaping and drying ranges.

Finishing.

All fabrics.

Padders and clip stenters

Padders and overfeed pin stenters

Finishing calenders

Polymerising chamber

"After" washing range

Cylinder dryer

Damping machine

Compressive shrinking range

Making-up machines

Inspection (perching) machines.

a.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 department duties, and in that the Quality Control job does largely consis 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 repetition, 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.

8.5. 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 is 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 responsibility 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.

Grey Inspection.

Unlike the "wool" fabric industry, in which the relatively high cost of a yard of fabric requires that physical blemishes be "mended", the cotton and man-made fibre fabric section rarely carries out mending as such.

In certain special cases, such as expensive coloured woven jacquard fabrics for furnishings, and for which little finishing is required yarn knots may be drawn to the back of the fabric.

Generally the grey inspection is limited to cropping or shearing on selected fabrics, followed by visual inspection on rolling or plaiting machines.

The inspection takes place on all fabrics, and is usually at the rate of 10-15 yards per minute machine speed, instead of the hand pulling of fabric yard by yard over a table, as is customary in the wool trade.

It follows that inspection is less critical than in wool type fabrics, and the main purpose is to place fabric into grades of quality. Gross single blemishes, such as "traps" starting places and occasional weft bars may be cut out and the two free ends seamed together. In general grading will be on a basis of

"pass" as satisfactory for the style of fabric and end use in view or grade as "seconds" for subsequent disposal as job lots.

Fabric faults including minor physical blemishes, such as "mis-picking", slubs, bad knots will be marked on the selvedges with "strings". "Seconds" will include gross warp stripe effects, continuous ends down, frequent weft bars, mechanical abrasion marks such as those caused by sand rollers and temples.

In filament type fabrics, ruptured or broken filaments are to be sought out especially on the weaker type yarns such as those of viscose or acetate rayon.

In particular, fabrics should be graded either as suitable for whites and pale shades, or only suitable for dyeing into dark shades or for printing.

It follows that the usual piece marking system should be modified to include this type of selection, and order sheets and work tickets marked accordingly, in order that fabric so graded can be selected for processing at the assembly stage before dyeing and printing.

It will also be obvious that a great many print designs will hide a number of manufacturing faults which would be too obvious on plain dyed grounds, and inspection and grading will take this into account.

One of the benefits of a separate Quality Control department is to provide staff who are free from day to day production problems, such as wage rates, absenteeism, 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 the grey inspection department is the starting point of Quality Control in finishing.

The relationship between Quality Control in finishing and Quality Control in other sections.

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 a 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 inspection 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 necessarily 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 deductions, 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 piquant phrase which summed up many managerial problems: "Co-operation must be enforced".

Procedures, Records and Reports.

The basic procedure is based upon key fabric inspection points. The main points are - (1) Grey inspection. (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 and printing.

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.

Even in processes such as continuous bleaching or continuous dyeing, whilst the machine itself may be operated continuously, 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 or printed, and where irregularities can be such that grading as seconds is not possible. Such pieces must either be re-dyed or re-processed, or re-dyed 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.

Grading of pieces will have taken place at grey inspection and strings inserted to indicate gross faults which remain visible.
(See Appendix A - Faults detected at grey inspection).

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 fents).
4. yardage cut from pieces and sent to fent 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 inspection 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 in grey inspection, 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 yardage fented, proportion of output in various grades and the number of strings per piece for specific customers or qualities.

This should be compared with the overall average of faulty production.

Likewise at the intermediate inspection point, the percentage of pieces returned for additional reprocessing should be recorded, and the type of faulty 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.

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.

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.

These are now illustrated by the following detailed consideration of chain mercerising, one of the more important and complex processes on cotton or cotton/man-made fibre blend fabrics. The process is frequently not carried out with sufficient attention to detail, or with sufficient knowledge of its importance with respect to its effect on later processing.

The process improves the lustre and substantially increases the tensile strength of the cotton component, and greatly increases the affinity for dyestuffs. It regulates the dimensional stability in the weft direction in particular.

1. The Method.

There should be a schedule or code, applicable to each quality of fabric and which lists the following process requirements.

Machine speed. (This is dependent upon the dwell time which is required in the caustic soda, and the ease with which a particular fabric may be washed during its passage on the chain section.

Concentration and Temperature of caustic soda solution.

Warp way tension applied to the fabric during caustic impregnation.

Weft way tension, (ie) width setting of the stenter chain section.

Temperature of wash liquors.

Residual caustic soda in fabric

(a) on leaving the chain section - usually not more than 5% on weight of fabric.

(b) on leaving the final wash box section - usually not more than 0.1% on weight of fabric.

There are other process requirements such as load upon the caustic impregnation mangles, caustic retention in fabric leaving the mangle nips, concentration of caustic soda in the wash liquor at various stages of washing, volume of wash liquor used etc., but these are concerned mainly with questions of

economy in caustic soda usage and not with instrinsic fabric properties.

2. Checking the operation.

It is obvious that the provision of a schedule is not sufficient to ensure uniformity of results, and whilst indeed it is the responsibility of the Production staff to regulate its departments, Quality Control staff can and should be called upon to assist in process control.
Reference to Appendix A will illustrate some of the serious faults which may arise due to incorrect mercerising, and too much attention can not be given to this important process if first class quality fabric is to be produced.

A typical survey or monitoring operation would include:

(a) check machine serviceability,

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

(c) check concentration of caustic soda (bulk supply, and bath concentrations),

(d) note machine speed, and calculate dwell time in caustic soda and check with schedule,

(e) check all operating temperatures,

(f) check warp tension indicator and stenter chain width with schedule requirement,

(g) take samples of fabric

(1) leaving the chain section

(2) leaving the final wash box

and arrange laboratory estimations of residual caustic content and check against schedule,

(h) inspect the fabric batch or lot after dyeing and finishing for dyestuff uniformity, and arrange for tests to be carried out to check the dimensional stability to laundering and the tensile strength, and compare appearance (coverage of dead cotton and lustre against the standard pattern for that quality),

(i) prepare a brief report on the findings.

All other processes require similar attention, and the foregoing should serve as a guide to checking that a method exists and that it is being carried out correctly.

All the methods should be stated briefly, or in code, in the master order book or on the works instruction tickets, and they should be supervised accordingly. Nevertheless, it will be found occasionally that 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 processing which a batch or "lot" 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 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 over-estimated, 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.

8.6. 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 "sealed" 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 or 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,

"Sanforised" (Cluett Peabody)

"Terylene"Cotton (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, 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 Washing				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 a furnishing repp will be considerably higher than that for a rayon garment lining.

Similarly, rayon lining fabric of viscose rayon would rarely require a specification in terms of wash fastness but rather in fastness to cold water and to perspiration, whereas a fabric used for mens 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 references to Performance Standards.

3.7. 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 customers 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 the presence 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 oils, fats and waxes in cotton.

(iv) Determination of the fluidity of cotton and viscose rayons.

(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 Society of Dyers and Colourists. The American Association of Textile Chemists and Colorists. The American Society for Testing Materials. British Standards Institution. (See Appendix C for references 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.

8. Control of Raw Materials.

There are three main divisions -

1. Raw fibre and filament yarn
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 the 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 staple fibre 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. (b) Practical application of Quality Control to a commission dyeing and and finishing company.

b.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 fabrics 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 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 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.

b.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.

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

Production - 1,000,000 yds per week 3 shifts
333,000 " " " 1 shift
66,600 " " day 1 shift
8,325 " " hour
140 " " minute (approx).

} at 100% production efficiency

Styles of fabric produced.

Whilst the title of the paper refers to man-made fibre products the scope has been widened to include cotton or cotton blended with man-made fibres. This is because man-made fibres have made their greatest impact on those styles of fabric which were or still are associated with cotton.

100% cotton fabrics,

synthetic fibre/cotton blend fabrics,

rayon/cotton blend or mixture fabrics,

100% filament synthetic fibre fabrics,

100% filament rayon fabrics,

mixture fabrics composed of filament and staple yarns.

Finishing machinery for the following processes.

The equipment which is listed is by type, rather than in the number of units required to achieve the assumed output.

Preparation. Singeing

Rope scouring and bleaching (Kier or J box)

Cylinder dryers

Mercerising (chain and chainless)

Open width scouring and bleaching (continuous range or "Pad-roll

Continuous solvent preparation range

Miscellaneous winches and large jigs

Heat setting stenters.

Dyehouse. Pad/Steam continuous dye range combined with Pad-Thermosol rang

Dye pads

Dye jigs

Dye winches

Pressure beam dye machines

Open width hydro extractors

Centrifugal hydro extractors

Water mangling

Cylinder dryers

Inspection (perching) machines

Print Shop. Clip stretcher and batching

Roller printing machines

Screen printing machines

Steamers

Soaping and drying ranges.

Finishing. Padders & clip stenters

Padders & overfeed pin stenters

Double action card wire raising machines

Finishing calenders

Embossing calenders

Schreiner calenders

Cylinder dryers

Damping machine

Polymerising chamber

"After wash" range

Compressive shrinkage machine

Continuous flat bed hydraulic press

Making-up machines

Inspection (perching) machines.

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 typical 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 post 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. Many firms use a 2 shift system, in order to be able to utilise 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 mixtures 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 finisher's 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 faulty batch.

If a faulty batch is beyond the customer's acceptance, even at a discount, then the Commission finisher is debited, at least, with the locostate cost of the fabric involved. In any style of fabric this far exceeds the price per yard charged for finishing. 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 inspection 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 loomstate 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 has 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 "scoured 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 in is 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 works tickets must be issued carrying instructions respecting the new process sequences 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 assortments 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.

b.6. Standards of Performance - see a.6.

b.7. Methods of Test - see a.7.

8. Control of Raw Materials - see a.6.

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 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 th specialists, but in a more narrow and detailed field.

PENDIX A. VISUAL FAULTS.

Common Faults seen at Grey Inspection.

a. Broken warp or weft threads.

b. Faulty interlacing and "trailers-in".

Such defects may arise from wrongly slayed ends, bent reeds, wrong lifting of 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 stripyness, 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.

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

In section a.5 on procedures, and in Progess Control, reference was made to the difficulty of producing a universal schematic analysis of the occurrence and treatment of faults, and those now referred to are described in the order in which they may arise at the various stages of processing. The description follows the order in which the finishing machinery has previously been listed, firstly for a vertical company, and secondly for the additional plant to be expected in a commission finishing company.

The faults are primarily visual blemishes due to deformation of the fabric structure and the many possible variations in the uniformity of colour. Faults arising from spinning and weaving are excluded. 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 usually determined by standardised Test Methods. 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.

PREPARATION.

Singeing.

This is a hazardous process at all times, and relies upon close observation and control of the flame by the operative. Too hot a flame may scorch the fabric which is then reduced in strength, or an uneven flame may cause warp way streaks shown show up in subsequent dyeing. Fabric containing thermoplastic yarns, in blend or in mixtures are especially susceptible to over-singeing.

Adequate "quenching" equipment is essential. A wet quench is preferable but where a steam box is used for this purpose a very careful watch should be maintained on the possibility of a spark causing a burnt hole. Where fabric is piled dry in plaited form into a truck or cart, a single spark may be the cause of multiple hole damages. Fabric which passes in creased form over the burner will show as a streak of unsinged or hairy fabric which may subsequently dye to a different shade.

Rope Scour and Bleach.

This process is largely restricted to cotton fabrics, but the process conditions may be modified to permit the handling of cotton blended with polyester, nylon or acrylic fibres as the object of such a process is to produce a fabric which is free of cotton seed, absorbent and of the required degree of whiteness, the main faults are under- and over-processing.
Appendix C gives details of the procedures and Methods of Test used to control this process.

Uniformity of processing must be ensured in the case of a kier installation by not overloading the kier, by maintaining the pressure and time

conditions, by checking that the pump system is maintaining liquor circulation, and that the washing stages are properly carried out.

Serious fibre degradation will occur if all the air is not vented from the kier chamber before pressure processing is carried out.

Continuous J box processing generally produces a more uniformly bleached fabric, but under- and over-bleaching requires the same degree of care as in kier processing.

Cylinder dryers.

Either under- or over-dried fabric may produce areas of patchy or variable absorbency which affect the uniformity of later processes such as mercerising or dyeing.

Damp patches produced by condensation drops or splashes from "doll-heads" will also show up during dyeing. Dents or badly finished seams on the cylinder surface may also cause variations in dyestuff uptake.

Mercerising.

Apart from the obvious faults such as fabric creases during processing, the two main faults are usually found only after dyeing or after finishing.

As the process substantially increases the affinity for dyestuffs, it must be carried out in a uniform manner.

Dimensional stability in a weft direction is also controlled by Mercerising.

In the previous section headed a.5 Process Control, the subject of Mercerising was dealt with in detail. It is only necessary to add that uneven Mercerising may be seen to be occurring when fabric is unevenly saturated at the caustic impregnation stage. This is more likely to occur on the heavier or more closely woven fabrics, especially if Mercerising is carried out on loomstate

fabric or after desizing. It may be necessary in such cases to delay Mercerising until thorough scouring and bleaching has produced a uniformly absorbent fabric.

The addition of wetting agents to the caustic liquor may be a useful expedient, but their use for fabrics subsequently to be finished as "Showerproof" is risky, as it may then be difficult to meet the appropriate showerproof performance standard.

Open width scour and bleach.

As in rope bleaching, under- or over-bleaching are the main hazards. Peroxide pad roll bleaching is liable to produce fabric showing random spots of differing dye affinity or as actual holes in the fabric. These are caused by over oxidation locally, due to the presence of traces of metal residues in the fabric.

This fault is far more likely to occur in single stage pad roll bleaching, that is, when fabric has not previously been thoroughly scoured and acid neutralised.

It is worth recording that short cuts in fabric preparation, by eliminating certain stages of a process, may ultimately cost much more than the potential savings in labour, power and steam etc. brought about by shortening a process.

This has come to be better appreciated due to the widespread adoption of continuous dyeing processes.

Where dyeing is by batch "exhaustion" techniques some deficiency in the absorption properties of a fabric may be tolerated, but in continuous dyeing, a fabric must be thoroughly and uniformly prepared, as there is no opportunity for dyestuff levelling to take place.

Heat setting stenter.

Under-setting or treatment for an excessively long time or at an unduly high temperature are the main faults to be found, apart from obvious

mishandling, such as mis-pinning of fabric on the pin-chain. As the main objects of setting are to improve the dimensional stability of synthetic fibre fabrics (or blends) and to reduce pilling on fabrics containing staple synthetic fibre, the conditions prescribed for particular fabric qualities such as speed of machine (time of dwell) and temperatures must be adhered to.

The power of crease recovery and dyestuff affinity of synthetic fibre fabrics are also affected by setting conditions. Non uniform setting brought about by allowing air circulation filters to become choked with "fluff" may be reflected by unevenly dyed pieces. These may appear as warp way bands of colour variation, or shading of colour from selvedge to selvedge.

Dyehouse.

Pad-Steam Continuous dye range combined with a Pad Thermosol.

It has already been made clear in discussing fabric preparation, that continuous dyeing must be preceded by thorough and uniform preparation. Even so, the main faults are variation in colour, either failure to match the fabric adequately to pattern, but more especially variation in shade across the width of a fabric or along the length.

Shade variations in width arise mainly because the dye or chemical pad nips are unevenly loaded, or because bowl deflection under load is not compensated by correct cambering of the bowl surfaces.

Uneven hardness or wear of the bowl rubber covering may also be causes of uneven dye pick up. Intermediate drying between the dye pad and chemical pad must also be uniformly carried out.

Shade variations in a warp direction are usually caused by selecting dyestuffs or combinations of dyestuffs with "tail" badly during impregnation. (N.B. The dye pad bath and chemical pad bath must be of small volume, and this is of course a matter of selecting the right equipment).

The chemical pad and steamer is also a likely source of warp way

variation in colour, due to incorrect formulation of the chemical pad bath and variation in rate of feed of addition liquors to the bath. Variations in steamer temperatures will also cause variations in colour development.

It also follows that uniform conditions must be maintained in the subsequent stages of oxidation, soaping and washing.

Dye pads.

As the object of dye padding is to "meter" or apply a dyestuff solution or dispersion in a perfectly uniform manner to the fabric, close attention must be paid to the uniformity of the nip of the squeezing rollers.

For most fabrics a single nip double roller squeeze is to be preferred and both rollers should be covered with rubber of the same degree of hardness. For fabrics which are difficult to penetrate 3 bowl padders are frequently used, but unless all three bowls are rubber covered, which is comparatively rare, because a hard vulcanite or metal bowl is preferred as a means of transferring the drive, then differences in shade between the back and face of a fabric are to expected.

Variation in shade in the warp direction can only be avoided by the selection of dyestuffs which possess minimum affinity under the conditions of application (i.e. time of immersion and temperature of dye liquor), and by the use of dye troughs of minimum volume, and which thus permit rapid replenishment of the trough content by the dye feed liquor.

The quality of the water supply, allied to the dye and auxiliary chemical contents of the dye bath must be such as not to form scums or foam on the liquor surface, or have any incompatibility which may cause dye aggregation or lack of bath stability, all of which may lead to serious staining problems.

Dye Jigs.

The major faults in jig dyeing are shade variations across the width and along the length and gross colour changes at the selvedges, along with a variety of stains which usually arise through lack of dye bath stability. In

'egard to small but important shade variations across the width and along the .ength. the best approach is to use a dye padder to apply the dyestuff and then :o use the jig as a means of developing and fixing the dyestuff.

Where the dyestuff is wholly applied on the jig itself then three points must have close attention. The most important is that of dyestuff selection, ideally the dyestuff should possess good levelling powers, be of slow strike, not susceptible to fine temperature differences and the exhaustion rate should not be too rapid.

The dye maker's manuals usually list such properties and show which brands are most suitable for jig application.

Secondly, the operator must maintain a close control on the temperature of the dye liquor, and thirdly it is often false economy to employ a fabric-to-liquor ratio which is very low. Economies in steam, water and dyestuff may certainly ensue, but only at the price of variations in shade from end to end of the batch.

Cross shade variations on the selvedges usually arise owing to variations in width from piece to piece, or to bad wirding on, both of which cause layers of fabric to protrude from the batch ends.

Invariably such layers will dye darker than the main body of the fabric on the batch, because the batch squeeze effect is absent and either cooling and/or oxidation effects can aggravate the differences in dye affinity.

Vat and sulphur dyestuffs are especially prone to what are often called oxidation stains or oxidised selvedges.

A dye jig is a most irrational piece of apparatus, but it is an extremely versatile machine, and controlled by a good technical dyer and well trained operatives is capable of producing first class quality fabric.

A purely mechanical fault is that of "Moiré" effects or watering. Man-made fibre fabrics such as taffetas or bold weft rib effects such as "poults"

and grosgrains are especially prone to these troubles when jig dyeing. For such fabrics the use of low warp tension jigs is essential, and it may be necessary to reduce the size of the batch in order to reduce the mechanical pressure on those layers adjacent to the draw rollers. Jigs possessing extra large diameter draw rollers are particularly advantageous for fabrics prone to moiré effects.

Pressure beam dye machines.

These find greatest use for dyeing fabrics with contain synthetic man-made fibres and benefitting from dyeing at temperatures in excess of 100°C. As in all liquor-circulating machines the main problem is to ensure an adequate rate of circulation of dye liquor through the batch.

Apart from unusually closely woven fabrics, 100% synthetic fabrics do not present any special difficulties in achieving an adequate liquor circulation and the main precautions are to ensure that the dye maker's recommendations as to suitable dyestuffs are followed and that the dye bath stability is maintained.

The greater the proportion of a swellable fibre present, such as cotton or polynosic viscose rayon, the greater the problem of ensuring adequate liquor circulation to maintain level dyeing. For such fabrics, batch sizes will have to be reduced, and special care taken in winding batches prior to dyeing with uniform and low warp tension.

An "end" fabric length, attached to the inner piece is usually necessary to cushion the batch on the dye beam and to prevent the perforations on the dye beam itself from marking off on the inner fabric piece.

As in all systems of dyeing in which fabric is in roll or beam form the pieces should be of uniform width and uniformly wound to give straight sided batches.

Open width hydro extractors and water mangles.

The likely faults are restricted to those of fabric folds or creases,

which in the case of a mangle may cause physical damage, or in general lead to lamp streaks on subsequent drying.

Cylinder Drying.

See earlier reference.

Print Shop.

Clip Stretching, batching and brushing.

The main object is to produce feeder batches for the printing machines which are of uniform and correct width, with weft threads straight and at right angles to the selvedges, and brushed free from lint or loose threads.

Roller Printing and screen printing.

These are highly specialised techniques requiring a complex blend of experience, art and technology to produce fabric of consistently high quality, and the following remarks can only be a general guide to a quality control section for recognition of certain common faults and the reasons for their occurrence.

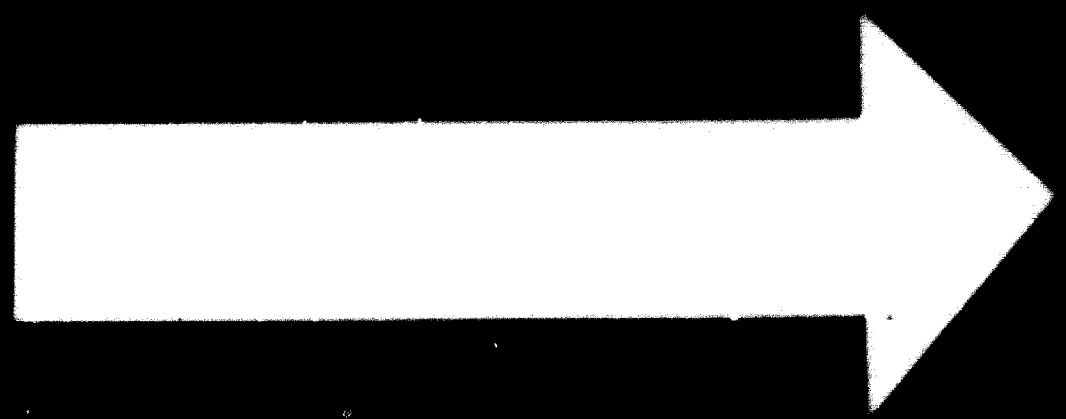
It is assumed in the first place that engraved rollers and printing screens have been checked after engraving or etching for any deficiencies, this being carried out on a "strike" off sampling machine.

Incorrect design register.

This is mainly due to inaccurate setting of rollers or screens with respect to each other. Rollers are adjusted by a pitching mechanism and flat bed screens are brought into register by a series of adjustable screws and bracket stops according to the size of repeat.

Variation in degree of imprint from selvedge to selvedge.

This is primarily a roller printing fault, due to bending of the engraved roller under pressure of application and is compensated for by lapping the cylinder under the rubber blanket with cotton wrapping material of different widths to give a cambered surface.



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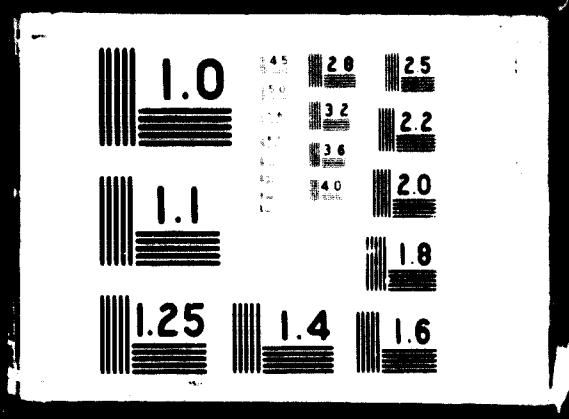


The fault is more readily noticeable on simple designs such as printed stripes.

Unprinted streaks.

Apart from creased fabric passing under rollers, such faults are usually caused by a foreign body lodging under the doctor blade. It follows that print pastes should be well mixed and sieved or vacuum strained and doctor blades accurately ground, and constantly inspected whilst a machine is running. They should be replaced by cleaned blades at regular intervals, for example between 2000-5000 yds production according to the design and type of fabric being processed.

Repeat Spots (unprinted).

Clearly, this is due to blocking of an engraved roller or screen by a particle of lint, fluff or similar foreign body which withstands the wiping action of a doctor blade or squeeze.

Imperfect "blotches".

The following are all possible reasons for failure to produce solid and level blotch effects.

Inadequate fabric absorbency.

Insufficient roller or squeeze pressure.

Wrong scale of roller engraving or too fine a screen.

Print paste too viscous.

Halos on design edges.

Sharp clear prints require a careful choice of print paste thickener. There is a bewildering choice of natural products such as starches and gums and of various chemically modified or purely synthetic products.

Colour makers and chemical thickener makers offer a comprehensive technical service in this highly important aspect of printing.

It is usual practice to print fabric lying directly on the rubber

blanket, as the use of back greys is expensive. Nevertheless on relatively non-absorbent fabric the only way of producing prints with a clear definition is to utilize a back grey. Flushing of design edges may also occur if steaming is too wet or prolonged or if soaping and or final washing is too intensive.

In the latter case it is often the wet fastness of the dyestuff which is in question and bleeding on to whites or pale print portions would occur at the same time.

Treatment with soap solutions (i.e.) "soaping" in the true sense of the word, is essential for obtaining the correct shade and fastness of vat colours, but in general, the steaming and wet aftertreatments must be just sufficient to remove unfixed dyes and thickeners without causing design flushing or colour bleeding. The conditions of aftertreatment should match the class of dyes being printed.

Design marking off.

Some steamers have a design deficiency in the draw roller or nip festooning device, but wet steam must be avoided. Wet printed fabric should never be allowed to lie about in trucks prior to drying; this applies especially where for commercial reasons dyes of relatively low wet fastness have been used.

Finishing.

Padders.

See previous section on dye padders, where the same principles are in use. A special point requiring constant attention is the stability of the padding liquor formulations. Many finishing mixes are complex dispersions, which tend to break down due to high shear forces at the pad nip. A variety of stains, blemishes or failure to meet performance specifications are due to lack of liquor stability.

Hot Air Stenters.

Reference has been made to stenters used for heat setting, and where

stenters are used purely to dry fabric to specified dimensions correct results are largely a matter of accurate machine setting.

Automatic guiders and weft straighteners require regular skilled maintenance if they are to function correctly. Lint screens must be cleaned regularly and lubrication devices set to ensure that no surplus can stain the fabric.

Finishing calenders.

Fabric must be presented crease free to the nips, and where cotton or viscose is present in the fabric, it must be pre-conditioned to "regain' values if reproducible effects are to be obtained. Cylinders and bowls should be inspected for burrs or foreign bodies to make sure that fabric damage does not take place.

Polymerising chambers or baking stoves.

These are relatively simple machines in which the times of dwell and temperatures of operation are the main control points.

Multi roller systems are bound to cause fabric creases occasionally if rollers and bearings are not maintained in first-class condition. Idler rollers should be free running, any eccentric rollers changed and all rollers should be square to each other.

After washing ranges.

All rollers and nips require the same sort of attention frequently referred to on other types of machines. From a process point of view it is essential to maintain the stipulated chemical feed conditions, speeds and temperatures of liquors, as after washing is primarily concerned with the achievement of certain standards of performance on the finished fabric.

Cylinder dryers.

See previously.

Compressive shrinkage.

Whether rubber belt or felt blanket type, both machines are relatively free from faults arising from mechanical operation providing rollers and blankets are maintained in alignment.

Makers supply manuals of operation and instructions regarding methods of fabric sampling to determine potential and residual shrinkage. Under shrinkage is not visible, but over-shrinkage often results in a rippled appearance to the surface of the fabric. Shrinkage cannot take place unless the fabric is adequately pre-conditioned, and the Palmer drying unit blanket must not be allowed to become damp through too high a speed of running, because the processed fabric will emerge damp and lack dimensional stability.

As in all mechanical nipping operations, flock and foreign bodies should be quickly removed from rollers and blankets.

Commission finishing.

Additional machines.

Dye Winches.

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

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

Embossing Calenders.

Again all the precautions regarding the operation of nips must be observed. Where a cylinder mates with a bottom bowl, the latter must be carefully "run in" so that when fabric is embossed a level pressure is exerted on the fabric

at all points. Fabric should be presented to the nip with a minimum of warp tension.

Camber on the bottom bowl should be according to the total load applied in order that the embossed impression is uniform across the fabric width.

For Ciré embossing, the edges of the cylinder design should be slightly radiused to avoid undue pressure on design edges which may lead to fabric damage.

Schreiner calenders.

The precautions are similar to those on other heavy duty calenders, in addition special care being taken to see that flock, dirt and any chemical deposits are kept free from the fine engraving.

Raising.

Like so many mechanical 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 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. It should be noted that cotton fabrics in particular require the presence of a lubricant to assist raising. This can be either residual natural waxes or more commonly, a lubricant composition dried into the fabric prior to raising.

A patchy or uneven pile effect may also be produced if the raising treatment is carried out too intensively. Card rollers should be regularly reground and maintained in good condition.

Flat bed hydraulic presses.

These are used extensively in the production of glossy "press" finishes on rayon linings.

Fabric must be evenly pre-conditioned, and the complex timing sequences of the machine regularly checked. Bent or cracked press paper sheets must be replaced, and the accuracy of the bed plates repeatedly checked.

Draw forward of fabric between press sequences is done in such a manner than an overlap impression is made on the fabric. Overlap is essential, but has to be readjusted if weft bar impressions are formed, which a check has shown are not due to faulty press papers.

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 screys, pallets, bobbins, trucks, mixers, buckets. Any untide and disorderly department is a breeding ground for careless workmanship.

Appendix B. REFERENCES TO PERFORMANCE STANDARDS.

For standard Methods of Test there is ample literature, but specifications for performance requirements of finished fabrics 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. blouse, lingerie, light weight skirts & slacks, and linings, for Women's Wear. (2) shirts, trousers, light weight jackets, and

linings, for Men's Wear. Industrial fabrics : overall fabrics, base fabrics for laminating or coating. Household fabrics : furnishings, upholstery, sheets and raised blankets.

There are many other sub divisions, but all such standards are applicable irrespective of the weight and construction details of fabrics destined for some particular use.

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 gives the test methods to be used with L22 standards.

Much more specific standards of performance are published by

H.M. Stationery Office,

Atlantic House,

Holborn Viaduct,

London E.C.1.

The specifications are listed under Ministry of Defence requirements. For example "DEF 1007 A Fabrics, cotton plain weave" lists 83 separate pattern numbers of widely varying weights and yarn particulars for such uses as shirts, interlinings, cleaning materials, tropical suitings. Appropriate tensile strength requirements are shown in a schedule, with a column for remarks on type of dye and finish required.

Special methods of testing and minimum standards of performance are listed on the schedule.

Useful Journal references concerning specifications and related Methods of Test are as follows:

"Cloth specifications in relation to consumer requirements"

by A.D. Ferguson. The Textile Institute and Industry. February 1963 Pages 15-21.

"Performance specifications for textiles and garments".

by H.W. Bent-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 3 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.

These may be factory methods for internal use only, or newly developed techniques as an improvement on older methods or new techniques to measure a novel property.

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.

1 G 103.

"Textile Materials, Yarns, Fabrics General Methods. 1970. Part 24".

c. American Association of Textile Chemists and Colorists.

P.O. Box 12215 Research Triangle Park,

NC. 27709.

"Technical Manual of A.A.T.C.C."

d. British Standards Institution

British Standards House,

2 Park Street,

London W.1.

"Methods of Test for Textiles". BS Handbook No.11.

e. The Society of Dyers & Colourists

P.O. Box 244,

Bradford 1.

"Standard Methods for the determination of the colour fastness of textiles" (Copy enclosed with this paper).

f. D N A

Deutscher Normenausschuss

4-7 Burggrafen Strasse,

1 Berlin 30.

Revisions to German standards are published in the

Deutsche Farben Kalendar

Editor Dr. J. Meechels and published by

Frans Eder Verlag

7 Stuttgart 1.

The following procedures have been found useful in works practice.

1. Grey Room. Fibre identification as desired. "Identification of Textile Materials" 5th Ed. The Textile Institute.

Fastness to preparing of coloured woven fabrics.

SDC Standard Methods. pages 14. 16. 18. 63. 87.

2. Dyehouse.

Periodic check on fluidity, wettability and pH of fabric prior to dyeing according to the following methods.

Fluidity. BS Handbook No.11. page 433.

Wettability. AATCC Manual 1970. page 249.

Oils, fats, waxes: BS. Handbook No.11. page 370.

pH: BS. Handbook No.11. page 350.

Periodic testing of colour fastness to light, washing, cold water, perspiration and wet and dry rubbing: See "SDC" Standard Methods.

3. Finishing.

Showerproofing.

Bundesman. BS. Handbook No.11. page 317.

Penetration. " " " 324.

Spray Test. " " " 330.

Crease Resistance: BS. Handbook No.11. " 198.

Wash and Wear Rating: AATCC Manual 1970. " 173/5.

Oil repellency: AATCC Manual 1970. " 214.

Flammability: AATCC Manual 1970. " 210.

BS. Handbook No.11. " 272.

Abrasion resistance:

The BS. Handbook No.11 has an appendix A page 555 which warns against the use of the results of laboratory abrasion tests to forecast ultimate wear performance, and methods of test have been omitted from that publication.

However, a method which is increasingly used for comparative purposes is the accelerator method described in the AATCC Manual 1970, page 168.

Pilling: "Atlas" Random Tumble procedure. ASTM Manual No.24. pages 289-293.

This method has largely replaced the ICI Random Tumble apparatus described in the ICI Terylene Technical Manual section C3.

Text Books.

Recommended books on Test Methods are listed below.

The Textile Laboratory Manual (6 volumes).

W. Garner.

Iliffe Books Ltd.,

Dorset House, Stamford Street, London S.E.1.

The principles of Textile Testing.

J.E. Booth.

Heywood, London.

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

Published by the Textile Institute.

Part 1. Physical Testing and Quality Control.

Part 2. Chemical Testing and Analysis.

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 control 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.F. Norris, and L.H.C. Tippet — 107 pages. (Textile Institute, 10 Blackfriars St., Manchester 3.)

and

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

By A. Brearley, D.R. Cox — 77 pages. (Wool Industries Research Association).

General publications include -

"Facts from Figures"

by M.J. Moroney. (Pelican Books).

"Introduction to Theory of Statistics"

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

A number of terms or statistical measures are widely quoted and used, and some of the more common terms 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 observations.

Mean deviation.

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

Variance.

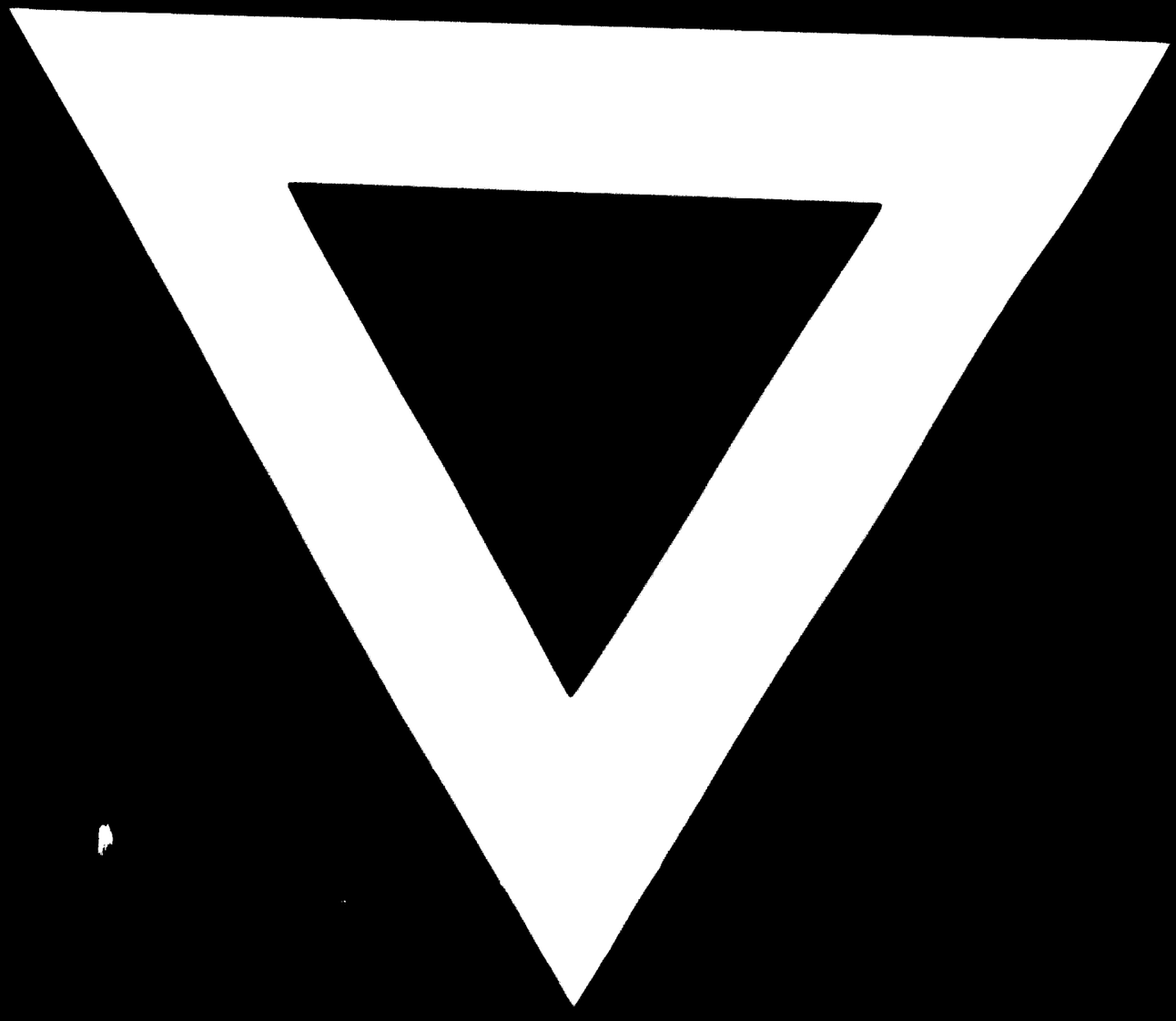
"The sum of the squares of the deviation divided by one less than the number of individuals".

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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