QUALITY SYSTEMS FOR GARMENT MANUFACTURE

ACHIEVING THE RIGHT FINAL PRODUCT ON TIME

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THE COST OF QUALITY

INTRODUCTION

A manufacturer stays in business only as long as his product quality satisfies his customers at the price they are prepared to pay.

Failure to maintain an adequate quality standard can therefore be disastrous. But maintaining an adequate standard of quality also costs effort. From the first investigation to find out what the potential customer for a new product really wants, through the processes of design, specification, controlled manufacture and sale, to the arrangements for aftersales service to the customer, effort is being spent on ensuring that the company's product - and reputation - are good. If it is spent wisely, it can result in savings greater than the increase in costs, and hence in an improvement to profits.

As products become more and more complex, and as customers - both Government Departments and individuals - become more conscious of the effects on their own economics of receiving a proportion of defective items, the effort required must continually increase.

The costs represented by this effort can be a significant proportion of the products sales value (Do you know what the total is in your Company? In some instances the cost of scrap, rework and inspection costs alone has been found to be as high as 20%

of turn-over) and any manufacturer should be interested in making sure that he is getting good value for his expenditure. He cannot feel sure unless he has studied what the costs are, how they are incurred and what they ought to be. If they are higher than they should be, he must consider ways in which they can be reduced.

Here we describe the nature of the costs incurred in ring product quality and reliability and shows how costs can be reduced whilst quality and reliability are maintained or improved.

THE NATURE OF QUALITY COSTS

Quality costs fall naturally into three main groups. First there are Costs associated with attaining or setting an adequate quality standard, sometimes called Prevention Costs. They are incurred largely in advance of production, when the quality standard is set. Insufficient money spent at this stage on, for example, design and development may well give rise to unnecessarily high costs later.

The second group is costs associated with maintaining an adequate quality standard, sometimes called Appraisal Costs. These are the costs associated with keeping the work manufacturing and buying functions up to the quality specified in the design.

The third category covers Failure Costs, or the costs associated with putting right any departure from standard. These include the costs of scrap, reprocessing, and guarantee claims. They are the costs, which arise as a result of shortcomings in, or insufficient expenditure on, the other two phases. They may be caused on the one hand by poor design, poor product engineering, poor operative training or, on the other, by bad workmanship, or slipshod inspection at the appraisal stage.

A list of the types of cost connected with quality and reliability will be found in the Appendix. Some difficulty may well be experienced in separating costs associated with quality and reliability from those more directly concerned with achieving the function of the product, for example, design and development. It is more important to recognise the changes deliberately made in these costs as action is taken to bring quality under control.

THE ATTACK ON COSTS

Obviously, the most significant improvements will usually be achieved by concentrating effort on the areas of high cost. For this purpose an analysis of the principal costs is required. Studies have shown that a fairly typical ratio between the three main groups of costs in a manufacturing company is: -

Prevention Costs 5%

Appraisal Costs 30%

Failure Costs - <u>65%</u>

Failure Costs, because they are typically the largest, will usually give the largest return for the effort involved in reducing them. An effective way of attacking Failure Costs is through a temporary increase in prevention and appraisal costs.

Appraisal Costs - for example, the cost of production and inspection - might be reduced by more attention to Value Engineering, which would to some extent increase prevention costs, and a closer control of the manufacturing process, which would increase appraisal costs.

Appraisal Costs will usually be the next to come under attack. An analysis of all essential quality control operations will often show opportunities for reducing expenditure without reducing effectiveness. For example, statistical sampling techniques may be used as a means of control, indicating trends in performance and assisting to maintain quality. By improving the control of the process, 100 per cent inspection may no longer be necessary.

Total costs will be lowest when design staff are aware of the cost implications of their work. Good design saves cost not only at the design stage itself but throughout production and testing: products become easier to make "right first time". Good design is needed not only when conceiving the product but also when conceiving systems for production and quality control. After failure and appraisal costs have been reduced by attention to the prevention aspect, it may be possible to reduce prevention costs as well.

We have seen that the process of reducing failure costs may well involve increasing expenditure on the design, developing, testing, manufacturing and inspecting processes. However, there must clearly be a point beyond which it would be uneconomic to incur additional expense. Failure costs might possibly be eliminated but at considerable, possibly prohibitive, costs in other areas. There is a point at which the aggregate of all costs is at a minimum for the intended selling price. Achieving this minimum cost will involve reviewing product designs, and improving planning processes, facilities and methods.

When the initial attack on costs has been successful, it will be logical to provide a means for analysing costs and for reporting on them in order to keep a close watch on progress so that, firstly, a worthwhile reduction in the attacked cost is achieved; and secondly, the expected increase in other costs is not exceeded.

SETTING STANDARDS OF COST

This can be done by setting a standard or budget for each cost item affected by the action, and by comparing periodically the actual cost with the standard. Differences between standard and actual cost are then notified to appropriate executives who can modify the tactics of the attack as necessary to ensure that the differences are reduced or eliminated.

Standards may be of two kinds: -

a. They may be set on the basis of the calculations made during the preliminary study. In this case, they will be agreed, by the quality controller, with all the executives responsible for ensuring that the study expectations will be realised.
b. They may be set by the more-or-less arbitrary decision of top management to reduce overall quality costs by - say - 5% or 10%.

In a company where executives are properly trained and motivated, the first type of standard is likely to be the more effective. Once the initial expectations have been met, further efforts can be planned and new standards set to correspond.

Improvement comes to be regarded as a normal and continuing process.

In companies where executives lack these qualities it may be preferable to adopt the second type of standard, in which a programme for improvement is autocratically imposed. Active follow-up by a strong personality is characteristically necessary in this situation, to see that executives really do all that is needful.

Standards will usually be set under conditions, which assume a certain volume of throughput and a certain level of incoming quality. If either of these factors changes significantly, the level and balance of costs will probably change also, and standards will need to be adjusted to suit the new conditions.

ASCERTAINING QUALITY COSTS

Cost data will have been required when the first study was made to determine the cost items most open to attack. These data will probably have been derived by ad hoc investigation and analysis. The same figures will have been used to derive standards or budgets.

When costs are to be ascertained regularly for comparison with standards, however, a number of steps are involved. First, it is necessary to decide which costs are to be analysed on a regular routine basis, which are to be analysed less frequently, and which will continue to be derived by special cost studies, or sampling cost methods.

The second step is to decide who is to make each analysis. The preference depends largely upon the source of the information. If the details can be made available from the accounting system the Cost Accountant will logically take on the task. However, if the information is of a technical nature or requires to be extracted from the records of Quality Control or other staff, it may be convenient to have it done by these departments.

Next a system of cost coding to simplify analysis must be provided. Where a code system is already in use it may require modifying to enable quality control costs to be collected in the most meaningful form. It is important that the causes of faults should be revealed and this may necessitate identification of the machine, operator or process where the loss arose.

Finally, one must define the procedure to be followed and the responsibilities of all the affected staff.

CONTROLLING COSTS

The only purpose of reporting costs is to provoke action. Without action the money spent on deriving and reporting data is wasted.

Action is required whenever there is a significant difference between an actual cost and the budget set for it. Action is also required to discover the reason for the difference and to eliminate it. If cost reports are to be effective in provoking this type of action they must be: -

- presented at suitably short intervals
- presented quickly following the period they represent
- presented in simple, direct, intelligible form
- presented to the people who have the authority and knowledge to act effectively.

It is often effective for reports to be sent both to the person who is expected to take action and also to his immediate superior.

It is important to remember that the actual costs revealed by control reports are the result of joint action by quality control staff and by the design or manufacturing functions. Action to correct undesirable trends may therefore have to be taken by all these groups in co-operation. Action by any one group may well be fruitless.

REPORTING COSTS

Effective quality cost control depends upon good cost reporting.

The cost reporting system should:

- identify the areas of expense, which are being reported
- show actual expenditure compared with that planned
- facilitate the comparison of benefits with the price that is being paid for them
- indicate the causes of excessive costs so that further investigations can be made and corrective action taken.

The data from which the Cost Reports are compiled should be so organised that such further investigations into specific excesses can proceed logically and without the need for too much re-analysis of basic documents.

Reports commonly take one of three main forms, corresponding to the main divisions of Quality Costs. The first is the Failure Cost Report. It is not usually difficult to produce adequate regular reports showing the level of failure costs - scrap, repairs, test rejections, after-sales service, customer returns etc. The essential data they should show includes the cause of failure, the value lost, and the department or process responsible (not necessarily the same, of course, as the department or process at which the failure was discovered and reported).

Supporting data for this report may include reporting point, description of product, part etc., and the responsible machine group or operative. Such supporting data is, however, probably best left out of reports for executive action. It may be more valuable in daily, un-costed, reports for information and action at "shop-floor" level.

The second type is the Appraisal Cost Report. This reflects the cost of operating the quality and reliability surveillance, as compared with budgeted expenditure. The division of account headings may sometimes make it difficult to include the cost of quality appraisal costs incurred by production operatives carrying out additional operations such as the inspection, testing, or grading of pieceparts, but such costs can sometimes be derived from a comparison of actual and standard times for the tasks, and included in a separate section of the report.

Finally, a Prevention Cost Report is required. So many functions of the typical business can be interpreted as contributing to Prevention Costs that it is normally wise to restrict reports to those areas which are being deliberately varied as part of the overall cost reduction project. The scope of such ad hoc reports can be enlarged to include data from which changes in Quality tactics can be planned. Such reports might include: an analysis of the effects on profits of changes in the system of setting manufacturing tolerances; the probable cost effects of introducing a Vendor Rating scheme; recommendations on the most economical points for inspection in a sequence of operations; and an investigation into the economics of buying new testing facilities.

Note that in studies involving a choice of methods we are concerned with the change in profit resulting from the decision - that is the difference in the profit-and-loss accounts before and after adopting the change. The costs which we use for studies of this nature are not likely to be the same as those used for normal cost accounting, for which purpose we have become used to the convention of expressing overheads as a percentage of - say - direct labour. This approach is unsuitable for finding the real cost, or change in cost, since in most cases the choice will cause little change in the fixed part of overhead costs, such as establishment and management expenses.

RECOMMENDATIONS

Here are ten steps that can be taken to reduce Quality Costs in your company:

a. Find out what Failure Costs are. The cost headings to include are listed in the Appendix
b. Decide, from the size of these preventable Failure Costs, the scale of extra quality control effort devoted to prevention and Appraisal which can be justified.
c. Nominate a senior member of the organisation to have responsibility for quality control. He should be familiar with and able to lead and train his staff in all aspects of quality control

d. Obtain from this manager a list of actions which can be taken, in the particular circumstances of your organisation, to reduce systematically your Failure Costs
e. Evaluate the approximate probable benefit of each action in reducing Failure Costs

   e.g. by how much will the customer guarantee claims be reduced? How large a reduction in scrap can be expected from Room "X"?

f. Evaluate the approximate probable cost of each of these actions separately,

   e.g. what will extra design administration cost? How much will have to be spent on new test gear?

g. Choose the one or two actions which are seen to offer the probability of largest return for the cost to be incurred
h. Make the quality controller responsible for seeing that these actions are taken and that the forecast benefits are actually secured:-

   i. Don't give him too much to do at one time
   ii. Give him a firm date for completion: make it tight but not impossible
   iii. Make sure he follows up each action and keeps it going
   iv. Insist on regular reporting of progress in cost terms - but don't interfere with the authority that you have delegated to him

a. As benefits are seen to flow from the first few - actions, initiate a few more from the original list - and insist that extra possibilities are constantly added to the list so that the process never comes to an end
b. Find out what the Appraisal Costs are and, in an exactly similar way, initiate actions designed to reduce specific Appraisal Costs by improving Prevention activities.

The precise contribution to profit made by the control of the quality costs will naturally vary with the size, type, and technology of each individual company. However, these suggestions can be regarded as the typical requirements for any programme. Because almost all operations of a manufacturing company have some influence on Quality Costs, a full and accurate analysis of costs can become very complex and may itself be costly to produce. Approximations and estimates will often therefore be adequate. Finally it will always be desirable to keep cost calculations and presentations- simple- so that they can be understood readily by those who will be required to take action upon them. -

APPENDIX

1. "Prevention Costs", i.e. Costs of Attaining Reliability

   Quality engineering, and testing through pre-production stages; material specifications and design tolerance.

   Training Quality and Production personnel in quality attainment.

Preparing test specifications and quality standards.

Specifying test and inspection equipment.

Advising on specifications of the production facilities needed to maintain quality standards.

Testing and calibrating inspection and production facilities.

Quality administration.

Replacement of hand by machine operations.

Replacement of hand operated by automatic machines.

Providing mechanical handling facilities.

Providing adequate protective packing.

Providing adequate protective storage.

Providing bins etc. to protect components during process.

2. "Appraisal Costs", i.e. Costs of Maintaining Reliability

   Vendor and incoming inspections.

   Inspecting and testing products and facilities.

   Field testing.

   Maintaining, re-testing and calibrating inspection and production facilities.

3. "Failure Costs" (whether through faulty- -workmanship, design, acceptance standards, machinery, packing, transport etc.)

Work scrapped: material and labour costs.

Sorting out bad work.

Reprocessing.

Re-inspection and re-testing.

Technical and clerical effort spent investigating faults and complaints.

Warranty claims, and gratuitous after-sales service.

Loss due to sale as second-grade product.

Delay in payment by customer - interest on outstanding money.

Double handling charges.

Double transport charges.

Double packing charges

From: "The Cost of Quality"

Norton, Ward & Elliott

British Institute of Management 1965

THE FUNCTIONS OF QUALITY ASSURANCE AND QUALITY CONTROL

DEFINITIONS OF QUALITY

"Quality" is defined as that combination of design and properties of materials of a product which are needed for the intended end use and level of the market in which it is sold.

"Requisite Quality" is defined as the design and composition of a product, which has been thoroughly proved by adequate development work, in order to establish its reliability under the conditions to which it will be subjected in use and to avoid producing too high a grade of product for the intended market.

AIMS OF QUALITY CONTROL AS THE INSTRUMENT OF QUALITY ASSURANCE OR TOTAL QUALITY CONTROL

"To ensure that the requisite quality of product is achieved"

This ensures customer satisfaction, but it leaves quality control as a necessary but expensive evil

"TO ENSURE, AT MINIMUM PRACTICABLE COST, THAT THE REQUISITE QUALITY OF PRODUCT IS BEING ACHIEVED AT EVERY STAGE OF MANUFACTURE FROM RAW MATERIALS TO BOXED STOCK.

This means six things:

a. *Checking the suitability of raw materials,*
b. *checking the manufacturing capability of the production undertaking*
c. *monitoring production; feeding back information; responding to that information; and so getting defects removed at source*
d. *reduction of the fault rate*
e. *saving costs*

f. *maintenance of product consistency*

All of these factors increase the possibility of developing further business and the competitiveness of the company, and is therefore to the benefit of the company; Quality control thus becomes a positive -benefit.

A further point stems from one aspect of Q.C: continually monitoring production and deciding whether, in any part of the manufacturing chain, materials, machines or workmanship need attention to effect a reduction in the fault rate. It is very easy to "pass the buck" that is for production personnel to blame materials or to say that it is the responsibility of QC, and so relax any endeavour on their part to avoid faults. In fact, quality cannot be inspected into goods; it is to direct attention and effort towards the most effective areas for avoiding faults and to maintain product consistency.

DEFINITIONS

Quality Assurance

"The establishment and maintenance of ALL activities and functions concerned with the attainment of requisite quality"

Quality Control

"The systems required for programming and co-ordinating the efforts of the various groups in an organisation to maintain the requisite quality" As such Quality Control is seen as the agent of Quality Assurance or Total Quality Control

Specifications

Quality Control requires the establishment of adequate specifications with proper tolerances

Objective

To maximise the production of goods within the specified tolerances correctly the first time.

By considering such information it can be decided what requires to be monitored. Monitoring the process is the essence of quality control.

We now know where we wish to go and what is possible. -

PREPARATION

The next stage after planning is to extract and expand along the guidelines established in the planning stage the technology or the basic know-how for each projected line. These technologies are;

Engineering - fabric, seams, garment

Communications and feedback sequences - without which there can be no control

Parameters - measurements and tolerances

Recording systems

Staffing decisions and the development of job specifications

IMPLEMENTATION

This is the practical control application to the day-to-day running of the factory - and extends from the basic concept of a style right through to the despatch of the correct boxed stock.

INSTALLATION OF THE OVERALL PLAN

The above plan is a continuing procedure in the sense that if starting from scratch one might have to begin with monitoring to get immediate results. This is then followed by a continuing process of refinement along the lines of adding the checking of raw materials and improving feedback routines.

SPECIFICATION

The requisite quality is the standard required to meet the needs of the customer: this must be determined and specified.

The specification must be clear and complete so that everybody from designer to production operative has a clear idea as to what is needed. Individuals within an organisation need only have parts of the specification that relates to their function. -

OBJECTIVE

To achieve a satisfactory design of the fabric or garment in relation to the level of choice in design, styles, colours, suitability of components and fitness of product for the market. This must be viewed in the context of overriding market considerations and production capabilities

APPROACH

1. Itemise the variables that occur in fabric and garment production in order to provide a complete specification.
2. Develop a specification in a number of parts or sections to ensure that all design and production staff have a clear idea as to what is needed
3. Establish acceptable working tolerances in relation to all values on the specification.
4. Establish fault rate recording systems
5. Improve technical understanding of the product including

a. fabric geometry and the interrelationship of yarn count, loop length, pick count, relaxation and fabric properties.
b. sewing problems
c. causes and prevention of seam breakdown
d. the effects of various factors on the apparent shade of goods affecting shade matching

1. Check consistency of incoming raw materials
2. Select suitable instrumentation for determining specified manufacturing values
3. Choose recording systems to provide a history of control
4. Select a method to assess operator effectiveness
5. Make periodic checks on:

   Fault level

   Waste

   Seconds

   Losses

   Delivery weight of yarn and record results

6. Commence testing of fabric and garments and record results
7. Analyse results
8. Check colour vision of personnel
9. Examine fabric on receipt
10. Consider fabric storage facilities
11. Examine fabric cutting quality
12. Cost the design quality in terms of:

    Cost of failure

    Cost of appraisal

    Cost of prevention

13. Introduce wearer trials and product testing
14. Develop through recording systems in the sampling department
15. Consider computer aids to development of specification
16. Prepare working standards and samples for shade matching
17. Examine potential for instrumental colour matching
18. Integrate techniques into a coherent GC scheme
19. Develop effective colour matching routines
20. Examine economics of cleanliness
21. Monitor cost levels at all stages

CONSISTENCY

Control must be applied to make sure that all goods passed to the customer reach the satisfactory level Planning procedures must be reviewed periodically -

<u>COST</u>

Cost of achieving the required standard of quality must be targeted at all stages -

PRINCIPLES OF QUALITY CONTROL

The essential requirements for producing a reliable product has been stated as follows:-

1. A satisfactory design of product, thoroughly proved by adequate development testing in order to establish its reliability under the conditions to which it will be subjected in use. This is the Requisite Quality of the product.
2. A full specification of the requirements of this quality, which must be clearly understood by everyone concerned with the production of the constituent parts and of the complete end product.
3. Confirmation that the manufacturing processes are capable of meeting these requirements.
4. Full acceptance, by all those concerned with production, of the responsibility for meeting the standards set by the specification.
5. Checks on the product at every stage of manufacture to detect any departures from the specification.
6. Record essential information derived from these checks to provide accurate evidence for action.
7. Establishment of lines of communication, - i.e. Feedback to Production, - to ensure that this action is taken to effect the appropriate adjustments to materials, process and operatives to maintain FUTURE production within the specification.
8. Instruction in the use, applications and limitations of the product.
9. A study of user experience, feedback to the department's concerned, and rapid remedial action.

An important feature to realise in the establishment of these principles is that, whilst tolerances and quality standards for goods going for despatch may often vary rapidly, depending on the urgency of call-off, it is the duty of Quality Control in enacting items 4-7 above, to stabilise the tolerances and quality standards for goods IN PRODUCTION, based on the recognised Requisite Quality and this largely established from the continual experience gained from item 9 above. Only by production personnel knowing exactly what is expected can they respond to the requirements of Quality Control.

ECONOMIC ASPECTS OF QUALITY ASSURANCE

The ideal situation is to keep the cost of conforming to the requisite quality as low as possible, whilst at the same time achieving the highest percentage of acceptable production.

To find if a company is approaching the optimum total cost trials need to be made to establish the costs of quality control and the cost of defectives.

As a first approximation and as a guide, this total cost is usually achieved when prevention costs = failure costs + appraisal costs, as illustrated in the above diagram, and in the diagram below:-

In this firm the total quality costs were approximately 10% of turnover (very low). By increasing appraisal and prevention a saving on total costs of 15% was effected. This is 15% on 10% of turnover, say 1.5% of £2,000,000 i.e. £30,000 saving in cost, improved product, improved delivery times, and improved customer satisfaction.

Additional benefits were

Quality Costs Sources of Cost information

COST OF FAILURE

Losses due to faulty and spoilt work

Examiners records

Mending

Reprocessing

a. additional materials
b. extra labour
c. disruption of production

Administrative Costs

a. reaching agreement with customers
b. replacing defectives or complaint adjustments
c. office administration

Penalties of not meeting delivery dates, e.g. failure to meet export arrangements, shipping. -

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COST OF APPRAISAL

1. Control of outside supplies, salaries and equipment less reclaims from suppliers

   e.g. testing incoming materials etc

2. Inspection

   e.g. 1st examination and final examination.

3. Fabric or garment tests,

   e.g. wash tests, yield tests, and appearance checks, any other checks

4. Maintenance of test or inspection equipment
5. Product value destroyed in testing materials consumed
6. Cutting Department - cutting losses
7. Services, e.g. electricity, steam, compressed air
8. QC outside endorsements, e.g. Woolmark
9. QC records & admin charges

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COST OF PREVENTION

Preparation and development of specifications

Time of personnel related to salaries

Developing consistency controls, e.g. use of stitch length

Equipment

Operating consistency controls

Costs and salaries of department personnel

Evolving more effective processes

Quality awareness training Wages, account, and training costs

Maintenance of machinery to maintain product quality, e.g. re-needling knitting machines

Production records, wages and equipment costs.

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THE BALANCE OF COSTS VERSUS SAVINGS - ASSESSMENT OF INNOVATIONS

The necessity of making conciliation occurs every time an idea or innovation needs to be assessed.

Suppose a new system has been thought up to meet a problem or situation which needs to be improved. The question before getting too involved in detailed planning of such a system, will be does it pay off? This question needs answering before much time, effort and money are spent.

1. Look at the present situation. Ascertain the cost of failure in the area where the innovation could be expected to have some effect. Analyse available records. If these are inadequate consider making records for a trial period. The resultant cost gives the potential saving and the scale of costs involved.
2. Make an assessment of the cost of carrying out the innovation - not so much the costs of installation as the continuing running and updating costs.
3. Next consider what degree of potential saving is likely to be achieved as a result of implementing the innovation. In the absence of any guidelines assume 50% achievement. This will at least give a guide to what savings realistically might be achieved.
4. Armed with this information a decision can be made, based on this assessment and the relevant recorded information. Keep notes as ideas and evidence develops. If the idea is worthwhile it is worth being persistent, but does not spoil a case by pressing for it before you are too sure, since time and credibility can easily be lost.

It is wise to seek a trial first, then the idea can justify itself on its own merits, or can easily be dropped if for any reason it proves to be unsuccessful.

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THE ROLE OF QUALITY CONTROL

1. In a total quality control scheme, the total involvement of all personnel is required as a philosophy.
2. The staff concerned in all duties must be given authority to carry out their functions. These functions should be defined.
3. Lines of communication and responsibility should be established to carry out an effective policy. Horizontal communication at all levels of personnel between Quality Control, Production and other departments is needed. Also there must be vertical lines, which follow the lines of responsibility and authority. In order to achieve this aim, the terms of reference under which staff work, must be established. This is, perhaps, best accomplished by job descriptions.
4. It is the job of Quality Control to establish the correct information concerning a quality situation, and present this clearly to their colleagues.
5. Persons outside Quality Control must be authorised to make the commercial decisions involved from a pre-established series of options, the consequences of each being fully understood.
6. Payment schemes should be re-examined where necessary to reward quality as well as production, in a balanced way, since both are commercially important.

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QUALITY CONTROL DATA GENERATED

Data is generated at each QC point. This must be recorded in simple systems to provide visual on-going checks. These records provide the means for personnel accountability and for rapid feedback for management action. -

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Raw Materials

a. Shade - checked to be within tolerance of standard pattern.
b. Delivery weights - checked and any shortfall claimed.

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Knitting Machine Settings

a. Yarn tension - levelled and to knitting specification.
b. Distribution - K.O. Depth, dials height - set to specification.
c. Loop/course length - Run-in levelled and to specification, positive feed checked.
d. Take-down tensions - checked for consistency. -

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Fabric Parameters, Fabric or Garment Blank Checks

a. Shade and appearance correct jacquard pattern correct, absence of barrenness.
b. Width normal - (this is only a guide with grey fabric).
c. Fabric weights per square metre (or preferably weight per predetermined revs) - checked to within tolerance of specification.
d. Blank weight per dozen to be within tolerance of specification.

e. Check fabric for faults and stains.
f. Finishing loss - on-going record of losses on scouring etc.
g. Accountability of knitters.

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Sewing Checks

a. Stitches per cm. and thread run-in ratio checked to be within tolerance of specification.
b. Evenness, balance and correct bight, no stitching missed
c. Extensibility and security correct (i.e. no cracking or laddering).
d. Absence of skip stitching.
e. Accountability of machinist.

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Final Inspection

a. Shade correct and not varying from one part of garment to another.
b. Cut is correct - e.g. neck, collar and sleeves balanced, pockets correct.
c. Measurements within tolerance of specification, weight correct.
d. Appearance correct, patterns matching.
e. Seams finished correctly, absence of miss stitching, cracking and laddering.
f. Accessories correctly applied and working.
g. Absence of fabric faults and stains.
h. Correct labelling.
i. Accountability of making-up (volume of work unsatisfactory; break-down under various fault categories.)

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Recovery Inspection

a. Check whether remedial works satisfactory.

b. Check on volume of work successfully recovered.
c. Avoidance of work recycling.

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Yarn Checks

1. Count Tests on Staple Fibre Yarns: Check on count variability, within cones and between deliveries: to be within tolerance of specification. If coarse, yarn utilisation impaired. Check on running average.
2. Bulking Tests on Continuous Filament Textured Yarns: Check on consistency, and on filamentation
3. Condition Checks:

   Check on incorrect condition

4. Yarn wrapping:

Levelness of yarn (also User levelness).

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Product Tests

1. Colour fastness to agreed agencies: (e.g. washing, rubbing, perspiration, lights) - checked and on-going continuity cards generated, showing rating, checked against specification.
2. Stability:

   Shrinkage, and extension recovery where needed - to be within tolerance of specification

3. Endurance:

   Abrasion, pilling or snagging - tested where needed. Rating checked against specification

4. Flammability:

Performance rating in appropriate test checked against specification. -

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Further Yarn Checks (2nd order priority)

1. Fibre analysis:

   As specified for correct labelling

2. Fibre quality:

   As required

3. Yarn twist:

   On new deliveries and on demand for fault diagnosis. To be within specified tolerance

4. Co-efficient of friction:

   Test and compare to specification

5. Oil content:

   When records of finishing loss, yarn utilisation, count, grey weights, or finished weights abnormal, oil content checked; and also if yarn running abnormally. Content figure to be within tolerance of specification.

6. Accessories Checks:

   Shade and size checked to be correct (e.g. buttons)

   Stability (e.g. linings and trims and zip tapes) within tolerance of specification. Extensibility and modulus (e.g. binding and elastic) within tolerance of specification. Items work properly (e.g. zips)

   Sewing threads, correct shade, ticket number and sews normally

7. Boxed Stock Audits

   Goods in warehouse - sample checked for quality and faults.

   Goods rejected - check to see if correctly rejected.

8. Machine Efficiency

   Ratio of knitting time or goods produced compared with basis if no down-time. Provides measure of machine performance - analysed against knitter, machinist, fabric quality, garment style and yarn. -

9. Yarn Utilisation
10. Fabric Utilisation

As with machine efficiency, checks on process performance.

Analysed against operation section, style, fabric or yarn.

-

QUALITY CONTROL RECORDS

The above data, immediately on being generated, is automatically entered on records as continuity charts, either in tabular, graphical or computerised form. This action takes very little time, and enables the current data to be compared with previous data and with other related Q. C. data. The visual impact of the presentation is immediate and creates rapid feed-back of vital information to production and other interested management personnel.

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BRITISH STANDARD 5750

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Introduction

British Standard 5750 Part 2 specifies a quality system, which is designed to provide a comprehensive, concise and logical approach to total Quality Assurance.

It relates to a method of working and not to any specific performance standard of a product. In principle it can therefore be applied to the manufacture of any product.

The essential features of the standard are contained in the following basic requirements:-

1. Quality System
2. Organisation
3. Review of Quality System
4. Documentation/Records
5. Equipment
6. Purchased Materials and Services
7. Manufacturing Control
8. Work Instructions/Workmanship
9. Corrective Action
10. Completed Item and Inspection and Test
11. Sampling Procedures
12. Control on Non-conforming Material
13. Alternative Inspection Procedures and Equipment
14. Indication of Inspection Status
15. Protection and Preservation of Product Handling, Storage and Delivery
16. Training.

To be of value each and every requirement requires individual manufacturer interpretation and implementation relating to the product being produced

This Quality Management Scheme has proven success in many UK industries. At first sight it appears complex and the first reaction is that it will add extra cost to implement. In truth it is a straightforward logical system which gives total control of quality which when implemented will prove fully cost effective.

-

<u>REQUIREMENTS</u>

1. <u>Quality System</u>

   To achieve the overall objective you will need to establish, document and maintain a system capable of ensuring that products conform in total to standards, specifications and sealed samples. This will be required at every stage of manufacture. Records must be maintained to give objective evidence that the specified requirements have been met.

2. Organisation

   You will need to appoint a management representative preferably independent of other functions to be responsible to oversee the total control system and inspection at each stage of manufacture. The person appointed should have the necessary authority to execute any action related to achieving the desired standard of product.

3. Review of the Quality System

   To be effective the system requires planned periodic review by Senior Management to ensure its effectiveness is maintained. This will entail internal audits, which must be positive and not conducted solely as a matter of expediency resulting from a quality problem.

4. Documentation

To be effective it is essential to establish and maintain clear, complete and current written records of inspection and test procedures for each operation.

These records should identify: -

a. Criteria for acceptance/rejection.
b. Action to be taken and by whom.
c. Essential information and data to identify item and batch.
d. Details of equipment and calibration.

Records must be kept up to date and be stored for easy access and retrieval and be available for examination.

1. Equipment

   All inspection, measuring and test equipment requires effective maintenance and calibration.

2. Purchased Materials and Services

   The quality system must be capable of controlling the standards of materials and services supplied by third party suppliers.

   Your purchasing documents must clearly define any desired standards or specification requirements.

All incoming goods from third party suppliers must be inspected and tested as appropriate and records maintained.

3. Manufacturing Control

   In-work inspection should be conducted during manufacture on all characteristics, which cannot be left until final inspection to prevent subsequent sub-standard products. This type of inspection to be effective must act as a process control.

4. Work Instructions/Workmanship

   The supplier must establish satisfactory written standards and representative samples or workmanship which must equate to standards and specifications laid down in Data Sheets, Make-up Specifications and Sealed Samples. These standards must provide an objective base on which decisions are made by skilled personnel.

5. Corrective Action

Documented procedures must be established and maintained to cover: -

a. The prompt detection and correction of inferior quality
b. A continual monitor of processes and work operations including performance testing
c. The action to be taken with third party suppliers on receipt of sub-standard materials.
d. The review of any corrective actions taken.

1. Completed Item Inspection and Test

   All finished products must be inspected and tested to ensure conformity against any relevant standard or -specification. The documented procedure established at this stage should ensure that any inspection or tests conducted at an earlier stage have been performed and the data obtained acted upon.

2. Sampling Procedures

   Sampling procedures used should be such that any information gained from the sample equally relates to the bulk from which they were taken.

3. Control of Non-Conforming Material

   There must be an effective system established to deal with non-conforming material to ensure it is clearly identified, segregated and disposed of. Adequate records must be maintained for subsequent review.

Any repair or rework activities to correct non-conforming material must be clearly identified and documented.

4. Alternative Inspection Procedures and Equipment

   Where you wish to use alternative inspection procedures and equipment valid evidence must be available to ensure they provide equivalent assurance of quality.

5. Indication of Inspection Status

   You must establish and maintain a procedure to clearly identify products at each stage of manufacture e.g. products not inspected; products inspected and passed; and products inspected and rejected.

6. Protection and Preservation of Product Quality during- -Handling, Storage and Delivery

Procedures and instruction must be established to: -

a. Clearly identify materials and products form receipt to despatch.
b. Control and protect all materials and products during handling, manufacture, storage and delivery.
c. Ensure finished products are stored and delivered commensurate to the quality standards demanded by the customer.

1. Training

All personnel involved with the management of quality must be experienced to receive adequate training to ensure they are competent to perform their required task.

Training must be an ongoing commitment with appropriate records being maintained.

-

QUALITY CONTROL IN THE DESIGN AND DEVELOPMENT DEPT

If disorganisation in sampling is to be avoided guideline procedure must be established beforehand.

Modifications to the development sample must be noted for inclusion in the final specification.

A handle sample (sealed if necessary) must be established as well as a working sample.

A proper flow diagram must be established with appropriate time factors, and all personnel concerned informed of the duty and timing of their part.

In the following pages, a diagram of typical steps is shown together with details of the duties of Q.C. personnel in this scheme.

In addition, Q.C. can be involved in development at an earlier stage by sampling new yarns. In combination with wearer trials and laboratory tests, assessments of seasonal and other goods can be made, e.g. tests made to ascertain whether fabric is too heavy for spring, is suitable for trousers, drapes correctly for dresses or curtains, or suitable for use in bright sunlight.

-

<u>QUALITY CONTROL FUNCTION</u>

1. Test Properties of Yarn

   a. If routine checks are carried out on yarn choose a delivery of average tex (count, denier).
   b. If incoming yarn is not checked then check the tex (count, denier) of the delivery intended for samples and only use if it is within acceptable limits.
   c. Carry out other appropriate tests on yarn e.g. crimp nylon-Crimp Rigidity test. Knit a small sample and check that dye is fast to light, washing and perspiration etc.
   d. Record details of yarn type, supplier, tex (denier, count) etc. and pass information to knitting room.

1. Knitting Specification

    a. Record all details required to produce the fabric or garment blanks including chain set out, stitch length and any instrument measurements.
    b. Record all details of making the trimmings
    c. Note any difficulties encountered e.g. stitch pattern causing occasional drop stitches. Pass information to making-up room.

-

-

1. Making-up Specification

    a. Record all details of making-up, including the type and count of the sewing thread, and the order of seaming the parts. b)
    b. Note any difficulties encountered e.g. difficult operation to attach collar.

1. Test for Physical Properties of Garments

    a. Record the dimensions of the garment as soon as it is completed
    b. For a fibre of high moisture regain find the weight in correct condition.
    c. Wash garment and recheck the measurements.

1. Liaison of Quality Control with Cost Department

    a. On completion, supply cost department with all information.
    b. For the correct tex (count, denier) of yarn, costing may be made directly on sample. For a count which is above or below the average (although within an acceptable tolerance) make an appropriate adjustment to yarn costs and weight.
    c. Make an allowance for any anticipated extra difficulties, or a higher than normal rate of seconds.

1. Subsequent Alteration

   a. Make any necessary alterations required by firm or by buyers.
   b. Record changes at each stage.

-

<u>A SAMPLE GARMENT TO FULL PRODUCTION</u>

(With particular reference to V-bed knitting)

Steps to follow

-

1. Prepare garment description

   describe type of garment with sketch/photograph

   weigh garment

   record seams and stitches for garment assembly

2. Analysis of sample

a. analyse all component structures e.g. body, ribs etc., seam and stitch types
b. identify yarns in sample
c. record all components other than fabric e.g. zip, buttons etc
d. count courses and wales per cm in each structure
e. determine stitch length and counts of yarns used by unroving
f. estimate likely gauge of machine on which sample knitted
g. if jacquard proportion of yarns in pattern repeat
h. measure all relevant seam properties e.g. stitches per cm, extensibility, depth of bight

1. Development of knitting specification

   select nearest suitable commercial yarn available and gauge of machine to be used for adaptation to reproduce sample

   on the basis of (a) calculate stitch length to be used

   on the basis of (b) calculate the courses and needles required in each structure calculate course lengths required

2. Setting up machine to produce garment

a. knit swatch for each structure at calculated course length based on experience of machine settings
b. check course length by unroving or marked yarn method
c. adjust until correct (tolerance of +- 2% suggested)
d. record settings e.g. input tension, weight of take down, knock over depth
e. knit sample panels
f. check and record complete panels for appearance, dimensions and weight

N.B. if (c) has been correctly carried out machine adjustment should not be required.

1. Setting up other machines

a. on the basis on data recorded set up other machines similarly
b. check for course length and adjust necessary

1. Garment assembly

a. decide on sequence of assembly operations
b. decide on seams and threads to be used and check machine availability
c. consider alternatives if machine not available
d. check seam properties under 2h of first garments.

1. Checking of finished garment

a. examine for appearance and compare with sketch/photograph
b. check all technical aspects for any fabric faults, seaming faults etc
c. check weight

1. Full production

a. check yarn of correct count on random basis or where weight discrepancies arise
b. check knitting quality e.g. course length on a regular basis
c. check on garment assembly particularly individual operative performance
d. record all faults found at final inspection for immediate correction and to identify need for preventative -action at a specific stage of production.

THE SPECIFICATION

The specification is the first stage in a quality control scheme to provide precise values of the variables and acceptable working tolerances.

The levels of the quality of design, and the cost related to it have already been determined when the specification is prepared. If this is not correctly determined the company could make a loss on the production, even when the goods are produced correctly to the specification.

Any modifications introduced into the manufacture of a product must be noted, and relevant details appear in the specification

The specification should contain enough information for any competent personnel to produce the required goods at anytime within tolerance.

To assist in preventing a specification becoming unwieldy, simplification can often be made by omitting those details not subject to change from line to line. These are taught to the operative as part of their induction and can be delegated to training.

Much information can be conveyed and a document provided for quick reference if a standard layout is always used. This is shown by the way we use such massive works as a dictionary or telephone directory. An organised and consistent layout minimises errors and time both in compiling and reading.

Different departments within the factory are concerned with different parts of a specification. It is convenient; therefore, If the specification is laid out in several sections, from which concise "see at a glance" details may be provided for each particular department by assembling just the relevant sections on a sheet from a pre-printed, sectionalised Master Specification.

A further method of simplification can be used in those cases where various lines or styles are produced from really the same fabric or knitting, or by using the same seams, apart from, say just one or two small changes.

The basic knitting, garment blank or sewing details can be recorded for each type or fabric, garment blank or seam, and then given a suitable reference number. The actual specification for a particular line will then call up only this reference, together with any appropriate alteration, as noted in the third paragraph above. This idea is, in a way, a development of the sectionalisation of specification.

This idea can be developed further in regard to yarns and seams.

All the various styles are likely to the produced from only a few yarns or seams, even though more than one type of yarn or seam will be required in a garment. Each yarn and each seam used is first stipulated adequately, and this recorded in an appropriate yarn or seam specification with its own reference. The garment of fabric specification will then make reference to the required yarn or seam by quoting just the yarn or seam specification reference. This will probably occur in the first section of the fabric or garment specification, where details of size, customer, order number, licence or trade mark requirements are given.

Each factory will need to prepare forms appropriate to their own requirements and example specifications, divided into sections are available to provide a suggested basis.

-

YARN SPECIFICATION - EXAMPLE

YARN TYPE - Cotton/Polyester blend, for single jersey knitting

YARN SPECIFICATION NO. DATE

DESCRIPTION **COUNT

*COMPOSITION

FIBRE QUALITY:

**TWIST FACTOR:

ASTM GRADING:

USTER LEVELNESS: CV%

Thins (50% setting) per 1,000m

Thick (setting 3) per 1,000m

Neps (setting 3) per 1,000m

WINDING

COEFFICIENT. OF FRICTION:

SHADES:

TOLERANCES:

COLOUR FASTNESS:

(Assessed on 1 x 1 rib fabric sample from yarn supplied)

<u>Change in shade</u> <u>staining</u>

Washing: - Rating

Perspiration

Rubbing

Dry Cleaning

Gas fumes

Light

Staining assessed on

<u>PRODUCT SPECIFICATION - Example</u>

<u>COMMERCIAL DATA</u>

GARMENT DESCRIPTION

SPECIFICATION No: - DATE:

STYLE NO:

DESIGN NO:

SIZES:

WT. PER DOZ.

TECHNICAL DATA

YARNS MAIN GROUND

PILE / INLAY

TRIMS

FABRICS MAIN

TRIMS NECK)

CUFFS)

SKIRT)

FINISHING MAIN

DETAILS

TRIMS

LAYING UP & CUTTING

Patterns Drawings

Lay markers

Cut

GARMENT ASSEMBLY

Make-up order and seam spec

Sewing threads

Tapes Zips

AESTHETIC DATA

SHADE AND HANDLE

As sealed patterns

FABRICS

YARNS

REQUIREMENTS

APPEARANCE AND HANG

As sealed garments ref.

-

CUSTOMER DATA

MEASUREMENTS: Size chart and measuring points as in drawings

LABELLING: Type

Location

Legend

PERFORMANCE

Stability

Colour fastness - BS 1006

Pilling

Extensibility (cuffs and skirts fabric only and in course direction)

Bursting Pressure (on main fabric only)

Seam stretch

Seam security

Needle damage

NON-KNITTING YARN

RAW MATERIALS SPECIFICATION - Examples

SEWING THREADS

-

SPECIFICATION NO: DATE:

Needle thread for o/lock, cover seams and L/S tabbing and finishing

Fibre

Structure

Designation

Shade

Other requirements

Colour fastness

Bobbin thread for lockstitch

Same as the needle thread

-

<u>TAPES</u>

SPECIFICATION NO DATE

Location

Width

Structure

Shade

Colour fastness

-

<u>ZIPS</u>

SPECIFICATION NO

Location

Length

Tapes

Shade

Colour fastness

Stability

Other requirements

-

PROCESS SPECIFICATION - Example

-

FABRIC

-

-

REFERENCES SPEC NO

FABRIC DESCRIPTION

PRODUCT SPECIFICATION Nos. RELATING

SPECIFICATION NO DATE

MACHINE GAUGE

DIAM FEEDERS

SPEED

WIDTH ROLL LENGTH FINISHED:

MIN. USEABLE ROLL WEIGHT FINISHED:

DOFFING REVS:

DOFFING TIME

-

<u>TECHNICAL MANUFACTURING REQUIREMENTS</u>

STITCH LENGTH Ground

Inlay

COMPOSITION FABRIC Ground

(off m/c) Inlay

WIDTH (off m/c)

-

<u>FINISHING REQUIREMENTS</u>

PROCESSES

-

FINISHED FABRIC PARAMETERS

C/3cm W/3cm wt/sq.m

Width overall

-

PROCESS SPECIFICATION - EXAMPLE

-

MAKE-UP ORDER

-

REFERENCES SPEC NO

MAKE-UP ORDER FOR

SPECIFICATION NO

PRODUCT SPECIFICATION NO. RELATING: -

-

MANUFACTURING REQUIREMENT

-

Operation Seam Spec. Ref. Extras/seam finish

-

-

-

PROCESS SPECIFICATION - EXAMPLE

-

SEAM SPECIFICATION

-

-

REFERENCES SPEC NO

SPECIFICATION FOR

SPECIFICATION REF. NO: DATE

MAKE-UP ORDER NOS.:

SEWING THREADS

-

MANUFACTURING REQUIREMENTS

STITCH

BIGHT S/5cm

RUN-IN

NEEDLE

TENSION

-

FABRIC STABILITY AND FINISHED WIDTH

-

Fabrics knitted on circular machines has a set number of wales, determined b y the knitting machine used, - its diameter and gauge (needles per unit length of cylinder circumference). The fabric will be knitted from a certain yarn type and knitted loop length, partly on economic grounds and partly to avoid being too dense or too light a fabric.

There is a commercial incentive to finish fabric as wide and as long as possible. The loop structure of knitted fabrics makes it possible to stretch these fabrics to an appreciable extent. However, in the stretched state the forces on each loop are not balanced, and so the fabric becomes unstable, giving it a tendency to revert to a more natural, relaxed state during which an increase in fabric stitch density will take place, together with a consequent reduction on area, i.e. shrinkage will always occur. It is not possible to set a fabric at what is in effect unrealistic dimensions and at the same time achieves a stable fabric. Therefore, certain diameters of knitting machines are to be used (which is a must unless we are prepared continually to replace existing machinery). Since the fabric will be knitted within fairly narrow ranges of yarn type, count and loop length, then the fabric must be finished as near as practical to its natural width and length and not over stretched, if it is to be without excessive shrinkage in service (e.g. washing). In this state the fabric will have fairly definite width and length dependent on the machine, yarn and loop length used. Efficient lays should be planned on these dimensions, and not on some predetermined ideal.

If shrinkage is not an important consideration, then extra width and length can be considered. The fabric characteristics can be determined by calculations form the fabric geometry and by trials, and the finished dimensions to be stipulated modified accordingly.

Unless these factors are fully understood, a satisfactory fabric specification will not be possible.

-

EXAMINATION ON RECEIPT OF FABRIC

1. Basic Problem

   As much as 10% of incoming fabric can be considered to be unsatisfactory, but due to inadequate control or commercial pressures less than 5% is returned. The figure of 10% is not surprising.

   The material cost saved by a 100% inspection may more than save the cost of that inspection. Moreover valuable information can be obtained to aid in production planning through the factory.

   Where the quality of each piece has been established before it is issued to the cutting room, the cutter can be given clear instructions in the preferred manner in which any faults can be absorbed.

2. Examination Sequence-

   Where 100% inspection is not feasible in the first instance

   Procedure for Incoming Fabric

   Check list Piece of

   Each pattern

   Or colourways

If satisfactory if not satisfactory

Check every check every

fifth piece piece

If satisfactory

Continue checking check every

every fifth piece piece

3. <u>Fabric Examination Specification</u>

   For examination to be a success it is vital that the examiner has an examination specification. This should include items along the lines of the following:-

   Length

   Width

   Weight

   Incorrect colours

   Incorrect pattern

   Bow and Skew

   Number of parts

   Fault rate

   Dye listing or tilt

   Stains and marks

4. <u>Physical Aspects of Fabric Examination</u>

There is more to examination machine design than meets the eye. It is worth considering a total examination environment which can improve the overall standard of the examination department.

The main action of a fabric examination machine is to unroll, measure and re-roll the fabric, and to contribute to an environment in which it can be inspected by an examiner. This requires the following characteristics:-

1. Suitable edge control to provide a finished roll of attractive appearance
2. Winding characteristics, which do not distort the fabric structure or dimensions, which suggests tensionless wind up through, overfeed in the case of stretch fabrics.
3. Stopping and starting which will not disturb the roll, nor the fabric structure nor its dimensions
4. Length measurement with the fabric in a relaxed tensionless state
5. The quality of wind-up should be such that auto-laying equipment can be used satisfactorily
6. Winding characteristics should be such that any form of handling by the examiner is minimised
7. The machine should be simple to load and unload
8. Lighting should be controllable and of variable intensity, so that the most critical faults may be detected most easily without loss of detection of less critical faults. For those fabrics which require transmitted light, the panel should be of appropriate dimension from top to bottom and from side to side.

There are a number of critical features of fabric examination machines apart from the above, but which can be expected to be incorporated within a machine which is of a standard which conforms to the above requirements. These include angle of slope of the examination table, distance of fabric from examiners position, speed range of fabric movement, light positions. There are a number of training exercises that have been suggested for new examiners to improve the range of the width of the fabric that is studied during examination and to reduce the training period.

Transmitted light - generally for Quality Control faults - e.g. a fluorescent light inside trousers. Reflected light - generally for commercial faults.

-

BASIC TECHNOLOGY OF SEAMS

-

THE PURPOSE OF SEAMS

The main function of a seam is to join pieces of fabric unobtrusively in such a way as the preserve as far as possible the basic properties of the fabrics being joined.

There are many seams and stitches, which are described in a comprehensive British Standard B.S 3870: Part 1 - Stitch Types, and Part 2 - Seam Types.

DESIRABLE FEATURES OF A SEAM

1. It must not pull apart under the stresses of service
2. It must not cockle or be too tight
3. It must be as extensible as the fabric or as needed by the movement demanded of each area of the garment
4. The sewing stitches must not cut the fabric, break or crack on stretching
5. The seam must not "grin"
6. The seam should be unobtrusive, unless it is specifically for decorative purpose

TYPES OF SEAMS

In B.S 3870 part 2, seams are divided into 8 classifications, in each of which there are many variations. However, for purposes of clarity, with weft knitted garments, the seams used may be considered under the following four main types.

1. Superimposed)
2. Overlapped)
3. Butted/Flat)
4. Edge finished)

Within each of these groups there are many variations of the basic theme. Many of the seams may be produced with one or more stitch types.

BRITISH STANDARD CLASSIFICATION OF STITCHES B.S 3870

Stitches are divided into six classes, within each of which are several types of stitch. The characteristics of each class are indicated below, followed by illustrations of commoner stitch types and details of their properties and applications.

Stitch class 100. Chain stitch

This class stitch is formed with one or more needle threads and has for its general characteristics intralooping*. A loop or loops of thread or thread is passed through the material and secured by intralooping with succeeding loop or loops after they are passed through the material to form a stitch.

Stitch class 200 Hand stitch

These stitches, having little application in mass production, are not included in the succeeding sheets.

Stitch class 300 Lock stitch

This class of stitch is formed with two or more groups of threads and has for a general characteristic the interlacing* of the two groups. Loops of the first group are passed through the material where they are secured by the thread or threads of the second group to form a stitch.

Stitch class 400 Multi-thread chain stitch

This class of stitch is formed with two or more groups of threads and has for a general characteristic the interlacing and interlooping * of the loops of the two groups. Loops of the first group of threads are passed through the material and are secured by interlacing and interlooping with loops of the second group to form a stitch.

Stitch class 500 Overlock stitch (overedge or edge seaming)

This class of stitch is formed with one or more groups of threads and has for a general characteristic that loops from at least one group of thread pass around the edge of the material. Loops of one group of thread are passed through the material and are secured by intralooping with themselves before succeeding loops are passed through the material, or secured by interlooping with loops of one or more interlooped groups of threads before succeeding threads of the first group are again passed through he material.

Stitch class 600 Flat seam stitch

This class of stitch is formed with two or more groups of threads and has for a general characteristic that two of the groups cover the raw edges of both surfaces of the material. Loops of the first group of thread are passed through loops of the third group already cast on the surface of the material and then through the material where they are interlooped with loops of the second group of thread on the underside of the material. The one exception to this procedure is Stitch Type 601 where only two groups of thread are used and the function of the third groups is performed by one of the threads in the first group.

***For the sake of precision in description the following terms have been used:**

Intralooping

The passing of a loop of thread through another loop formed by the same thread

Interlooping

The passing of a loop of thread through another loop by a different thread

Interlacing

The passing of a thread over or around another thread or loop of another thread

RECORDING SYSTEMS

Reasons for recording

Recording provides

1. a quick visual check of the effectiveness of the control

2. a means of discovering treads
3. information for tracing the trend to the source
4. information on consistently unsatisfactory materials, machines or operatives
5. evidence for management and other personnel for action
6. information of the frequency and areas of the checks being made
7. information on which to assess the suitability of the tolerances or levels
8. the vital information, without which it is impossible to know the situation at any given time and so make sound decisions

It is essential for any Quality Control System that adequate records should be devised and kept. Such records are required to supply essential information when goods being manufactured are failing to conform to the specification and the standards required. In the making up room records are needed for

1. Seam control checks
2. Operative quality checks

Seam Control checks

These checks should be made on a regular basis usually by the quality control staff; to ensure that the seams being produced are meeting the technical specification laid down. An example for a Seam control check card is given below:

RECORD CARD FOR SEAM CONTROL

(DIAGRAM)

Operative quality checks

These checks should be made not less than once a day by each supervisor. These are checks to ensure that each operative is producing seams that appear satisfactory. In most factories one of a supervisor's duties will be the responsibility for the quality of the work produced in that section.

An example for an Operative quality check card is given. This would be kept by the machine.

Entries on the card would only be made if one or more checks under any one day, or item, are substandard.

RECORD CARD FOR WEEKLY CHECK OF OPERATORS' PERFORMANCE

(DIAGRAM)

As each fault is noted it can be entered against the appropriate item no. In the column for the particular day as five-barred-gates, from which the totals, daily and weekly, for each item can be quickly assessed.

Similar card for Supervisor's record

(DIAGRAM)

To obtain the all-important overall picture of operatives over a period, it may well be a time saver in the examination of these weekly reports, to enter the weekly totals on a Trend Chart.

(DIAGRAM)

EXAMPLE SINGLE OPERATION CHECK

(DIAGRAM)

EXAMPLE REPAIRS RECORD

(DIAGRAM)

It is often helpful for a Supervisor to have a checklist for each operation under her control, as a reminder.

SUPERVISOR'S CHECK LIST

(DIAGRAM)

(DIAGRAM OF REVERSE SIDE)

-

SEAM CHARACTERISTICS

STITCH CLASS 100 - CHAIN STITCH

Stitches within this class have excellent extensibility and a neat appearance but will unravel easily if the thread is broken.

The single thread Class 101 chain stitch is extensively used for basting, i.e. sewing with temporary stitches and, in the knitted sector for linking neck ribs to garment bodies. The linked seam may be identified by the passage of the sewing thread through the loops of the knitted structure rather than a random penetration.

To form the Class 103 stitch (blind stitch) the needle and thread is passed through the top ply and horizontally through portions of the bottom ply without actually penetrating it to the full depth. The stitch is invisible from the outside and this s used extensively for hemming

Class 104 is essentially decorative and is known as saddle stitching.

STITCH CLASS 101 - Chain Stitch

PROPERTIES

1. Good elasticity
2. Neat
3. Easily unravelled

APPLICATIONS

1. Used where easy unravelling is required - as in basting i.e. sewing with temporary stitches. The sewing machine for this purpose is similar in appearance to a lockstitch machine.
2. Linking of neck ribs etc. in knitted garments. By placing the fabric stitch by stitch on the dial points the sewing needle is enabled to pass cleanly through the knitted loops resulting in a neat, unobtrusive seam.

STITCH CLASS 103 - CHAIN STITCH (HEMMING)

PROPERTIES

Invisible from the face side of the garment as the needle and thread is passed through the top ply and horizontally through portions of the bottom ply without penetrating it to the full depth.

APPLICATIONS

Turning up hems on trousers, skirts, etc.

STITCH CLASS 301 - LOCKSTITCH

PROPERTIES

1. Does not unravel
2. Flat, neat and unobtrusive
3. Of similar appearance top and bottom
4. In most circumstances has limited extensibility
5. Can be started and finished at any point on the fabric surface.

APPLICATIONS

The most widely used stitch in the clothing sector. By virtue of 5 above is very suitable for darts and pleats. Can be secured at both ends of seam by back tacking, i.e., reversing machine over two or three stitches. This stitch is also used in the knitted sector for such applications as stitching pockets onto cardigans.

NOTE

Length of sewing between bobbin renewals limited by the small capacity of the bobbin.

STITCH CLASSES 304, 308 - ZIG-ZAG STITCHES

PROPERTIES

As for lockstitch class 301 except: -

The zig-zag configuration gives a significantly higher extensibility than class 301.

Length of sewing, limited as with type 301.

APPLICATIONS

Widely used in foundation garments and in swimwear.

STITCH CLASS 401 MULTI-THREAD OR DOUBLE LOCKED CHAINSTITCH PROPERTIES

1. The three dimensional construction is closely allied to the construction of knitted fabric.
2. Relatively high elasticity if sufficient needle thread is introduced.
3. Tends to eliminate or reduce puckering problems.
4. Good lateral strength.
5. Unlike the single thread chain stitch Type 101 this will not unravel readily.

APPLICATION

1. Eminently suitable for most clothing sector applications in which the lockstitch might be used but where double jersey fabrics are being used in place of woven suiting.
2. For the same reasons, can and is used for woven suiting for such applications as waist bands and centre seat seams of trousers.
3. Linking of neck bands etc. as an alternative to the single thread chain stitch. Also toe closing of half-hose.

****

STITCH CLASS 402 & 406 - MULTI THREAD CHAIN-STITCH (Cover Stitch)

PROPERTIES

1. Construction closely allied to knitted fabric.
2. Relatively high elasticity.
3. Tends not to pucker.
4. Good lateral strength.
5. Will not unravel easily.

APPLICATION

1. Where a cut edge is folded back and sewn down neatly.
2. Any point in a garment at which an overlock seam has been used and, for reasons of comfort and/or additional security, that seam should be flattened and covered.
3. Where two cut edges are folded together and sewn down as in belt loops on trousers.

STITCH CLASS 500 - OVEREDGE STITCH

These are more commonly referred to as over-lock stitches although, to the purist, this is a name peculiar to Wilcox and Gibbs machines.

Contained within the class is the very well known Class 504 three-thread overlock, its subtle variant the Class 505 three thread and the not dissimilar two thread stitches. The class also contains a single thread version.

Eight twin needle overlock stitches are listed in the British Standard 3870 ranging from two to four threads. The most widely used is the four threads Class 505 which is frequently referred to as a "mock safety stitch".

STITCH CLASS 504 - THREE THREAD OVERLOCK

PROPERTIES

1. Very high extensibility - up to 300% when suitably adjusted.
2. Upper and lower looper threads inter-loop to bind the trimmed edge of the fabric.
3. Good lateral strength consistent with a bight suited to the fabric being sewn.

APPLICATION

1. This is the most widely used seam in the hosiery sector and may be found at any place in cut and sewn garments at which a trimmed and bound edge is required. Such applications include setting in of sleeves, closing side seams on T-shirts etc.
2. Is widely used for similar application in modern shirt manufacture from fine warp knit fabrics.
3. Crutch seaming of tights.
4. Felling of trousers and other garments.

STITCH CLASS 503 - MOCK WELT

This type of stitch is formed with two threads: one needle thread, A and one looper thread, B. Loops of thread A are passed through the material and brought to the edge where they are inter looped with thread B. The loops of thread B extend from this inter looping to the point of needle penetration of the next stitch and then inter loop with thread A.

PROPERTIES

1. Extensible seam
2. Structure is such as to make the seam lie flat.

APPLICATION

This seam is used for "serging" or binding edges of trouser seams. Is also used for mock welting of which there are two types - inverse and standard - these names refer to the way in which the fabric is folded. One gives a seam, which is a mirror image of the other.

It is used for underwear e.g. vest bottoms.

STITCH CLASS 514 - TWIN NEEDLE OVERLOCK (MOCK SAFETY)

CONSTRUCTION AND APPEARANCE

Requires, in the case of some three-thread overlock machines, no more than the fitting of the second needle together with the thread and a suitable all round tension adjustment.

PROPERTIES

As Type 504 overlock but with the additional security afforded by the larger bight required by the second needle. Is sometimes referred to as a 'mock' safety stitch.

APPLICATION

Any application in which a three-thread Type 504 overlock seam could be used but, by reason of a very open structure in the knitted fabric, an extra bight and the additional security afforded by two needle threads is desirable.

Such applications frequently include the crutch seam of tights. The seam is also used extensively in modern shirt manufacture from fine gauge warp knitted fabrics.

STITCH CLASS 512 - FOUR THREAD TWIN NEEDLE OVERLOCK

CONSTRUCTION AND APPEARANCE

Similar to Type 514 but both loopers carries over both needles.

PROPERTIES

Similar to Type 514 but with both loopers engaging both needles, there is greater security and extensibility.

APPLICATION

As replacing Type 514

STITCH CLASS 600 - FLAT SEAM STITCH

Flat seam stitches were developed to provide the elasticity necessary in seaming knitted fabrics together with the strength to produce a secure butted seam. They range from three to nine thread stitches and have a wide application.

Seams are formed with three groups of threads, the general characteristic being that one group bridges the butted join on the face of the fabric, the second group bridges the butted join on the reverse of the fabric; the two groups are interconnected through the fabric by the third group i.e. the needle threads. The exception is the Class 601 which is comprised of only two groups, the function of the first group being performed by one of the threads of the third group.

Certain Class 600 stitches are referred to as cover stitches but it should be noted that, unlike Class 400 cover stitches, they cover both the top and bottom of the seam. Notable among them is the Class 602 which is identical to the twin needle Class 406 but with the addition of a top cover thread laid on by an auxiliary finger. The Class 605 is a three needle version of the Class 602.

By virtue of their lack of bulk and covered raw edges stitches in this class, principally the well known nine thread Class 606 and the more extensible six thread Class 607, are used for such applications as gusset insertion, reinforced sections in girdles and corsets, side and shoulder seams on vests and on some of the more expensive garments.

STITCH CLASS 602

PROPERTIES

1. Secures cut and folded-back raw edge neatly and securely, top and bottom cover.
2. Flat and comfortable.
3. Will not unravel easily.
4. Very good extensibility.

APPLICATION

A widely used stitch in girdles and corsets. Also used for finishing hem of skirt bottoms

STITCH CLASS 605

PROPERTIES

Same as for stitch class 602.

Stronger than 602, but uses more sewing thread.

APPLICATION

This widely used stitch is sometimes referred to as "triple interlock". Typical examples are in the legs of swimwear either with or without elastic insert. There are other applications in lingerie, underwear and corsetry, e.g. gussets in briefs and panty girdles.

STITCH CLASS 606 - NINE THREAD FLAT-LOCK

PROPERTIES

1. Flat and comfortable - thickness no more than that of the fabric.
2. Construction complementary to that of the knitted structure being sewn.
3. Extensibility not less than that of the fabric.
4. Very high lateral strength.

APPLICATION

1. Shoulder seams of good quality underwear.
2. Girdles, panty girdles and corsets.
3. Good quality surgical and support tights.
4. Good quality swimwear.

STITCH CLASS 607 - SIX THREAD FLAT SEAM

PROPERTIES

As Class 606, which seam the Class 607 was designed to supercede by reason of simplicity and improved extensibility.

APPLICATION

As Class 606.

There are machines available which will produce simultaneously stitches from two of the classes mentioned above, for example, a 401 (twin thread chain stitch) in combination with a 504 lockstitch. These are referred to as safety stitches (see mock safety stitch under class 504).

STITCH FORMING ACTION OF THE ROTARY HOOK MACHINE

Rotary hook machines form the Type 301 lockstitch by carrying the needle-thread loop around the bobbin containing the under thread, in the following manner:

Commencing with the needle at the lowest point of its stroke, as the needle starts to rise the needle-thread, being flexible bulges out away from the need to form a loop. (See Diagram 1)

The needle penetrates the fabric with the needle-thread taut to either side of it. The thread is shrouded in the long groove on the feed in side and is thus free from friction as it passes through the fabric.

As the needle commences to rise from the lowest point of its stroke the combination of thread to fabric friction and the upward movement of the needle eye causes the needle thread to bulge out away from the needle to form a loop on the opposite side of the needle to the long groove. (See diagram 1)

DIAGRAM 1

The loop formed in the needle-thread is entered by the point of the sewing hook, as illustrated in diagram 2.

DIAGRAM 2

As the needle continues to rise and the hook progresses in its rotation, the needle-thread take-up arm provides sufficient slack thread to be drawn down through the material to increase the size of the loop.

On its first revolution, the sewing-hook carries the needle-thread loop around the bobbin-case and bobbin, the inside of the loop sliding over the face of the bobbin-case whilst the outside passes around the back (as shown in Diagram 3) to enclose the under thread.

DIAGRAM 3

As the needle-thread take-up starts to rise, the loop is drawn up through the 'cast-off' opening of the sewing-hook before the revolution is complete.

During the second revolution of the sewing-hook the thread take-up completes its upward stroke, drawing the slack thread through the material and setting the stitch. Meanwhile, the feed-dog has moved forward carrying the material with it and drawing the required length of under thread from the bobbin.

The presser-foot guards against slippage by holding the fabric firmly against the teeth of the feed-dog whilst the feed-dog is carrying the fabric across the smooth face of the throat or needle-plate.

The all important timing relationships between the needle-bar, sewing-hook, thread take-up, etc. are established by the fact that all motions are derived from a common shaft.

VARIABLES OR FACTORS AFFECTING SEAM PROPERTIES

The overlock seam can be taken as an example of the inter-relation of seam variables and properties.

DIAGRAMS

Fabric strength

Needle thread strength

Bight

Seam stitches per unit length

Affect strength across seam

Fabric stiffness

Needle thread extensibility

Needle thread tension

Seam stitches per unit length

Affect seam grinning and gaping

Seam stitches per unit length

Needle thread extensibility

Fabric extensibility

Combined thickness of fabric plies

Cover thread thickness

Needle thread tension DIAGRAM

Presser foot pressure

Affect seam extensibility

Stitches per inch

There is a minimum below which a seam will not hold without gaping and grinning, and the stitches will ride prominently on the fabric surfaces.

There is a maximum above which the seam jams with sewing thread, the base fabric is damaged, the seam puckers and is thick and rigid.

Cost increases with increasing stitches per inch. Thus stitches are kept as low as possible for the seam to look right and to perform correctly - i.e. stitches per inch is a matter of experience. However a guide is provided by dividing the mean of the courses and wales of the fabric by 2.

Bight

This is the term given to the distance between the edges of the fabrics being joined in the seam and the line of the needle thread, - i.e. the sewing line.

This can be too big for comfort and aesthetic considerations or too small so allowing slippage to occur. Again, experience, i.e. appearance, feels and stretching across the seam will decide. If narrow bights have to be used, stitches per inch may need to be increased above the first estimate or a stitch with more than one needle thread used.

Extensibility

If this is inadequate the seam is either too tight or cracks.

The required extensibility is achieved by: -

a. by extensible sewing thread. IF too extensible, the seam will grin. Also, the cost of such thread tends to be too high;

b. by getting sufficient thread into the seam by the correct adjustment of needle thread tension and presser foot pressure.
c. by using the correct stitches per inch or cm.

Summary

The inter-reaction of the various factors is shown below:

DIAGRAM

RECORDING SYSTEMS

Reasons for recording

Recording provides

1. a quick visual check of the effectiveness of the control
2. a means of discovering treads
3. information for tracing the trend to the source
4. information on consistently unsatisfactory materials, machines or operatives
5. evidence for management and other personnel for action
6. information of the frequency and areas of the checks being made
7. information on which to assess the suitability of the tolerances or levels
8. the vital information, without which it is impossible to know the situation at any given time and so make sound decisions.

It is essential for any Quality Control System that adequate records should be devised and kept. Such records are required to supply essential information when goods being manufactured are failing to conform to the specification and the standards required. In the making up room records are needed for

1. Seam control checks
2. Operative quality checks

Seam Control checks

These checks should be made on a regular basis usually by the quality control staff; to ensure that the seams being produced are meeting the technical specification laid down. An example for a Seam control check card is given below:

RECORD CARD FOR SEAM CONTROL

(DIAGRAM)

Operative quality checks

These checks should be made not less than once a day by each supervisor. These are checks to ensure that each operative is producing seams that appear satisfactory. In most factories one of a supervisor's duties will be the responsibility for the quality of the work produced in that section.

An example for an Operative quality check card is given. This would be kept by the machine.

Entries on the card would only be made if one or more checks under any one day, or item, are substandard.

RECORD CARD FOR WEEKLY CHECK OF OPERATORS' PERFORMANCE

(DIAGRAM)

As each fault is noted it can be entered against the appropriate item no. In the column for the particular day as five-barred-gates, from which the totals, daily and weekly, for each item can be quickly assessed.

Similar card for Supervisor's record

(DIAGRAM)

To obtain the all-important overall picture of operatives over a period, it may well be a time saver in the examination of these weekly reports, to enter the weekly totals on a Trend Chart.

(DIAGRAM)

EXAMPLE SINGLE OPERATION CHECK

(DIAGRAM)

EXAMPLE REPAIRS RECORD

(DIAGRAM)

It is often helpful for a Supervisor to have a check list for each operation under her control, as a reminder.

SUPERVISOR'S CHECK LIST

(DIAGRAM)

(DIAGRAM OF REVERSE SIDE)

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ANALYSIS OF RESULTS OF QUALITY CONTROL CHECKS

Compare: -

a. present results with earlier ones in the one set of results;
b. different materials on same machines with the same operatives
c. different machines using same materials with same operatives;
d. different operatives using same type of machine and same materials;
e. results with outside sources to confirm or modify standards.

-

Courses of action

If the results show that

1. the situation is satisfactory - no action is required
2. although satisfactory according to existing standards, improvements could be made - reduce tolerances or lower levels.
3. the situation is unsatisfactory - take appropriate action to counter it.

-

TOLERANCE LIMITS

Introduction

All products are subject to variations in consistency, caused by variations in raw materials, processes, operatives, conditions, measuring and so on. The likelihood, therefore, of a product being exactly to specification are therefore remote. However, the variations are just as likely to give results that are too high as they are to give results that are too low - the results will vary in a random manner. This law of randomness is fundamental to an understanding of the statistical approach to quality control. -

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RANDOM DISTRIBUTION

If repeated measurements of any particular factor are taken as production proceeds, the results will be found to cluster around a figure we call the average, with a spread of results on either side, with diminishing frequency as we move away from the average. A graph of the result, shown horizontally on the graph below, against the number of occurrences of that result, we obtain typically the shape shown. The specified tolerances ought to bear some relation to the peak in the curve.

Tolerances

If we fix limits within which we will accept a product as satisfactory, then clearly the further apart and on each side of the average we set limits, or tolerances, the greater will be the proportion of production that we will accept. If the tolerances are set too close, then we cannot get it all 'right first time' but if they are too wide, then we will get, for example, garments which will not fit even though manufactured to specification.

Conventional statistical approaches suggest that tolerances should be set from knowledge of the standard deviation of the results obtained. This is perhaps rather like setting the cart before the horse, and suggests that there have to be a certain level of rejected items come what may. Thus it is conventional to reject a certain proportion of production set at perhaps 4%. This is of course a nonsense, since what we are striving to do with our 'right first time' approach is to set everything up carefully, and to manufacture the goods to the best of the capabilities of the personnel and equipment. The tolerances should be set so that if they are made on a machine properly all the goods will be within tolerance. It is only when the mean of the results obtained changes, that our monitoring techniques should cause the alarm to be raised. When we get a drift of the mean then the plan of remedial action set out below comes into play.

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Standard Deviation

The scatter of results can be measured through the statistical measure of standard deviation - which is the measure of the spread of results. A number of factors stem from the standard deviation, which also have statistical value, but outside the present scope.
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Action derived from Tolerances

Tolerances, once agreed upon, can be used to decide courses of action.

If a machine average drifts, the machine will produce rejects with a noticeable reject rate. Tolerances will indicate when adjustment is needed, and by how much. The right hand curve represents work from a machine whose average has drifted. The work out of tolerance can be seen.

In order to contain and check any drift without the dangers of over-correction, the required action can be summarised as follows: -

1. If work is within tolerances

   normally no action

2. If work on a check is out of tolerance:-

   a. repeat check. If now within - no action. If still out, adjust machine by an amount expected to bring work just within tolerance. *
   b. continue checks until work is within tolerance.

This avoids over-correction.

1. If work on regular checking is consistently within tolerance, but near one of the limits:-

   a. adjust by an amount expected to bring the average back to the specified figure.
   b. continue regular checking

Before making any actual adjustment it is well worth checking that no obvious fault has occurred, say yarn path dislodged, dirt, lint etc. If it has, rectify the situation and then recheck. If still out make the appropriate adjustment.

Although a certain percentage of work will always be outside the tolerances the whole point of a QC scheme is to prevent as far as is practicable, any drift in the average, in other words that the overall average remains exactly the same. -

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<u>TRAINING QUALITY STANDARDS AND FAULT ANALYSIS-</u>

Quality is of prime importance in any aspect of business. Customers demand and expect value for money. As producers of apparel there must be a constant endeavour to produce work of good quality.

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QUALITY STANDARDS

1. Quality control and standards are one of the most important aspects of the content of any job and therefore a major factor in training.

By a Quality Standard we mean the establishment of the threshold at which level of severity a defect becomes unacceptable, i.e. a fault. It is the equivalent of tolerances applicable to measurable factors.

Systematic training involves the training of a person in: -

a. Basic knowledge
b. Correct methods
c. Quality standards

Without this last item defective production cannot be prevented.

These standards are established from the Specification and buying sample, etc.

Next step is control of consistency, - i.e. supervision of, and inspection after, each stage of manufacture.

Quality cannot be inspected into a product; it is either there or not. It must be bred into the making of the product by the operative; this is where quality starts. Instructors of trainees are therefore at the controls of quality.

It is vital that all faults and defects that are likely to arise in any job should be taught to all trainees during their instruction. A machinist, knitter or operative of any kind must be able to recognise these faults and take action on them, that is, to report, correct or prevent them!

Quality Standards must be recognised and agreed by all levels of Management. In the absence of such agreement the operative does not know what is expected of him or her, becomes frustrated, and leaves, with the ensuing needlessly high labour-turnover and training costs of new labour.

This recognition and agreement is greatly assisted by reference to a library of faults, each fault being illustrated in the various degrees of severity, - from certainly acceptable to definitely no. This is discussed in item 6 "Fault Analysis" later in this handout. A major difficulty here arises from the fact that quality standards applied to goods going for despatch may often vary rapidly depending on the priorities balance at that moment for urgency of delivery. However, whatever the situation here, it is the duty of Quality Control to stabilise the Quality Standards applied on the production line. The standards will gradually vary in time, and must be agreed by all levels of management, taking into consideration the feedback from Customer Returns and Store Returns.

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Cause of Faults and Action to be Taken

1. Faults may exist in a completed product due to one or more of the following causes:-

    a. Faulty raw materials - the operative must recognise these and report.
    b. Faulty machinery - the operative must recognise and adjust if this adjustment is his or her responsibility, or report if not.
    c. Faulty operative performance - the operative must recognise shortcomings in her own performance and get assistance to correct them.

-

Supervision

1. The supervisor, in operator-dominated stages of manufacture (e.g. making-up, pressing, and inspection), must make systematic checks of the work. These should cover each operative in all operations that they carry out, and at varying times of the day and days of the week. The checks should be at irregular and thus not anticipated by the operative.

    Training and Reward on the Shop Floor.

2. Faults must be explained in a fully comprehensive manner to trainees.

    Telling is not sufficient. Trainees must be shown examples of faults and shown the way to correct or prevent them. Faults must be explained and demonstrated: this is where quality-control begins, and only in training will it have the long-term desired effect.

    Without proper training there can be no effective and fair redress of malfunctioning operatives.

    Encouragement on the shop floor must reward aims consistent with those set out in the quality standards, in balance with volume of production.

    Teaching Fault Recognition and Correction

3. Faults can be divided into 2 categories:-

    a. General Faults
    b. Job Faults

General faults are, for example, those resulting from machine or operative defects, such as: -

- i. Incorrect threading
- ii. Careless handling
- iii. Slipped stitches
- iv. Bad tension
- v. Seam breaking away.

Job faults are those which occur specifically in the job being studied, in overlocking sleeves, for example: -

i. Step joins
ii. Pleating
iii. Wrong measurements

General faults should be kept with each machine type used in the factory, so that when asked to teach a new job only the actual job faults need to be studied.

-

<u>Fault Analysis</u>

1. An analysis of faults is a description of all faults in a product, which the operative is, expected to recognise and take action upon, whether to report, correct or return. It provides a valuable teaching instrument.

It is desirable, in order to teach quality standards well, to build up progressively a library of these faults.

a. Finding Faults

   With the exception of glaring examples, faults do not normally come readily to mind. Therefore, it is important to make a habit of noting and, if possible, seeing examples of faults as they occur. By doing this a comprehensive list and collection will be built up within a short period of time.

   In order to achieve the constancy of quality standards throughout the factory (the importance of which was discussed in the last paragraph under "Quality Standards"), full discussion with all concerned must take place.

   Where it is difficult to decide what will just and what will just not pass it is best to keep several well-labelled examples for anyone to check with. Border line examples are vastly more important than obvious ones, which a trainee would readily recognise anyway. Collect faults that will marginally pass and those that will marginally fail.

   Once the faults have been collected they should be written down and recorded on a fault analysis card or chart. These are also known as FACERAP cards, and will be discussed later.

   FACERAP is a mnemonic for FAULT, APPEARANCE, CAUSE, EFFECT, RESPONSIBILITY, ACTION, and PREVENTION.

b. Mounting examples

   Generally, examples will be handled by many trainees and will, unless suitably mounted and protected, deteriorate very rapidly. Fabric samples could be mounted flat on a background of stiff card. This could then be sealed in a clear envelope, enabling them to be handled almost indefinitely without detriment. An alternative would be "swing-out" FACERAP cards mounted on a wall, with the actual fault example being mounted under the "Appearance" heading.

c. Storage of Examples

Fabric faults in envelopes may be conveniently stored in filing cabinets, drawers, or boxes of suitable depth, with the related FACERAP card being clipped on.

Careful storage will cut down the tedious non-productive effort of constantly replacing examples.

d. Collecting Information

The background and implications of each fault should be listed under the FACERAP headings. It is essential to ensure the accuracy of the information, which can be obtained from a number of sources: -

1. The experienced worker, who, over a long period will have gained a knowledge of the subjective quality standards required at each stage of the job (as distinct from any written quality standard)
2. Technical Staff
3. Technical bulletins.

The information is recorded under the following headings to facilitate teaching: -

FAULT - Correct name/agreed name. (Taught so that trainees can report to the Instructor/Supervisor/Mechanic.)

APPEARANCE - Clear description or an example attached. (Trainee cannot take remedial action unless he/she can recognise the appearance or feel of the fault).

CAUSE - All the main causes, for example: - faulty cutting, incorrect machine setting, machine breakdown, mistake by operative or previous operatives.

EFFECT - Result of the fault, cost of the fault, for example: - weak edges likely to break away, scrapped or seconds, loss of incentive pay.

RESPONSIBILITY - Which defects are trainees' own fault and which are the responsibility of others. Do not encourage the passing of blame, similarly, do not blame unfairly.

ACTION - What action is to be carried out on discovery of the fault, for example: -

reject, unpick and re-sew,

report to Instructor/Supervisor/Mechanic.

PREVENTION - Any action which can or should be taken to avoid a recurrence of the fault should be recorded, for example: - check tensions and stitches on every third garment. Ensure edges match before sewing, etc.

An example is given below for a fault in half hose.

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FAULT ANALYSIS CARD

FAULT	APPEARANCE	CAUSE	EFFECT	RESPONSIBILITY	ACTION	PREVENTION
Split Stitch on Linking	Half stitch or part Of stitch	Failure to place whole stitch on point	Weak part in seam which under pressure will break away	Operative	Remove fabric from points and run on	Check each stitch is on a constructive point when fabric is run on

-

SUGGESTED TEACHING METHODS

This should be carried out by means of knowledge lessons and some suggestions regarding time and how to organise the main part of the session, are given below: -

a. Limit the session to 30 minutes. This will involve a limitation of the number of faults, dependent on their complexity.
b. Have a card for each fault, showing a complete analysis.
c. Show the example of each fault and discuss the cause, how to recognise it, and explain whatever action by the operative is appropriate.
d. Place examples of faults around the room, shuffle the analysis cards, and then get the trainees to match the cards with the appropriate examples.
e. A particularly effective technique is to issue trainees with blank FACERAP cards, show the fault, and then ask the trainee to complete the cards.

Then compare the trainees completed cards with the master card and discuss.

A range of examples from various sections of the industry is given below: -

-

LEVELS OF FAULTS AND SECONDS

-

USE OF SAMPLING TECHNIQUES

In many situations the cost arid expediency considerations force us to judge a state of affairs from the results of sample tests despite the risks of loss of accuracy. In such situations clearly the larger the sample the more accurate the result, but — the more costly the exercise. Statistics can give us guidance on the optimum size of sample to take. This then leaves us to decide on frequency of testing.

A. Sample size

In order to illustrate the principles involved, let us consider a sample of 50 dozen garments examined for say total faults although it could have been for any particular fault. Supposing 6.8% of the garments bore faults. The fault rate in the sample is 6.8% What can we say about the fault rate in the production represented by that sample? Clearly the chance of its fault rate being exactly 6.8% is very small. If however we allow anything between 6.5 and 7.5 to be called 7, we have in fact a range or tolerance of + - 0.5 and can now use statistics.

Just as individual results can be graphed, so can the averages of samples be plotted. These averages will have an overall average, and will themselves behave according to the law of random distribution. Thus their own standard deviation can be calculated.

Consider table 1. In this, the garment lengths for a particular style and size have been recorded over a period, and the frequency of occurrence plotted in column

2. For instance there were 50 garments whose length was between 19.0 - 19.5 inches, so 50 is written in column 2 opposite 19.0 -19.5. The standard deviation of this batch of 500 garments was 1.53 inches, and the average 20.04 inches. Now if *we* take samples of 5 garments from this batch and plot the averages of each of these samples, we should find the results as in column 3. The spread of results can be seen to be much less. If we now take samples of 10, then of 20 and then of 40, and out of more than one batch of 500, and again plot the respective sample averages, the spread of results continues to decrease as shown in columns 4, 5 and 6.

The standard deviation of these sample averages can be calculated and was found to be as shown in table II, column 3. Comparison with column 4 shows that there is a close relation between the standard deviation of the average of a sample of a set number of measurements and the intrinsic deviation of the individual measurements.

Clearly we can, by adjusting the size of sample, arrange for the standard deviation of the sample averages to lie between the limits we need, - from a knowledge of the S.D. of individual results.

Now it can he seen from considerations discussed elsewhere that there is an optimum position at which to set tolerance limits to minimise rejects while still rejecting those seriously wrong, and that it occurs when 95-96% of the work is accepted - the 95% Confidence Factor - which arises when the tolerances are set at a deviation from the average equal to approximately twice the Standard Deviation.

Going back to our original 50 dozen garments examined for total faults, we have arranged our tolerances at + - 0.5, i.e. 6.5 to 7.5% so it becomes possible to select a sample size so that the standard deviation of the sample averages gives us a 95% confidence factor of the average lying between 6.5 and 7.5% - that is the average of the actual production represented by the sample lying between 6.5 and 7.5% when the sample average is within those limits, again depending on the standard deviation of individual results.

A study of the chance factor etc. shows that this standard deviation increases as the percentage of the fault rate being recorded increases. The following tables gives the sample size required for this 95% confidence for different fault levels.

Example of use of table

Make an educated guess of the present level of defectives say 7 %

Read off the sample size against 7%, that is 651 or 54 doz.

B. Frequency of sampling

This will depend on the volume of production, various cost considerations and the reason why sampling is required. The sample size does not depend on volume of production, but simply requires that the line is a long run. In this connection a line, or rather a category, can be regarded as containing all items carrying substantially the same fault types and fault rates. Often the whole production is sampled on the basis of the overall fault rate.

The frequency of sampling will largely depend on the desired speed of feedback, and decided in the light of experience. Generally a weekly basis is satisfactory, with sub-weekly sampling, when a situation, i.e. fault rate, goes above the agreed level.

Sampling may be carried out in its own right to obtain information otherwise not available at any stage in the manufacturing chat may he carried out as a regular Q.C. check on any 100% testing already in operation, - e.g. final inspection,

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<u>INSPECTION AND RECORDING TECHNIQUES</u>

<u>Inspecting for defectives</u>

Make a quality control inspection of a representative sample.

For example - Total number to be inspected in week, 54 doz.

Week 's production 400 doz. of A, 200 doz. of B, 100 doz. of C.

Sample for inspection 30 doz. of A, 16 doz. of B, 8 doz. of C.

Make a form with suitable headings and record faults building five-barred gates. See diagram.

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Suggested Sub-Headings for the Extension of Columns

Knitting: - Knitter's knots, press-offs, needle marks, dropped stitches, cuts, moles, swarf, dirt,

Columns "Making-Up" and "Dyeing and Finishing" can be extended in a corresponding manner.

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Recording Results of Period Checks

The results of each sample inspected will have been obtained on a percentage basis. These then need to be recorded sequentially on a chart for the reasons given.

A recommended method is to plot on a graph the percentage levels obtained in the inspection. See diagram.

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Period checks

Reasons for carrying out periodic checks are:

1. To check that the acceptable levels are being maintained.

2. To provide information on which reappraisals may be made.

3. To obtain a more accurate value of the levels of the total population, and modify the sample size accordingly.

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SEEING COLOUR AND EFFECT OF THE TYPE OF ILLUMINANT ON THE APPARENT SHADE OF A SAMPLE

1. SEEING COLOUR

   a. Reflected Light

      Objects appear white when the whole of the visible spectrum (i.e. white light) falls upon them and is reflected equally over the whole of the spectrum. They are called black when they reflect virtually none.

      Objects appear coloured when they reflect part of the visible spectrum more than other parts. They will take on the colour of the light reflected. The eye perceives colour from the nature of the light it receives i.e. the nature of the light reflected from the object.

      A white object would appear the same, therefore, as a particular coloured object, if it were lit by light of that colour. The white object would take on the colour of the original light, because it reflects any light equally. A coloured object, because it reflects parts of the spectrum, will take on its true colour in white light or light of its own colour. Thus, a red object in white light is red. In red light it is red. In blue light it is very dark or even black. A white object in white light is white, in red light is red, in blue light is blue and a black object, if fully black, is always so in any light. So we see colour from the light reflected.

      For example, a mid-yellow surface looks yellow because the light reflected by it looks yellow to the eye.

   b. The Eye

The eye sees colour by reason of three sets of receptors (called cones). One set responds from red to blue with a peak response in the orange band (the "red" receptor); one set responds from orange to blue with a peak at green (the "green" receptor); and one set responds between green and violet with a peak at blue-violet, (the blue/violet receptor).

Consider yellow light reflected from a mid-yellow surface. This light stimulates both the green and red receptors, and the brain says "yellow", as if this occurs in the yellow part of the spectrum. In fact, the tones of yellow, whether orange-yellow or green-yellow are determined by the relative amounts by which the red and green receptors are stimulated. In orange-yellow light the red stimulus predominate, in green-yellow he reverse.

It follows then, that green light and red, because they stimulate their respective receptor, could be blended to give these shades of yellow without yellow light being there at all. The eye would still see yellow shades. This applies to all the other colours between violet and green as well as green and red.

1. <u>EFFECT OF COLOUR OF ILLUMINANT - METAMERISM</u>

Referring back to the mid-yellow surface, it could be obtained by a colour agent or mixture, reflecting both in the green and the red bands, or by colour reflecting across green to red.

This is so in pure white light. Supposing the light is not pure, but is "warm" i.e. pinkish, it will have more red or orange proportionally than he pure white. The colouring reflecting just yellow continues to reflect yellow and will look he same in both lights. But a colouring reflecting into the red band, when viewed in warm light, will not now match the first, because more red is in the illumination, so more red is reflected and the colour becomes redder.

This effect is called <u>metamerism</u>

This is the reason when you go into a shop to choose cloth, wallpaper, furnishings, curtains, paints, you might look at the pattern cards in the store light and then take them to the doorway to check again that the colours will go together.

In colour matching one must check the match in all the colours of illuminant under which it is likely to be judged.

These effects apply mainly when establishing recipes or making initial checks against a customer's pattern. In production shade matching, where one is engaged in checking a sample dye in an established recipe against an established standard, only one standard source of illuminations is generally needed.

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EFFECTS OF INTENSITY, ANGLE OF ILLUMINATION ON THE APPARENT SHADE OF A SAMPLE

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PART 1. THE EFFECTS

A. EFFECT OF INTENSITY

The eye and brain see colour as a result of interpreting light sensations received in the eye. The eye must adapt to different intensities of light. In so doing, the colour sensation may vary and thus the apparent shade. One cannot clearly judge colour unless a room or object is well lit. Shapes can be discerned in quite dull light, but not colour.

It has been found those below 500 lumens per square metre, colour judgement fails. This light intensity is obtained in front of a window receiving north light on a clear or lightly cloudy day, except near sundown or sunrise. It is given in the average well-lit room and in colour matching cabinets - e.g. one lit by two 65-watt artificial daylight tubes about 30 inches or 75cm above the viewing surface.

B. ANGLE OF ILLUMINATION AND VIEWING-

Most surfaces, unless fully matt, have some degree of grain or of lustre. So some white light is reflected from the face of the object or pattern in addition to its true coloured light reflected from the body of the object. The best judgement of colour will be when lustre and grain effects are minimal. Colour is reflected at all angles, lustre and grain tend to be directional

The recommended standard procedure is to hold the patterns at 45 deg to the direction of illumination and view at right angles to the pattern, i.e. from directly over it.

C. ORIENTATION OF PATTERN OR SAMPLE

Many fabrics have some degree of "nap". This effect is most pronounced in velvets and meltons. But brushed fabrics, Terry and many others have a grain or nap. This will effect the lustre rather like the alternate light and dark rows along a freshly mown bowling green. According to where you stand, the light and dark parts interchange in shade. Thus it is not difficult to see how "nap" can cause great confusion, which can only be avoided by ensuring that the patterns being compared are orientated with their structure or nap going in the same direction.

This is also important with fabrics having a structure such as ribs or twills. There is a difference in the "shadow" effects and also a degree of confusion produced by seeing conflicting structural lines.

D. EFFECTS OF COLOUR OF ILLUMINANT

Illumination of different colours - for example daylight compared with tungsten filament and certain "warm light" fluorescent tubes and the high output colour rendering fluorescent tubes such as the TL 84, give different colours different appearance making certain colours change, so that a match in one light may not be in another.

For this reason it is important to ensure that samples are compared under the illuminations representative of those likely to be encountered in sale and service, and if possible, to specify the illuminants under which matches are to be judged.

E. EFFECT OF FLUORESCENT AGENTS

If brightening agents or fluorescent colours are present in a dyeing; these will affect the shade when viewed in daylight and under most fluorescent tube lights, but to a lesser degree under tungsten filament lights.

These substances absorb energy in the ultra violet, violet and blue regions of the spectrum and re-emit energy as visible light. The re-emitted radiation is always longer wavelength - i.e. shifted towards the red end and away from the violet end of the spectrum, compared with that first absorbed. So if these agents are to emit in the blue end of the spectrum, absorption will have to occur in the violet and ultra-violet bands.

Thus illumination containing ultra-violet light will activate these agents, whereas those deficient in ultra-violet will not, and the pattern will look different.

Daylight contains this radiation, tungsten filament light much less. So it is necessary to stipulate the types of light to be used for this reason too.

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PART 2 - TYPES OF STANDARD ILLUMINANT

A. Gas filled tungsten filament lamp operating at about 2850K, illustrated by a new 60-watt bulb at correct voltage.

B. Noon sunlight. This is obtained with tungsten lamps and filters, and would be given by a colour temperature of about 4850K.

C. Noon north sky light. This would be given by an incandescent body at about 6500K. It is obtained from "Artificial Daylight" tubes. This is obtained with filters and tungsten filament lamps.

D. Artificial day light, illuminant D65.

The spectral distribution or wavelength ranges of these illuminants are shown in the diagram.

These items are defined in clause 12 "Conditions of Viewing and Illumination in Assessing Colour Fastness" in B.S. 2661, which itself is titled "Principles of Colour Fastness Testing". It is also given under the same clause and title in the Society of Dyers and Colourists' Publication "Standard Methods for the Determination of Colour Fastness of Textiles", and in B.S. 950 part 1 Artificial daylight fluorescent tubes for colour matching.

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MOUNTING FABRICS FOR VIEWING

There are three important considerations.

a) Area exposed to view.

This has a distinct effect on the apparent degree of miss-match, the larger the area the greater the apparent disparity.

The size of specimens to be used should be agreed, and then maintained throughout with a minimum deviation.

b) Mounting.

The effects of lustre, "nap" and structure are detailed, together with methods of minimising errors through them elsewhere.

The true colour of a fabric is that of the light reflected from the constituent fibres. However, depending on the degree of "cover", the colour of the surface underneath can show through and confuse the fabric colour. This applies whether a specimen is actually attached to a supporting surface, placed on a surface temporarily for viewing or just held in the hands. This is because whatever is behind the specimen is likely to affect its appearance. For instance, fabric viewed when held above a dark or shaded bench or floor may well look different when held over a light coloured surface or well-lit part of the floor. However, it should be stated as a further point, that when not mounted or held on a rigid surface, the errors due to incorrect viewing cannot be reliably controlled.

It is vital therefore, either that the surfaces on which patterns are examined be of an agreed standardised colour such as a grey or white, or that sufficient layers of fabric are being viewed that the surface is immaterial. The latter is preferable, because it permits the maximum discrimination. Surfaces considerably different in colour from the fabrics reduce the apparent difference between those fabrics. An adequate number of thicknesses have been achieved when further folding or thickness do not affect the appearance of a pattern.

c) Viewing Distance.

The greater the distance, the less apparent any discrepancies. This effect can be overcome by increasing the area viewed proportionally so that the "visual angle" of the specimen is the same. This has a beneficial effect with fabrics, which have a pronounced structure (e.g. ribs), in that confusion due to fabric surface structure is less.

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COLOUR VISION

Three sensors in the eye, for red, green/yellow, and blue.

About 92% of men, 99.5% women use similar amounts of standard red, yellow, and blue to match particular colours -

NORMAL TRICHROMAT

5.5% of man (M) require different proportions of red, yellow, and blue to match particular colours - ANAMALOUS TRICHROMAT.

Matching yellow with red and green - more red PROTANOMAL 1%M

Matching yellow with red and green - more green DEUTERANOMAL 4.6%M

Matching cyan with blue and green - more blue TRITANOMAL

2.6%M require only two of the three (red, yellow, blue) to match particular colours - DICHROMAT.

Behave as if red missing PROTANOPE 1.2%M

Behave as if green missing DEUTERANOPE 1.4%M

Behave as if yellow missing TRITANOPE 0.04%M

0.003%M has no sensation of hue - MONOCHROMAT.

TESTS FOR COLOUR VISION

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AO H-R-R PSEUDOISOCHROMATIC PLATES (ISHIHARA)

Supplier: H K Lewis Ltd

136 Gower Street

London WC1

Telephone: 01 387 4282

The test consists of a series of plates containing coloured geometrical symbols on a grey background. Observers with particular colour defects fail to see certain symbols. One assessment of the test (K. McLaren, Journal of the Society of Dyers and Colourists, 1966, 82, 385) concludes "...the industrial examiner can be reasonably confident that -

1. Any observer classed as normal will have normal colour vision or, at worst, be a very mild anamalous trichromat whose hue discrimination lies with the normal observer's range.
2. No observer classed as defective will have normal vision, and can therefore be fairly excluded from tasks where critical colour vision is essential.
3. All defectives classed as mild will be mild anamalous trichromats who, although incapable of critical colour discrimination, will be able to recognise colour-coded wires, to carry out volumetric analyses, etc.

Diagnoses of medium and strong defects, however, are quite unreliable and cannot be used to differentiate mild anamalous trichromats from dichromats, let alone from extreme anomalous trichromats; protan/deutan differentiation is also unreliable." -

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FARNSWORTH-MUNSELL 100-HUE TEST

Supplier: Tintometer Ltd

Waterloo Road

Salisbury

Wiltshire

Telephone: 0722 27242

The test consists of a series of 85 half-inch coloured discs forming a hue circle of constant brightness and saturation. The discs are arranged in four wooden trays, each covering a quarter of the hue circle.

Observers are required to arrange the discs in the correct order. This test provides a useful confirmatory test for an AO H-R-R diagnosis; it can also be usefully employed to assess the hue discrimination of an observer with normal colour vision. -

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D & H COLOUR RULE

Supplier: Tintometer Ltd

The Colour Rule is a slide rule with two 21-step painted colour scales of constant lightness, one from purple to green and the other from brown to blue. When used under a standard illumination (e.g. Artificial Daylight tubes) the position of an observer's match on the two scales gives a measure of the yellowness of the observer's vision (retina).

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ASSESSING OPERATIVE EFFECTIVENESS

The assessment falls into two fields of activity: -

checking work from operatives

checking work from examiners

Work from operatives is checked as outlined for levels of faults and seconds. Analysis of the records will indicate any operatives requiring special attention.

Similarly with work from examiners.

Graphs are suggested in which performance, under the appropriate heading, of each operative is recorded on the same scale for ready comparisons.

Action against an operative is not recommended unless the operative is consistently worse than the others.

It is generally advisable for the operative to see only his/her own graph. However, it may well be useful to foster a competitive spirit and for the operatives to compare their own individual performance with the average of the group, with that of good members of the group or with the target for the department, and to see the averages of the other groups.

Changes with the passing of time, in materials, processes, machines, lines etc., together with labour turn-over, will all cause changes in the situation. Thus there is a need to repeat these surveys periodically - say annually. The results of the repeats will indicate the optimum frequency.

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THE SUPERVISOR AND QUALITY CONTROL

Introduction

The supervisor has a major role in ensuring that the required quality of the product is being achieved. She will be unable to play that role if firstly, she is not aware of precisely what is required and the means of monitoring it, and secondly, is not convinced of the necessity for it.

Even if the above conditions are satisfied, her efforts will be inhibited if she is required to devote the greater part of her time to mundane roles such as that of a service girl, - albeit a highly paid one. In short, a supervisor must be encouraged and permitted to supervise.

As a result of systematic development the supervisor should, amongst other facets of supervision, be:

1. thoroughly familiar with the specification
2. .thoroughly familiar with and skilled in techniques of monitoring the consistency of the product
3. convinced of the necessity for the required quality

Given then, the ability to communicate, she can pass that conviction and knowledge on to her operatives and, by so doing lay the foundation for an overall improvement in workroom standards.

Cost of Poor Quality

A realistic approach to making the supervisor aware of the necessity for quality is to outline the cost of poor or inadequate quality. Such an approach may be based on:

2.1 Basic Cost of re-work

2.1.1 Cost of returning work

2.1.2 Cost of operative time

2.1.3 Cost of supervisors' time

2.1.4 Cost of re-inspection

2.2 Loss of production because of operatives repairing defective work.

2.3 Loss of production by a likely quality purge all round.

2.4 Late delivery because of rectification time.

2.5 Customer dissatisfaction with quality.

2.6 Cancellation of orders

2.7 Reduction of profit possibly evens a loss due to excessive rejects.

2.8 Any other points which may serve to emphasise the picture.

3. The function of the Q.C. Department

   It is advantageous if the supervisor spends a short period of training actually working in the Q.C. Department.

   During this period the supervisor should become fully conversant with the specification, how it was derived and the significance of each item contained therein.

   He or she should be taught sampling procedures and checks and should practice those checks.

   Faults should be taught in a systematic manner - a manner, which the supervisor can, in turn, employ when teaching trainees and retraining, experienced operatives.

   Such knowledge is vital, as knowledge is one of the many facets through which a supervisor gains respect, - and without respect a supervisor cannot function efficiently.

4. Checks on operatives by Supervision

   Supervisors should be aware of the quantity of each item to be checked to achieve a given level of confidence at any fault rate.

   In essence the chosen system should measure an operative's quality rating according to the percentage QK29 number of defects produced. This is measured daily or more often, as required, and the operative quality rating adjusted daily. The quality of performance of an operative today will determine how much of that operatives work will be inspected tomorrow.

   It is important that sampling is random - the aptitude of some operatives to attempt to "beat the system" is legendary. In the absence of a table of random numbers a pack of cards may be used to achieve the same end.

5. Faults

It is vital that all faults and defects likely to arise in the job should be taught to trainees and, where it has not already been done, to experience machinists. A machinist must be able to recognise faults for what they are and to take the appropriate action, e.g. to report, return, correct and, where possible, to prevent their recurrence.

Much duplication of effort is avoided if the faults likely to be encountered are categorised under one or other of two headings: -

1. General faults
2. Job faults

General faults are, for example, those resulting from machine or operative defects, which may be common to any garment in the workroom. They may include such as:

1. Skip stitches
2. Unbalanced seams
3. Careless handling faults
4. Seam breakaway
5. Incorrect tensions

Job faults are those which are specific to a given garment e.g.

1. Bad pattern match
2. Wrong measurement

6. Faults Analysis-

'Fault Analysis' is the name of a well tried technique in which all facets of each fault are recorded under appropriate headings. Together with an example or examples of each fault the analysis provides an invaluable teaching aid. The headings are indicated below with an explanation of each

a. Fault. - Enter here the name of the fault. The correct, or agreed name. This must be taught in order to ensure that everyone concerned refers to the fault by a common name.
b. Appearance. - Write a clear description of the fault, and/or attach an example of the fault. No one can take remedial action with a defect unless they can recognise the appearance or feel of the defect.
c. Cause(s). - List under this heading the main cause(s) of the faults. For example, "Incorrect machine setting", "Faulty cutting", "Contamination",

"Faulty measurements". Operatives will be better armed to identify faults if they are aware of what can cause them.

d. Effect(s). - The fault being analysed if not rectified will have certain effects. Describe what these effects or results will be. For example, "Fabric will be scrap", "Garment will be a reject or second", "Loss of earnings". Operatives need to be taught the effect of faulty work.
e. Responsibility. - Record under this heading who is directly responsible for the fault. Operatives need to be aware of which defects are their own fault and which are the faults of others. This discourages the passing on of blame, and at the same time avoids blaming unfairly. Basically it is not a question of apportioning blame but we do need to know where the responsibility for a fault lies in order that corrective action may be taken
f. Action. - List the action or actions to be taken when the fault is found. For example, "Reject", "Unpick and re-sew", "Report to the Supervisor", "Call the mechanic", or whatever. Each and every operator must know what action they personally are to take, and the right action is vital.
g. Prevention. - At times faults will occur over which no one has control, in other words there is no prevention. However if there is, record any action, which can, or should be taken to avoid a recurrence of the fault. For example, "Inspect needles frequently", "Check tension and stitching every fifth garment", "Ensure edges match before sewing". Prevention where it is possible is invariably better than cure.

It can be seen from such a chart or card that if all this information is properly recorded there is nothing else anyone will need to know about a fault or defect. You have equipped yourself with a comprehensive record of everything that needs to be known and the information can now be suitably applied in your teaching of operatives, the chart forming the basis of any notes you need. A completed example is shown

6. Collecting Examples of Faults

Collect an example or examples of all faults which an operative must know in order to be classed as competent, analyse them and record the information which is then used for teaching purposes. In almost all cases the faults which are of most importance are the borderline examples. Even new workers will recognise obvious faults. The critical faults are those where it is difficult to decide what will just pass and what will just not pass. In essence the sort of faults which cause people to resort to opinion instead of facts.

It is prudent to keep several well labelled examples of the faults for both comparison and for teaching purposes. Examples which the Instructor and management have reached an agreement on. In this way operatives can usually check when in doubt and by comparison make the right decision regarding acceptability. At the same time such examples may also be employed for teaching purposes.

7. Mounting examples

   Generally, examples will be handled by many trainees and will, unless suitably mounted and protected, deteriorate very rapidly. Fabric samples could be mounted flat on a background of stiff card. The whole of this would then be sealed in a cellophane or clear envelope, thus enabling them to be handled almost indefinitely without detriment. An alternative would be "swing-out" FACERAP cards mounted on a wall, with the actual fault example being mounted under the "Appearance" heading. For protection and convenience they could be enclosed in a cabinet.

8. Storage of Examples

   Fabric faults in envelopes may be conveniently stored in filing cabinets, drawers, or boxes of suitable depth, with the related FACERAP card being clipped.

   Careful storage will cut down the tedious non-productive effort of constantly replacing examples.

9. Suggested Teaching Method

This should be carried out by means of knowledge lessons and some suggestions regarding time and how to organise the Development, or main part of the lesson, are given below.

a. Limit the session to 30 minutes. This will involve a limitation of the number of faults dependent on their complexity.
b. Have a card for each fault, showing a complete analysis.
c. Show the example of each fault and discuss the cause, how to recognise it, and explain whatever action by the operative is appropriate.
d. Place examples of faults around the room, shuffle the analysis cards, and then get the trainees to place the cards against the appropriate examples.
e. Alternatively, issue trainees with blank FACERAP cards, show the fault, and then ask the trainee to complete the cards.

Then compare the trainees' completed cards with the master card and discuss as at c) above.

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6. Summary

Good quality products or processes can only be produced by the operatives, that is the Spinner, the Winder, the Knitter, the Dyer, the Finisher, the Cutter, the Machinist, the Presser or those who fold and pack, no one else. They cannot produce quality without being fully aware of what exactly is required. Responsibility for the production of good quality lies with, and is in the hands of, the person teaching the job, primarily by good communication, by making the newcomer aware of specifications and tolerances, faults themselves, their effect and the appropriate action to take.

Such communication or training if properly planned and executed will greatly assist in minimising the cost of poor quality. The operatives will know from the start what is required, and equally important be able to spot trouble before it gets out of hand and know how to handle it. It will also help to avoid the painful scenes of huge piles of sub-standard work being returned for rectification, which more often than not are due to a lamentable lack of positive communication. Only in this way will quality be controlled, costs remain at an acceptable level and customers be satisfied.

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<u>WEAR TESTING</u>

It is unreasonable of management to expect the textile technologist to be an expert in predicting consumer acceptance and satisfaction of what in reality may be a totally new product.

The physical test procedures, which the technologist has at his disposal, may have been developed to a great extent to measure the performance of relatively uncomplicated fabric structures and thus may not be entirely suited to the new product.

Wear trials are a relatively recent innovation in textiles. They are complimentary to laboratory physical tests and, in themselves possess both advantages and disadvantages.

The serviceability of a specific fabric can be determined effectively and accurately by wear testing, and wear testing has indicated that fabric serviceability is often a function of specific end use.

Garments, which have been wear tested, are extremely effective tools for convincing merchandisers of the advisability of careful end use selection. A fabric or garment construction, which is completely satisfactory in adult wear, may be disastrous in children's wear.

Conversely, the same high level of strength or resistance to abrasion for ladies' dress fabrics as for children's play clothes can result in unnecessarily high costs.

A standard which is too low can ruin a manufacturer's reputation. One, which is too high, can so limit the stylist/designer/producer/manufacturer as to make it impractical even to attempt to do business, or it can result in unrealistic costs for fabric, threads, linings, etc.

Wear testing can highlight shortcomings in some physical test methods and may promote additional confidence in others. It is, in fact, an objective of wear testing to develop physical test methods which can be correlated to end use and which can be applied quicker and in many instances more cheaply in decision making processes than full scale wear testing.

A very real advantage arising from wear testing is the ability to determine what care instructions should be given to result in the greatest consumer satisfaction.

A disadvantage of wear testing is that it is very slow and cannot be used for making day to day decisions. However, for long range decisions it might prove invaluable.

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Setting up the trial

Wearer trials must be very carefully planned or completely erroneous results may arise.

Through careful experimental design the number of wear test specimens included in any wear test can be minimised. Using a technique involving a series of incomplete randomised blocks and outlined by Davies in -Industrial Experimental Design- it is possible to keep the number of wearers to a comparatively low figure, possibly within the same department or work group. This can improve control over the wear test itself since the technologist i.e. the test is able to pick up the soiled garments and return the washed garments for the next wearing.

Experience indicates that washing and record keeping is best kept under the control of laboratory personnel since the wear test subjects sometimes forget to keep records or tend to wear one garment to the exclusion of another.

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Summary

The object(s) of the trial must be clearly defined.

All participants in the trial must be properly briefed and provided with clear and unambiguous written instructions.

All the factors to be investigated must be covered in the one trial. Extensions after the initial investigation and using the same samples do not provide reliable results.

Washing should be done under carefully controlled conditions, preferably all the garments receiving the same washing treatment to be washed as one load.

Do not lose sight of the fact that some of the properties can be ascertained quickly and relatively free from subjective variations by means of carefully selected and properly set up laboratory tests.

Owen L Davies, Design and Analysis of Industrial Experiments pp 229-235P

AUDIT INSPECTION

Before handling, each product is checked for packing and presentation, and is then examined as suggested below.

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Example Products

a. Knitwear

i. Open out on the table, pat gently flat, and measure, without distortion, at the stipulated measuring points in the size chart diagram, and check the major dimensions against the size chart and that they are within the tolerances given. Major dimensions are:-

back length

sleeve length (left and right equal)

neck width

chest or under arm width

bottom or waist width

cuff width

ii. Put on a model (dummy or person) and check make-up as follows:-

fit

balance of left and right parts, hang,

location of pockets, collar points, neck "V" mitres and fastenings etc.

neatness of collar edges

matching of panel edges at waist and cuff, of patterning and of buttons and buttonholes tightness and strength of the welts. I

iii. Scrutinise on the table for:

yarn and fabric faults

seaming faults and seam stretch, finishing of seams

stains

dirt

shade and shading between garment parts

trims, zips, plackets are correctly inserted, are of correct shade and that zips work.

a. Socks and half hose

i. Place on the appropriate specified form or board in the correct manner, i.e. firmly but without undue distortion, "tweak", (i.e. pull sharply a little way and immediately release) the toe and heel turn, check if they lie at the correct position. Check "equality" of each sock in the pair.

Measure the leg and "rib" or top depths. Check against the specification using the tolerances given. Again check "equality".

ii. Remove and:

Check the extension (max.) and "pull" of the tops, check the recovery from extension, immediately and after the stipulated time interval.

iii. Scrutinise on the table -and- on the form or board for:

yarn and knitting (fabric, welts, elastic, heel and toe pouches) faults

toe closing - seam finishing and smoothness

stains, dirt and dye marks

shade of ground and patterning equality in the pair

a. Underwear

i. Open out on the table, pat flat gently and measure, without distortion at the stipulated measuring points in the size chart diagram, and check that major dimensions are within tolerances.

   Major dimensions suggested:

   <u>Vests Pants</u>

   Length bottom to shoulder Depth crotch to waist

   Depth of front and back scoops Depth of side seam

   Bottom width or waist Waist or hip width

ii. Examine make up:

   correct stitch types used

   correct binding etc. used

   evenness of waist band, welt and binding

   firmness of elastication.

iii. Scrutinise for:

yarn and fabric faults

scouring faults and seam stretch and finishing of elastic sewing

stains and dye marks

dirt

shade and shading between panels and trims or binding fastenings - plackets, button and holes, zips, studs etc. - correct insertion, colour, working etc. -

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<u>Recording results - any product</u>

For both New Line and the weekly Routine Audits two types of records are required, - General Fault and Specific Fault Records.

a. <u>General Fault Record</u>

This enables the faults detected to be analysed in the main production areas to establish rapid feedback and remedial action.

Faults observed are noted as strokes entered in the appropriate column, and are totalled up by the "5 barred gate" process.

The separate totals, and the Gross Total Faults, divided by the number of garments give the respective fault rates for this record.

Priority areas become immediately apparent and follow-up inspections become a necessary consequence in the production departments, and in the successive routine audits using the Specific Fault Record Sheets, if considered necessary.

These breakdowns a particular or specific fault type for further analysis if a particular fault type has a high incidence (e.g. constituting 25% or more of the total faults).

b. <u>Specific Fault Record</u>

These records cannot be planned in advance and depend on the fault types discovered. They will permit further breakdown of any particular fault type.

This will make reporting and feedback more specific. The records will vary with time. -

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<u>Reporting Results as a basis for remedial action</u>

An effective Report must be concise, well laid out, and the critical features highlighted. It is the basis on which management will implement remedial action.

a. <u>Routine Weekly Audit Report</u>

The total fault rate is compared with the costed and with previous routine audit results.

Any discrepancy discovered is checked to establish which type or types of fault are mainly responsible or if any particular section of machines or stage of production is a source. Discrepancies are also checked against any change in the product or production situation.

If it proves impossible to trace work back to source, this fact must be noted.

b. <u>New Line Audit Report</u>

The total fault rate is compared with recent results from an Audit of the nearest similar line.

Any discrepancy discovered is checked to establish what is the source of the problem, e.g. what production stage is the source, whether materials, process or skills appear to be inadequate, whether all section or machines engaged on the particular process are involved or only certain ones.

c. <u>Feed-back of these reports to Production Management</u>

Consideration must be given at the highest level to whom this Report is given.

It is suggested that the weekly report is sent to:

Chief Executive

Production Director

Factory Manager

Q.C./Technical Manager

These people should then ensure that remedial action is taken.

d. <u>Monthly Audit Report</u>

Every fourth working week a statement should be prepared covering the following.

1. Tabulated fault position on the last week of the previous month
2. Tabulated fault position on last week
3. Action taken (with reasons if not obvious)
4. Explanation if improvement is not achieved by this action
5. Suggested further action (if needed)

The results of this Report should be reviewed at Board level.

a. <u>Continuity Record</u>

A further type of record sheet is the Continuity graph. This is invaluable for presenting information collected over a period, and also to highlight any adverse trends. These present the information in an easily understood pictorial form.

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CONTROL OF QUALITY IN GARMENT ASSEMBLY

1. Components of an Effective System

The requirements of an effective system are:

i. Specification - i.e. that parts of the total specification which is required by the making-up supervisor.
ii. Monitoring of
    a. the product to ensure conformity with the specification
    b. the machinists to determine where non-compliance with the specification arises.

i. Collection of data - from supervisor's sample checks. Analysis of data.
ii. Corrective action
    a. short term- fault correction
    b. long term - fault prevention

1. Garment check by Supervisor

The sample of garments checked by the Supervisor must be representative of the total production.

Sample size is a function of the fault rate and the degree of confidence required. Typically, at a confidence level of 95% and a fault rate of around 5% the sample size would be 54 dozen or 648 garments. In the case of a complex garment this would almost certainly absorb a disproportionate amount of the supervisor's time - bearing in mind her other duties.

The solution is firstly to concentrate the check on the less dependable and skilled machinists, checking the others mainly at a major change, such as a change of style.

Secondly, by checking those critical faults which are currently at an unacceptable level or are showing an upward trend.

By this procedure a sample of meaningful size can be take in the critical areas.

i. Where it is not possible to take the optimum sample, bear in mind the square-law, i.e. that a four garment, sample is 4x4=16 times better than 1 garment, and eight garment sample is 8x8=64 times better than a single garment and so on.
ii. The sample should be truly random i.e. of a number of garments, which have passed through a given operation each one, should have an equal chance of being selected. Checking a given machinist at precisely the same times each day will not produce a meaningful sample.

1. <u>Data Service for action by Supervisor</u>

   Data arising from final examination is invaluable to the sewing room supervisor. Typically findings are recorded on a chart as shown below and the rate for each fault calculated.

   <u>Examiner Fault Record</u>

   diagram

   Comparisons of any given fault on successive recording sheets indicate the level of that fault together with any trends. It is perhaps most meaningful to many people if these results are presented in the "trend-graph" form illustrated,

   <u>EXAMPLE CONTINUITY GRAPH</u>

   diagram

   It is not suggested that each supervisor should graph her own inspection results in the same manner, but some do, as a personal check. Its form should approximate to the graph from final examination.

2. <u>Corrective action by Supervisor</u>

   Short-term action involves fault correction through the normal process of supervisory communication and line instruction.

   The long term is concerned with fault prevention, which again is a training function. The competent machinist should be sufficiently knowledgeable to recognise faults in her raw materials, appreciate when her machine is not perfect and, within reason, take action to correct it and recognise and take the appropriate action to correct shortcomings in her own workmanship.

Paramount amongst the requirements is fault knowledge (what to look for); as without it there can be no recognition. Well proven as a means of teaching faults is the "FACERAP" system. FACERAP is an acronym for Fault (name), Appearance, Cause, Effect, Responsibility, Action and Prevention under which heading faults are analysed as shown below, one card per fault:

diagram

Usually an example of the fault is filed in conjunction with the analysis card. Where tolerances exist, and judgement is subjective, "marginal pass" and "marginal fail" examples may also be attached. This system lends itself to a variety of imaginative ways of teaching.

3. <u>Example Supervisor's Check List-</u>

<u>PROCESS CONTROL SLIP 3 & SLIP 4</u>

<u>1st CROTCH</u> Check stitch tensions and stretches before starting work morning and afternoon. Also check 1/12 beginning, 1/12 middle and 1/12 end of each trolley for needle damage.

<u>2nd CROTCH</u> Check stitch tension and stretch before starting work morning and afternoon. Also check 1/12 beginning, 1/12 middle and 1/12 end of each trolley for needle damage.

<u>SIDE SEAM</u> Check stitch tension before starting work morning and afternoon. Check 1/12 beginning, 1/12 middle and 1/12 end of each trolley for needle damage.

<u>LEG ATTACH</u> Check stitch tension and stretch before starting work morning and afternoon. Also check 1/12 elastic in each bundle for size.

<u>WAIST ATTACH</u> Check stitch tension and stretch before starting work morning and afternoon. Also check 1/12 elastic in each bundle for size.

<u>COVER SEAM</u> Check stitch tension for cracking that guide is in correct position and make sure condenser is working correctly.

<u>ALL OPERATIONS</u> On all operations a regular quality check should be done by operative on 1/12 at the start, middle and finish of every trolley. Before starting work morning and afternoon on all operations a sewing check must be done twice daily on a piece of waste material which will be supplied by your supervisor and collected and checked by her morning and afternoon.

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ACTION TO BE Any problems that arise must be brought to the

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TAKEN attention of your Supervisor immediately.

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THE COST OF DIRT

Surveys conducted indicate that dirt; marks and stains cause the loss of several million pounds a year in the apparel section of the British Textile Industry alone. If this were prevented, we would receive a bonus. This means an increase in productivity with no outlay in materials whatever.

Increased care and trouble costs money, and taken to extremes could reduce productivity. Yet to allow goods to become spoilt just by dirt with consequent trouble in cleaning, reprocessing or down-grading, is just stupid.

1. To strike the right balances the following five areas have been found to be worthy of study. By taking care continuously as a philosophy, stains, dirt etc. drop phenomenally, - with little or no outlay at all. - This should be exploited to the full by everyone.
2. The methods of handling and stacking goods, - from yarn to finished articles - should be considered. For instance, quite simple considerations will avoid the carelessness that leads to spillage on to the floor, or overhangs to wipe the sides of walls or machines or swarf from hoist gates.
3. Examine ways of protecting goods, which are standing. What are the main types of dirt and stains occurring. Trace the more obvious causes and attack these. There are various possibilities including:

    a. cleanable plastic covers or bags
    b. disposable covers or bags
    c. storage bins of -planned- shape and size for ease of handling and storage, and to get the best use of their capacity by fitting the goods to be contained. Plastic or fibre-board containers are rugged, and have often met the need.

1. All goods standing should be checked to see if any are remaining over-long, and if so, whether ways can be planned to reduce this. It is likely to be extremely difficult in practice to succeed significantly in this area, but even so, if successful only on 10% of occasions, is still going to be worthwhile.

   Clutter must be avoided -all- the time. It is necessary to cultivate a discipline of regularly saying "why is this here?" If there is no good reason, then remove it to the best place - even if this is to salvage, because space is valuable. This discipline, once cultivated, becomes automatic. It is not generally realised how clutter slows down every activity because of confusion, of losing things and being involved in more handling and movement than is really necessary.

2. Personal cleanliness always pays off. Whatever the operation or activity, some thought can usually reduce the degree of dirt on the hands or overalls with consequent less risk of contaminating goods, whether yarn, fabric or finished articles. -

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COMMENT

Management of progressive firms will always consider thoughtful and constructive suggestions, - from all levels of personnel. However, it may not be practical to implement every suggestion, perhaps for economic reasons.

The whole point of the economics of cleanliness is that, whilst it could be dangerously impractical to go to extreme lengths, every survey has shown that if -all- personnel will examine all their activities, a little extra time and trouble reduce soiling dramatically with consequent savings in seconds and the cost of recovery. It provides an excellent return on the effort involved. In fact experience again teaches that the greatest single factor involved is the attitude to dirt of all personnel.

Once orderliness and cleanliness has been established, any deviation is immediately apparent, and thus a state of order becomes far easier to maintain.

Most people will add to a pile of rubbish, but few will start one.