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PRODUCTION, QUALITY AND PROCESS CONTROL IN FOOTWEAR UNITS [1/]

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INTRODUCTION

The footwear industry is a fashion industry using mainly naturally occurring raw materials. The unpredictability of the former and the variability of the latter are factors which bedevil all functions within the industry - from the Buyer to the Closing Room Operative; from the Market Research Manager to the Cutter; and the functions of Quality Control, Process Control and Production Control are in constant battle to salvage some order out of the chaos.

No paper of this length can do other than attempt to do justice to any of the latter three functions, but it is possible to illustrate a basic philosophy and to highlight those foundations upon which a degree of logical control can be built. Illustrations from the writers own experiences are used merely to indicate one type of structure that uses such basic foundations. It is to be hoped that the paper will indicate that the structure can be adapted to suit the size and requirements of any production unit, but that the fundamental requirements remain the same.

Meaningful definition is the first problem encountered by the would-be speaker. The definitions of Quality in itself are many - varying from the pompous to the facile - but in this paper Quality is defined as meaning those factors in a product which fit it for the purpose for which it is intended or required. Quality Control, therefore, is a system whereby production is subject to systematic examination in order to maintain those factors within certain prescribed tolerance.

In the shoe industry this is too often seen as an inspection of purely visual attributes. This quite illogically assumes that "beauty is only skin deep", whereas the very definition of

Quality used above indicates a functional (and frequently non-visual) aspect. It is this aspect of Quality which is served by Process Control, and this paper promotes the claims of Process Control as the equal partner of Quality Control in the maintenance of a Quality Policy.

The link between Production Control and Quality is perhaps a little less easy to see at first glance. However, the best use of resources is by even loading and experience has shown that quality levels are affected by uneveness in production - quite apart from the fact that any Quality Control scheme has to take into account the loading on Quality Control resources.

In the text of this paper, all three functions are examined together with a consideration of Management and Supervisory responsibility. Emphasis will be placed on the interaction between the functions as the writer believes that Quality must be approached as a "total" concept involving all those engaged in the industry, whether their particular interests lie in production or administration. To say that Quality is the responsibility of the Quality Controller is to reject the true concept of Quality.

I. QUALITY CONTROL

Quality is controlled by action following feedback or interchange of quality information, This information and action form a continuous cycle which is common to all industries.

The degree of control exercised over quality depends on the accuracy of the quality information. The efficiency with which it is communicated and the effectiveness of the ensuing action.

It will be shown that the control of quality is everybody's business, from Designer to Packer; from Factory Manager to operative. Whether or not there is a need for a separate Quality Control Department, and how big that department should be, depends on the size and complexity of obtaining and communicating quality information, and also the total quality costs involved. However, regardless of the existence or non-existence of a specific department, the level of quality produced will depend on the technical competence of the management team in taking correct action.

The problem areas.

Problems in quality control are associated with four main areas: DESIGN, MATERIALS, PRODUCTION and PERFORMANCE. In broad definition, a DESIGN is produced to satisfy a demand at a certain price. The details are based partly on anticipated customers requirement, partly on experience of production capabilities and partly on customer reaction and complaints of similar designs in the past. MATERIALS and components are chosen because of their suitability for the particular design and also for their ability to fit into the particular construction. PRODUCTION has the responsibility of assembling the particular components into the design within predetermined quality standards. Finally, PERFORMANCE must be such as to ensure customer satisfaction regarding fitness for purpose.

Each problem area should represent a quality data centre from which and to which information flows from other areas to enable a constant monitoring of quality enabling corrective action where necessary. It is advantageous to consider each of these quality data areas in turn.

A. The Quality of Design.

The Designer, in order to play his part in overall quality, must have three inter-related objectives:

a) Produce a design which will sell and give satisfaction to the customer.

b) Design the shoe to give minimum production difficulties.

c) Produce complete specifications which define the design thus enabling correct buying and manufacture.

A. 1. Design Evaluation - Customer Requirements.

a) Styling is evaluated by Marketing and Sales specialists at Stock Committees and Sales Conferences.

b) Fitting is evaluated by fitting feet and dynamically in wear tests.

c) Durability is evaluated by Wear Test and by historical data of similar materials and/or constructions.

A. 2. Design Evaluation - Production Requirements.

a) Pathfinder tests - a small batch put through factory processes for supervisory comment on production difficulties. (These can then be tackled before bulk.)

b) Use of production data of jobs, recuts and production problems on similar styles or constructions.

A. 3. Specifications.

a) Shoe Specification - comprising a complete list of properly evaluated materials and components, plus correct patterns correctly graded to cover the size and fitting range.

b) Material Specification - comprising statements of physical and/or chemical requirements which must be met before the material is suitable for use.

c) Component Specification - comprising detail of material plus dimensional tolerances such that the component will "fit-up" satisfactorily and prove acceptable in wear.

B. The Quality of Materials and Components.

a) Specifications - The Supplier must be informed exactly what he is required to supply by detailed material and component specifications.

If possible this should be backed by liaison between technical personnel on both sides, so that the Supplier has a clear idea of the use and pressures that his material will be subject to, and thus can judge what effect his actions can have.

b) Goods Inward Inspection - Inspection of incoming supplies is essential to prevent production problems and to inform the supplier quickly when his product is failing to meet specification.

This inspection can range from random but systematic inspection of components by floor supervision, to sophisticated statistical sampling by a Quality Checker, dependent on the seriousness to meet specification. Normally this is associated with a "failure" clause in the buying contract which allows for the Supplier to bear the cost of (a) Sorting, if the reject level is above an agreed figure, or, (b) Return, if the reject level is at a higher agreed figure.

C. The Quality of Manufacture.

The foregoing has emphasised the contribution of the Designer, the Product Engineer and the Buyer to creating the conditions where a good quality product becomes a possibility.

However, despite this contribution and despite the introduction of many mechanical aids to production, the transformation of materials and components into finished shoes depends ultimately upon the correct and consistent application of operator skill.

This section will discuss:-

C.1. The contribution of "Service" Departments towards creating conditions wherein the operator may apply his skills.

C.2. The contribution of Supervision.

C.3. The use of Internal Quality Cost and Quality Analysis information.

C.4. Visual and Functional Quality Standards.

C.5. Process Control.

C. 1. Service Departments.

a) Work Study - The contribution of Work Study in setting equitable payment rates and in being highly self-critical when advocating reductions in cost which may have repercussions on quality cannot be over emphasised.

b) Factory Layout - Efficient application of skill depends on personal control by supervision. This control can only be effectively applied if every unit is of such a size that it can be controlled by one supervisor (i.e. not shared by two or more) and if each unit produces a recognisable end product identifiable with and by the supervisor.

c) Method Development - This Department should be involved with developing methods and mechanical aids, not only to reduce cost, but also to give operators the maximum opportunity of achieving the required quality standard. Stitching guides would be a good example.

d) Technical Services - Supply back-up skills in materials methods and processes to assist in the solution of technical production problems which are beyond the capabilities of production supervisors.

e) Production Control and/or Planning - Consider the production capabilities of the factory in detail as well as the requirements of stock holdings when planning work.

It is essential there is close co-operation between the Production Controller and Line Supervision in laying down medium and long-term production requirements to give the Supervisor maximum opportunity to adjust the short term production requirements to give maximum line balance.

The degree of line balance is one of the most significant factors affecting quality. In this respect the role of Production Control is dealt with only briefly at this stage - a more detailed consideration is given later.

f) Factory Engineer - There is no need to emphasise the importance of the service given by the Factory Engineer in repairing and maintaining all machinery and equipment in good working order.

g) Quality Control - The Head of Quality Control has the overall aim of influencing the production of optimum quality at minimum Total Quality Costs. To achieve these aims, he uses Quality Cost and Quality Analysis information to influence Management and Supervision to improve quality in the way that the Accountant uses Cost information to influence Management to improve profitability.

He acts as co-ordinator in the exchange of information in the Quality data areas and prompts action whenever these areas are weak or ineffective. He promotes efficient Final Passing and supplies a service of inspection and quality checking if needed.

C. 2. Production Supervision.

Whether or not assistance is available from the Services, the contribution of Supervision occurs in these stages:

a) The first and most important is to activate the operators to apply the skill they have consistently. Each supervisor will have his own way of doing this, but it will always involve systematic inspection of each operators work - using the inspection to educate the operators to an understanding of the standard of workmanship he expects, and using praise, assistance and discipline to achieve results.

b) Use Quality Cost and Quality Analysis information to distinguish between operator and management controlled problems and to use either his own ingenuity, or services available to supply solutions to the problems.

c) Take action to apply such solutions successfully. If he cannot do this due to time involved, specialised technical nature of the solution, or for any other valid reason, he should bring pressure to bear on those who can take the required action.

d) Ensure the efficient selection and training of new operatives, and to correct (by removal, replacement or retraining) those operatives shown to have insufficient skill.

C. 3. Quality Costs and Analysis.

One reason for the control of quality being one of the most difficult tasks of supervision is the intangible nature of "quality". Quality is never perfect, only "good" or "bad". But how good, and how bad? And how good is good enough?

It is quite natural when supervision is chasing the impossible "perfect" quality, and at the same time, achieveable and tangible output and cost targets, that they will concentrate more on the more meaningful targets.

It is important therefore to be able to measure quality and to set achieveable targets in terms of these measurements.

a) Internal Quality Costs.
When sub-standard work is produced it appears internally as a direct loss, either a loss on a pair of "jobs" or as the cost of re-cutting or repairing. These losses are defined as Internal Quality Cost incurred by each Supervisor in the past, and from this information establish targets for the future. If current costs are then fed back to the Supervisor daily against his target he can use them to identify his quality problems in the same way as he uses his non-productive labour costs to identify production problems.

b) Quality Analysis.
Quality cost information should be backed by analysis of the causes and this will give supervision more direct guidance as to their main long run quality problems.
(Pareto's Law applies - the majority of costs will be seen to be incurred by the minority of causes.

In other words, a limited number of causes will be identified as the source of major quality costs, therefore identifying the priorities which should be applied in taking corrective action.)

C. 4. Quality - Visual and Functional Standards.

Reference has been made to good and poor quality. This classification is made relative to a standard of acceptability which is itself partly visual and partly functional. In this section the setting and maintenance of such standards will be discussed.

a) The Visual Quality Standard.
The visual standard of acceptability is that used by the Final Passer when making Accept/Reject decisions. It is based among other things on aesthetic appeal, symmetry, cleanliness, shade of colour, freedom from damage and freedom from visual constructional defects. As such it is, of course, impossible to define verbally.

Fundamentally it is a conception in the mind of the observer, backed up by a limited number of dimensions and comparison with standard reference shoes.

Setting and maintaining this standard in the minds of passers as a criterion of acceptance and supervision as an aim in production is fundamentally important to the control of quality.

The standard must be set originally by Factory Management, who can best do this by making decisions on the acceptance or non-acceptance of pairs of shoes.

Maintenance can be assisted by routine systems, such as:

(i) The 11 o'clock Check: A small number of completed and boxed shoes from the day's production are taken at random, laid out and reviewed by senior factory staff at the same time every morning.
The object of the review is mainly to determine whether visual quality standards are being maintained and to refresh Management's mind as to that level of quality.

(ii) Boxed Work Check: A number of tickets of completed work are randomly selected and inspected by a Quality Checker. Faulty pairs are identified for subsequent review by the Factory Superintendent, or a person deputised by him.

During this review, decisions are made by the reviewer as to the seriousness of faults, i.e. a Grade A fault is an irreparable and unacceptable fault; A Grade B fault is repairable; and a Grade C fault is minor and acceptable. (It will be seen that Grade A and B faults result in a direct quality cost). Again, this review assists in defining the borderline of acceptance.

The results of this check give a numerical estimate of the level of outgoing quality (in terms of Fraction Defective) against the Quality Standard.

N.B. If the visual and functional standard of the end product is to be maintained it is necessary to hold visual standard of acceptance at each operation. This acceptance standard must be confirmed by each operator before passing work on to the next operation. One of the tasks of line supervision is to ensure that each operator understands the acceptance level of workmanship under each heading of the Quality Standard.

b) The Functional Standard.

The visual condition of shoes, e. g. satisfying the Visual Quality Standard will influence the first sale to a customer.

The functional performance - fitness for purpose over a reasonable period of wear - will influence the sale of the second and subsequent pairs.

Functional standards may be established by physical tests on the finished shoe and by wear test. An example of the former is bond testing.

In the Direct Stuck construction, the most common failure in performance is that of sole adhesion. The level of sole adhesion can be measured quite simply - by apparatus such as the SATRA Toe Tester, by cutting test pieces out of jobbed shoes, or, in the simplest form, by simply tearing back the sole. In practice this very simple test not only produces information on the level of bond, but is also used to identify those processes involved in sole bond which have gone out of control.

Wear Testing is an obvious method of identifying Functional Quality standards, but it is a method beset by pitfalls for the unwary. It is a "model" of the wear which we expect our footwear to undergo in actual use and must be planned to reproduce these variables as far as possible - i.e. the wearers should not be factory management, but hard wearers who use the footwear in all sorts of conditions. Only then can a reasonable extrapolation of results represent what we can reasonably expect of our product in wear.

Such a test results in decisions of acceptance or non-acceptance against an implied functional standard, and it is a prime requirement that this standard should be stated as precisely as possible. For example the functional standard could be stated thus:
No more than 'x'% of shoes will be below the standard acceptable as a Worn Return after 'y' weeks wear by an average wearer.
Obviously 'x' and 'y' will vary dependent upon the type of shoe, its price and the market it is intended to serve.

C. 5. Process Control.

As fundamental to meeting functional standards as normal aspects of Quality Control are to meeting visual standards, Process Control specifies parameters of time, temperature, pressure, method, etc. dictated by the technical requirements of individual processes and infers a system of regular checking against those parameters.

More detail of a typical Process Control approach is given later in the text of this paper. At this stage it is only necessary to identify Process Control as an integral part of Quality in Manufacture.

5. The Quality of Performance.

The object of analysing returns is to identify principal causes and to take corrective action.

Three types of returns must be considered:

a) Those which were anticipated by information feed back from functional standards or Process Control.

b) Those which were not anticipated or which occurred at a much higher frequency than anticipated.

c) Those which were anticipated, but did not occur or which occurred at a much lower frequency than anticipated.

Returns occurring under the first heading should, if Quality Control communication is effective, already have had corrective action considered or applied.

Returns occurring under the second heading suggest either that there is a loophole in Final Passing, the control of technical processes, the techniques of arriving at functional standards, or that the standards set are too low. This implies three types of corrective action, i.e. remove the cause in production; add to the inspection; or raise the standard.

Returns occurring under the third heading suggest either that corrective action is being taken by somebody else (retailer or consumer) or that the standards applied are too high.

D. 1. Review of Worn Returns Data.

In order to make sense of the very complex information resulting from the analysis of returns it is necessary to review them in at least three ways:

a) Short Term - Examine for high frequency of individual faults on a weekly basis, looking mainly for unanticipated returns which require 'crash' corrective action.

b) Long Term, Analysed against Faults - Examine monthly against moving six monthly average of faults for all styles combined to identify long run problems related to overall production methods and to detect changes as a result of action in the past.

c) Long Term, Fault Analysis for each Style - Examine monthly against longer term analyses of faults by individual styles to determine whether corrective action should be applied to, or has been effective on, styles rather than production processes.

D. 2. Main Groups of Returns.

The main causes of the two broad groups of returns, Worn and Unworn, should be defined.

a) Worn Returns - Occur as a result of functional failures not normally visible at final passing, and therefore cannot be reduced significantly by improved final passing. They are usually caused by the use of sub-standard materials or components, lack of control over technical processes, or by inherent faults in design.

b) Unworn Returns. The vast majority of unworn returns occur as a direct result of inefficient final passing and therefore can be reduced by improving that function.

However, it must be emphasised that unworn returns occur because of poor final passing, they are not caused by poor final passing. They are caused by the same factors as Worn Returns - materials, processes, design, etc.

Therefore, although they can be reduced by improving final passing, it is still necessary to identify and take action on the real cause.

II. PROCESS CONTROL.

One characteristic of variation in the functional standard of shoes is that they are unlikely to be visible at Final Passing and thus, if Final Passing is the only check, they are likely to go unidentified. Under these circumstances control can only be exercised by controlling the processes which have been developed to ensure a satisfactory product.

Control is established in three stages:

A. Identifying control areas.

B. Specification of materials, machines, machine settings, and methods involved in the process.

C. Setting up systematic checks against specification to ensure compliance.

A. Identifying Control Areas.

In order to concentrate resources on those processes which will most benefit quality it is normal to identify by analysis of returns, historical evidence of reject shoes, or evidence of production problems. Such processes may be single (such as heat setting) or multiple (such as sole bonding). These processes, then, are selected in consultation with factory management and may indeed differ from factory to factory dependent on type of product.

B. The Process Specification.

The next stage is to draw up a clear technical specification for the selected process, normally under the following headings:

a) Materials and equipment

b) Method

c) Special Requirements

d) Operating checks

e) Supervisor responsibility.

Every aspect of the Specification is discussed with floor supervision, both to add to his understanding of technical constraints, and to ensure that the final draft is workable.

Handling methods are only specified where particular sequences are necessary to meet basic technical requirements (this also aids Work Study in setting up standard methods.)

Every specification relative to a specific production unit is numbered and filed. The file is issued to line supervisors and is their reference book on any question of method.

C. Process Control Monitoring.

The "Operating Checks" item from each specification of a production unit is listed separately, and that list represents the total check cycle for the unit. Frequency of checking for each item on that list is then established on a basis of (a) the likelihood of a single parameter drifting out of control; (b) the priority placed on the operation; and, (c) the time available to the Process Checker. This will result in a combined Check and Frequency List - effectively a Job Description for the Process Checker.

The Supervisor is then issued with a file summarising what checks should be carried out on his line and the standards (with tolerances) which Process Specification lay down. Each day the Process Checker completes his cycle of work he inserts a check sheet into that file identifying any fault in process, and it is the Supervisor's responsibility to take action on that fault.

At the end of each week a Process Control Meeting is held between Factory Manager, Line Supervisors and the Quality Controller (who is responsible for Process Control checking) to discuss action taken.

All this adds up to the Supervisor knowing what he is doing, why he is doing it, and whether it is being done properly. Note that, as with Quality Control, Process Control data is fed to the supervisor. It is his job to take the necessary action.

II. PRODUCTION CONTROL.

Reference was made earlier to the part played by Production Control in the quality of manufacture, and it may be opportune at this time to consider the need for, and general organisation of Production Control.

A. Market Requirement.

The market requirement is seasonal and subject to fashion changes. Selling to retailers starts by Salesmen taking orders for the new range four months or so before the season of selling in the shops begins - delivery being agreed for a date which will allow change of stock in the shop in time for public demand for the new range. These advance orders for new styles are known as "forward orders".

A service is also provided for replenishing the shop stocks through the season, retailers being able to order for delivery "by return". These orders are known as "instock" orders".

Despatches from the warehouse over a season therefore tend to "cycle", i.e. high volume in the early months, falling to comparatively low volume in the later months of the season.

B. Long Term Planning.

Planning begins with annual budgeting when sales and despatches for each season are forecast and broken down month by month. Stock levels are then decided on a basis calculated to provide a good cutomer service - at the same time smoothing predicting seasonal production levels to an acceptable standard (taking into account the risk factor of over-stocking on lines which may become obsolete.)

C. Development of a New Range.

Consideration of new Autumn ranges starts in the previous August and new last shapes must be considered at a very early stage. Two or three months are spent making large numbers of experimental samples from which the new range will be selected. Two or three months more are then required to develop the equipment for bulk production.

D. Tooling Up.

As soon as the new range is selected (by Marketing and Sales Meetings), Marketing produce forecasts of the pairages likely to be sold in each style, whilst the Work Study Department estimate the work content of each style in terms of "standard minute" values. From these two sets of figures estimates can be made of requirements in terms of trained labour and machines, so that training or re-training can begin and additional machines ordered where necessary. Also material orders can be placed for initial production.

E. Monthly Re-Appraisal of Production Plans.

At the beginning of each month the actual orders on hand, stock levels and production to date are compared with budgets, and in the light of these comparisons a revised production plan is produced.

F. Weekly Planning.

Production schedules are produced weekly, though there is a lead time of about two weeks before that production begins to allow for organising supplies and the necessary paper work.

Stock Control decides what proportion of the input shall be allocated to Forward Orders and how much to topping-up stocks to supply the Instock service.

The detailed output is then drafted, selecting pairage as far as possible in the order in which it has been promised to the retailers, but some re-shuffling is permissable to avoid extremes of fluctuation in the pattern of input imposed on rpoduction. It is at this stage that constraints have to be considered in detail:

a) Availability of Supplies - despite much forward planning, supplies do not always match requirements. Every week, however, a revised forecast is produced setting out in some detail the expected inputs for the coming six weeks so as to assist in maintaining material supply.

b) Machine and Plant Capacity - as an example a given number of lasts will produce only a certain number of shoes (limited by number of lasts and speed of turn round) so input by size must be considered.

c) Operative Capacity - the loading which the proposed input will place on the various operations is calculated in terms of standard minutes and compared with potential output of each group of operatives capable of performing the necessary skills. It will be seen that a number of versatile operatives allows for re-deployment within limits. These "utility" operatives also allow maintenance of balance in case of illness, etc.

G. Daily Schedules.

The week's plan is broken down into daily schedules and a batch production system is used. Each batch is given a serial number and the schedules list all the batches due into each Department each day, and, similarly, what is due out.

The work is booked out of each Department at the inspection point, then those batches which have not been booked out on time are listed as arrears and become subject to chasing action.

It will be appreciated that in this system pre-planning is the major control function and there is virtually no re-scheduling once production is under way.

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