# How Far A Quality Control Cell in Paper Industry is Permissible in View of Modern Development in Pulp And Paper Manufacture

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*Any improvement in the manufacture of a Product can be achieved through not only a purely Engineering–Oriented technoloigical approach, but also through the most popular productivity services. Statistical Quality Control (S.Q.C.) is one of such important fields in Productivity Services. It becomes absolutely essential here to discuss the extent to which S.Q.C. should be permitted in Paper Industry as the latter has got a strong footing in Sellers' Market.*

*This article is directed towards convincing the paper Technologists that application of S.Q.C. principles will strengthen their hands to bring out paper with effective adherence to the specifications, with minimum labour and with desired accuracy. It also enters in to a detailed discussion on the functions of a Quality Control set up and tries to justify that a full-fledged Quality Control cell deserves an important place in Paper Industry.*

*A Case-Study is made available here to demonstrate how effectively the erratic fluctuation in the behaviour of substance in a light-weight paper can be effectively arrested by using the simple tools offered by S.Q.C.*

**Introduction**

Ancient days of approaching the paper making process on intuitive basis are over. Of late, there has been a consistant and healthy trend of manufacturing this scarce product on scientific and well defined technological ground. The idea of preparing this article has been conceived by a reasonable comprehension that any improvement in the manufacture of a man-made or man-invented consumer product can be achieved through not only a purely Engineering-Oriented technological approach, but the most popular productivity services as well. We find in almost all developed industries–whether they deal with steel or Baby Food–a full-fledged cell consisting of trained staff in productivity lines It is assumed here that an industry standing today in sellers' market has to adopt itself to an altogether distinct situation in the course of time and hence it has no excuse to overlook the utilisation of guidelines offered by Productivity Services, for economic manufacture of the product.

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The reaction of Industrial Engineers in the initial stage of introduction of a quality control programme was not encouraging. That too, when quality control with sanction from Statistical principles was suggested by W. Stewart in 1920's in Bell Telephone Industries, USA and demonstrated with facts and figures the feasibility of controlling the undesirable fluctuations in the process behaviour and of arresting the assignable causes causing the fluctuation and of determining the process capability of the Machines, many rejected them as baseless on the ground that presence of innumerable variables-their interaction effects–in the process would allow neither the determination of capability of machines nor the control of the process.

**Scope of this paper**

This article hopes to argue over

the above hurdles and prove that permission of quality control with a fair minimum assignment and application of Statistical Quality Control [Note:—hereafter Statistical Quality Control is abbreviated as SQC.]Principles will strengthen the hands of technologists to bring out paper with effective adherence the specifications, minimum labour and desired accuracy.

**What is quality control and where it is experienced (with speeific Reference to Paper Industry)**

Quality Control is defind as the totality of all means whereby we establish and achieve a quality specification. On the other hand S.Q.C. is looked upon as that set of means for establishing and achieving a quality specification which requires use of the tools of statistics. The term "Quality Control" is of recent origin and is used in a variety of meanings[1,2].

Exercising Quality control irrespective of the potentiality of the Industry is an age-old practice. This is done with knowledge of application by some and with intuition by many. At a recent seminar conducted by JURAN[3] a dozen industrlal executives prepared a list of 37 functions, each carried on by one or more of the Companies. It may be observed from this list that the Quality control programme can embrace all vital units of an industry once it is given a fair trial. The functions listed below has been borrowed from the book, reference of which is given under[3].

**A Function Associated with Planning or Controlling the work of the Inspection Department**

1. Definition of essential Quality characteristics of the product, or classifying their relative importance.
2. Preparation of inspection methods sheets.
3. Preparation of quality specifications for appearance and other non-measurable quality characteristics, condition of shop practice.
4. Training of inspectors and operators.
5. Design of Gauges and test equipment.
6. Maintaining the accuracy of Gauges and test equipment.
7. Investigation of Salvage possibilities for non-acceptable material.
8. Suspension or Conduct of laboratory testing Services.

**B Functions of relations with consumers or Vendors**

9. Analysis of customer complaints.
10. Analysis of Goods returned for quality reasons.
11. Conduct of Customer Surveys to study reactions to product quality.
12. Liaison with Customer's Inspectors.
13. Proving in new sources of supply.
14. Analysis of Rejections made on Vendors.

**C Function of Quality Planning.**

15. Appraisal of Competitor's Product.
16. Determination of Economic level of Quality.
17. Measure of Process Capability.
18. Preparation of Process specifications.
19. Liaison between product research and production.
20. Participation in new product Planning Committees.
21. Study of materials handling as it affects quality.

**D. Functions of Defect Prevention.**

22. Planning defect prevention programme.
23. Investigation of Causes of Chronic defects.
24. Trouble Shooting on current production.
25. Stimulating corrective action in other departments.
26. Leadership in campaign for quality mindedness.

**E. Functions of Quality Assurance.**

27. Measure of loss due to defects.
28. Rating the quality of outgoing product.
29. Conduct of quality audits.
30. Measuring the effectiveness of inspection (Usually Inspector Accuracy).
31. Analysis of Cost of Inspection.
32. Measure of Customer Satisfaction.
33. Measure of trend of customer complaints and return.
34. Preparation of executive reports on quality.

**F. Miscellaneous Functions.**

35. Study of quality implication of operator incentives.
36. Selection, training, and placement of quality control Engineers.
37. Consultation service on stati-

tical methods to entire Company.

Careful examination of these prescribed functions reveals that the list is exhaustive in all respects. Consultation of the above list of functions to a quality control set-up in Paper Industry does not seem to be in anyway different from a control cell in any other industry. [Note: For a different opinion on this point, please refer (4)].

It will be more appropriate to be specific about quality control activities in a typical Paper Industry which is interested in exercising control in a planned fashion. In a birds eye view, quality control performance in Paper Industry may be listed out as in Chart I (enclosed) with a special reference to the layout of the quality control cell (5).

The excellence of allotting the above essential control tests and other activities relevant to the process under the Quality Control Cell rather than with a Common Laboratory is obvious. In an ideal structure of testing for various characteristics of the product and reporting the results to the concerned units without loss of time-note here that control staff cannot afford to overlook the timely reporting of results-preference is usually laid with a unique control cell rather than with a common laboratory. Constructive thinking in the line of linking various factors contributing towards the unwarranted departure in the process from the normal conditions can be made available in a relaxed manner by the staff meant exclusively for that job.

**IV. The Role of Statistical Quality Control**

IV.1 The long range contribution of statistics not so much upon getting a lot of highly trained statisticians into industry as it does in creating a statistically minded generation of physicists, chemists, engineers and others who will in anyway have a hand in developing and directing the production processes (6). This applies to paper industry too.

Techniques exposed under S.Q C. may be expected to offer any technologist four major benefits:

a) Determination of Basic variability of the quality characteristic. (Note:—In the sense used in SQC, Quality characteristic may be a measurable characteristic or an attribute. Before the application of control charts or sampling plans, definition of quality characteristic in the appropriate form must be made clear without ambiguity.

b) Determination of Consistency of preformance of a Machine or group of machines in manufacturing a product, meeting the company standards/party's specifications.

c) Determination of Average level of the quality characteristic.

d) Simple sampling theory based on effective statistcal methods that deals with the quality protection given by any specified sampling acceptance procedure.

This article is restricted from entering into further detailed discussion on the above functions of SQC. However, it will not be out of place here to mention that it is possible to take reliable decisions in the line of either suggesting fresh control points or tolerence limits or shift in the average level of a quality characteristic of the product with a desired level of confidence and accuracy framed by the statistical procedure. Control tests are made more viable by subjecting the data to statistical analysis (7).

One such case study has been discussed below :

**IV.2. CASE STUDY**

**IV.2.1. Problem**

In the manufacture of a 50 GSM (Grams per square metre) Colour Printing paper, the substance has fluctuated in an erratic manner. The basis weight, (Note:—Basis weight in grams per square metre of the sample sheet.), being low, has been found to be within control in the standard of the paper maker at the paper machine stage. Control or non control of this essential property of paper has been determined by the shift paper makers through Average of Deckle weights in a traditional fashion. When the paper is converted and ream weights are observed at inspection stage, they have absolutely no relation between what they have maintained at M/c. & what they have observed at inspection stage. This problem has called for an urgent solution as substance in the paper is an index to the economy part of manufacturing the product.

### IV.2.2. ANALYSIS

**a) Sampling Procedure**

Collection of samples for determining the substance (for that matter, for other tests of paper also) is carried out as follows: 3 samples are drawn normally (Note:—When the lot size is considerably large and the process has been stabilised, drawing of samples is done at less frequencies. This relaxation is a tradional practice based on experience and intuitive knowledge of the paper makers.) each from three sides-Drive side, centre and tender side. The decision-making, as far as the control of Substance is concerned, is usually done by the senior operators responsible for the 'Get-up' of the parent rolls. It has been observed in this connection that there is no hard and fast rule for the different operators to comply by an uniform code of procedure in determining the 'Passability' of the paper based on the sample weights. It is more or less an 'individual decision' and it does vary from operator to operator.

Apart from the three samples drawn, a deckle-wise sample (which provides as far as 7 to 8 sample sheets in a specific size) is also drawn and sample weights are recorded.

***b) Defects in Decision Mrking***

i) As mentioned above, decision taken with the sampling procedure in practice is an individual decision, which is bound to vary in all essential aspects of decision-making from one operator to the other. The serious mistake committed by the concerned crew is determination of substance control by the averages of deckle weights alone.

ii) Defective sampling procedure that gives sample scope for various assignable variables to escape the attention of the operators.

iii) Non-availability of instruction calling for an uniform procedure down to the first-assistants who should be aware of the 'Warning limit' and 'Action limit' so that they will know when to disturb the process. (Note:—To realistically judge the conformance of a lot of paper to specifications, we must remain aware that each time we adjust the process significantly, we are creating another lot of paper.

**c) Corrective procedure and method of Analysis :**

Chart II and Table I provide the data for the Averages of Deckle sample weights. 40 Continuous parent rolls (running for 30-35 hours) have been concentrated.

A glance at Chart II will induce mostly all to conclude that the process was under control. As a matter of fact the above set of figures may fall within 'Passable' limits prescribed by the paper maker. The result of this coincidence does end at a relaxede attitude on the part of Assistants (in charge of the paper in their shift) and a philosophical approach to arrest the fluctuation: 'Average is within control; Everything is perfect'. Let us observe the corresponding individual sample weights—collected in a manner as outlined above-given in Chart III, Table II (enclosed)

The figures are subjected to statistical analysis.

The result of analysis shows that as far as 6% of total individual sample weights have fallen out of the trial control limits. Apart from this, the Average listed in Chart II are not found to be under Statistical Control. (Note:—The method of analysis has been explained in later portion of this Article.) Hence the 'passable' limits suggested by the Paper Maker have little or no relevance to the primary idea of making paper that succumb to economic limits for any property of the product.

The problem of suggesting Economic Control limits may be tackled by Control Chart technique as follows:

**IV.2.3. Work Sheet for Evaluation of Control Limits for Averages.**

Property under study : Substance of the Ptg. Paper.

**Data:**

Given Under Table I

**Let:**

(1) $\bar{x}$=Arithmetic Mean of a given set of figures.

$$\bar{\bar{x}} = \frac{1}{n}\sum_{i=1}^{40} \bar{x}_i$$

(2) R=Range

(3) $\sigma$=Standard deviation from either Average or Specified single figure.

$\hat{\sigma}$=Estimate of $\sigma$

(4) N=Total number of samples subjected to Analysis.

n=Sub-group sample size.

(5) $d_2$=A constant that varies with sub-group size n, used for computing the control Limits. (Note:—Further discussion on $d_2$ has been intentionally avoided.)

**COMPUTATIONS:**

$$\bar{\bar{x}} = \frac{1}{N}\sum_{i=1}^{40}\bar{x}_i = \frac{1943.0}{40} = 48.58 \simeq 48.6$$

$$\bar{R} = \frac{1}{N}\sum_{i=1}^{40} R_i = \frac{69}{40} = 1.72 \simeq 1.7$$

$$\hat{\sigma} = \frac{\bar{R}}{d_2} = \frac{1.72}{2.704} = 0.64 \text{ —(A)}$$

$$2\hat{\sigma} = 2\frac{\bar{R}}{d_2} = 2(0.64) = 1.28$$

$$3\hat{\sigma} = \frac{3\bar{R}}{d_2} = 3(0.64) = 1.92$$

$$2\frac{\hat{\sigma}}{\sqrt{n}} = \frac{2(0.64)}{\sqrt{7}} = \frac{2(0.64)}{2.64} = 0.48$$

$$3\frac{\hat{\sigma}}{\sqrt{n}} = \frac{3(0.64)}{\sqrt{7}} = \frac{3(0.64)}{2.64} = 0.73$$

**Warning Trial Control Limits**

Upper control limit (UCL)=

$$\bar{\bar{x}} + 2\frac{\hat{\sigma}}{\sqrt{n}} = 49.06 \simeq 49.1 \quad \text{(B)}$$

Lower control limit (LCL)=

$$\bar{\bar{x}} - \frac{2\hat{\sigma}}{\sqrt{n}} = 48.10 \simeq 48.1 \quad \text{(C)}$$

**Action Trial Control Limits.**

$$UCL = \bar{\bar{x}} + \frac{3\hat{\sigma}}{\sqrt{n}} = 49.31 \simeq 49.3 \text{(D)}$$

$$LCL = \bar{\bar{x}} - \frac{3\hat{\sigma}}{\sqrt{n}} = 47.85 \simeq 47.8 \text{(E)}$$

It will suffice to mention here that $2\hat{\sigma}$ limits (warning limits) contain almost 95% of total values if the process is under 'Statistical Control'. Similarly $3\hat{\sigma}$ limits will contain 99% (Approx) of total values in which case the process is deemed under 'Statistical Control'. $3\hat{\sigma}$ limits are considered to determine the out-of-control phenomenon for our purpose.

(D) and (E) are referred to individual $\bar{x}$ values. F.P. We observe the averages for parent roll number (1), (5), (6), (7), (12), (15), (17), (20), (22), (27), (28), (29), (30), (31), (32), (35), (36), (37), (38) have fallen out of the limits (D) and (E). It means that 47.5% of the total averages have to be eliminated to strike out fresh UCL and LCL.

### IV.2.4. INTERPRETATION

1. It is not advisable to go by a set of figures which have got 47.5% values not belonging to its fold. Probably these out-of-control values may be said to have come out of a significant shift in the process.
2. Records maintained by the Q/C cell have been verified. Signs of presence of definite assignable causes such as trouble at consistency regulator, appointment of a fresh hand at Head Box, defective First Press felt and inadequate crowning in the press rolls have been traced.
3. There is no statistical justification to suggest modified control limits for averages after eliminating the above figures as it is found that the variation control chart itself gives evidence for process not under statistical control. It is a norm well defined too-that control chart for averages should not be evaluated unless chart for variability contains all R's. (Note:—Derivation of control limits for variability control chart is achieved by using Ranges information. In a nutshell, we proceed as follows:

$$
\begin{aligned}
\bar{R} &= 1.72 \\
UCL &= D<\bar{R} \\
&= (1.924)\ (1.72) \\
&= 3.309 \qquad (1) \\
LCL &= D_3\bar{R} \\
&= (0.076)\ (1.72) \\
&= 0.131 \qquad (2)
\end{aligned}
$$

$D_3$ and $D_4$ are constants varying with the sample number.

Refer indvidual Range value R to (1) and (2). It is observed that 5 out of 40 figures have either fallen out or on the borders.

However, if variability of the process is within control, we can proceed to derive fresh contral limits by further eliminating those out-of-control figures till all fall within the limits.

**Action to be taken after evaluation of limits**

UCL and LCL thus finally arrived at may be made available to the entire paper machine crew. They may be instructed to strictly adhere to these limits and any change that is likely to be taken (as far as the characteristic under study and for which limits are evaluated are concerned) should essentially be based on these control limits.

We can expect a process which has been deemed under statistical control to behave as shown in Chart IV (enclosed).

## V. CONCLUSION

1. A sincere attempt has been made here to argue for the relevance of a control cell in spite of the fact that the paper Industry does have a strong footing in Sellers' market today. In making decisions on matters related to quality, it is essential to examine the relative economy of the alternatives under consideration. Techniques exposed under S.Q.C. will contribute towards achieving this goal to a larger extent, thus justifying existence of a full-fledged quality control cell.
2. It is an approved fact that Statistical methods do serve as land marks which point to further improvement beyond that deemed obtainable by experienced manufacturing men. When normal logic proves futile and hunting for obvious correctives is exhausted, statistical methods still point towards a reasonable chance for yet further gains, thereby injecting sufficient courage to the trouble solver to proceed to the ultimate gain.
3. Finally it is upto the individual concerned, to take a decision on the question posed earlier that how far a quality control cell is permissible in a paper industry in the light of the merits discussed in this article taking into account managerial and technical needs of the plant.

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**CHART—I**

**Schematic Description of Quality Control Functions Relevant to Various Departments of Paper Industry**

Director

Manager

| **Supdt. Production** | **Quality control cell** | **Research & Development** |
|---|---|---|
| **Sr. Prodn. Assts.** | **Its activities may be systematically** | |
| **Prodn. Assts.** | **planned as follows** | |

| Pulp Mill (including Chipper House | Stock Preparation | P.M/c. | Finishing Department |
|---|---|---|---|
| Given under Chart I (a) | (Given under Chart I (b) | (Given under Chart I (c) | (Given under Chart I (d) |

**CHART I (a)**

Tests at frequent intervals concerning strength and quality of the pulp. Some of the notable tests are :

1. **Chipper House**
   a) Chips Classification and
   b) Moisture in Bamboo Chips
2. a) White Liquor Analysis as $Na_2O$
   (Here NaOH, $Na_2S$, $Na_2CO_3$, Active Alkali may be concentrated upon)
   b) Sulphidity
   c) Causticity.
3. **Brown Stock Washing**
   *Washers-wise detailed testing of* :
   a) Twaddle and
   b) Temperature.
4. Determination of K. No.
5. *Unbleached Screening Consistency*
   Primary, Secondary & Tertiary
   a) Inlet, and
   b) Accepts.

**Pulp Mill**

6. *Thickener Unbleached Pulp*
   a) Consistency at two equal intervals in each shift. Samples points, frequency for collection of samples and quantity of sample to be drawn will be determined after analysing the process data.
   b) pH in the same equal intervals in each shift.
7. **Bleach Liquor Analysis**
   a) Average Chlorine
   b) Free CaO
   c) pH of Black Liquor and
   d) NaOH

Table-1

(Figures given here are coded)

**Decklewise Sample Readings of Substance**

**Quality : Colour Printing**
**G.S.M. : 50**

**Lot Number : X**
**Date of Manufacture :**

| Roll No. | Decklewise Sample Readings (1) | (2) | (3) | (4) | (5) | (6) | (7) | X (Mean) | R (Range) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 48 | 48 | 47 | 46 | 47 | 47 | 47 | 47.1 | 2 |
| 2 | 49 | 49 | 48 | 48 | 47 | 47 | 47 | 47.9 | 2 |
| 3 | 50 | 50 | 48 | 48 | 49 | 48 | 48 | 48.7 | 2 |
| 4 | 51 | 51 | 48 | 48 | 48 | 49 | 48 | 49.0 | 3 |
| 5 | 47 | 47 | 47 | 46 | 47 | 47 | 47 | 46.9 | 1 |
| 6 | 49 | 49 | 48 | 48 | 46 | 47 | 47 | 47.7 | 3 |
| 7 | 48 | 48 | 48 | 47 | 47 | 48 | 48 | 47.7 | 1 |
| 8 | 49 | 50 | 49 | 48 | 48 | 49 | 48 | 48.7 | 2 |
| 9 | 49 | 49 | 48 | 47 | 48 | 48 | 48 | 48.1 | 2 |
| 10 | 50 | 50 | 49 | 49 | 48 | 49 | 48 | 49.0 | 2 |
| 11 | 50 | 49 | 49 | 48 | 49 | 49 | 48 | 48.9 | 2 |
| 12 | 48 | 48 | 47 | 47 | 47 | 47 | 47 | 47.3 | 1 |
| 13 | 50 | 50 | 49 | 49 | 49 | 48 | 49 | 49.1 | 2 |
| 14 | 49 | 49 | 49 | 50 | 49 | 49 | 49 | 49.1 | 1 |
| 15 | 49 | 50 | 49 | 50 | 50 | 49 | 49 | 49.4 | 1 |
| 16 | 48 | 49 | 48 | 49 | 48 | 49 | 49 | 48.6 | 1 |
| 17 | 50 | 50 | 51 | 51 | 50 | 49 | 49 | 50.0 | 2 |
| 18 | 48 | 49 | 50 | 49 | 49 | 48 | 48 | 48.7 | 2 |
| 19 | 48 | 49 | 49 | 49 | 48 | 47 | 49 | 48.4 | 2 |
| 20 | 48 | 48 | 47 | 48 | 47 | 48 | 48 | 47.7 | 1 |
| 21 | 48 | 49 | 48 | 49 | 48 | 48 | 48 | 48.3 | 1 |
| 22 | 47 | 48 | 48 | 48 | 48 | 48 | 47 | 47.1 | 1 |
| 23 | 48 | 49 | 48 | 48 | 47 | 47 | 48 | 47.9 | 2 |
| 24 | 50 | 50 | 50 | 49 | 49 | 48 | 48 | 49.1 | 2 |
| 25 | 49 | 49 | 50 | 49 | 47 | 47 | 47 | 48.3 | 3 |
| 26 | 48 | 47 | 50 | 49 | 47 | 47 | 47 | 47.9 | 3 |
| 27 | 49 | 49 | 49 | 50 | 50 | 50 | 49 | 49.4 | 1 |
| 28 | 49 | 50 | 50 | 51 | 51 | 51 | 50 | 50.3 | 2 |
| 29 | 52 | 51 | 52 | 51 | 50 | 50 | 51 | 51.0 | 2 |
| 30 | 52 | 51 | 52 | 51 | 51 | 51 | 51 | 51.3 | 1 |
| 31 | 52 | 51 | 53 | 50 | 49 | 49 | 50 | 50.6 | 4 |
| 32 | 47 | 47 | 48 | 48 | 48 | 47 | 48 | 47.6 | 1 |
| 33 | 49 | 49 | 50 | 49 | 49 | 49 | 49 | 49.1 | 1 |
| 34 | 49 | 49 | 48 | 48 | 47 | 48 | 48 | 48.1 | 2 |
| 35 | 48 | 47 | 47 | 48 | 47 | 47 | 47 | 47.3 | 1 |
| 36 | 47 | 49 | 48 | 48 | 47 | 47 | 48 | 47.7 | 2 |
| 37 | 48 | 48 | 47 | 48 | 47 | 48 | 48 | 47.7 | 1 |
| 38 | 48 | 49 | 48 | 47 | 47 | 48 | 47 | 47.7 | 2 |
| 39 | 49 | 49 | 48 | 49 | 49 | 49 | 49 | 48.9 | 1 |
| 40 | 50 | 49 | 49 | 49 | 49 | 49 | 49 | 49.1 | 1 |

8. i) **Unbleached Pulp from Flow Box to Chlorine Tower**
   a) Permanganate Number.
   b) Consistency
   c) pH

8. ii) **Chlorine Tower**
   a) Chlorine %
   b) Consistency
   c) pH

8. iii) **Chlorine Washer**
   a) Temperature
   b) Free Chlorine
   c) K No.

8. iv) **Alkali Extraction**
   a) NaOH
   b) Temperature.

8. v) **Pulp from Flow Box**
   a) Consistency
   b) pH

8. vi) **Alkali Washer**
   a) Permanganate Number

8. vii) **Hypo Towers**
   a) Hypo %
   b) Sulphamic Acid
   c) Temperature
   d) Consistency
   e) pH

8. viii) **Hypo Washers**
   a) pH
   b) Brightness

9. Determination of Brightness (°GE) and Viscosity for bleached pulp.

Table-II

Sample Weights (GSM)

Sampling procedure adopted . Normally 3 samples each one representing the Tender, Center and Drive side of the Parent Roll.

| Parent Roll Number | Position: Tender Side | Center | Drive side |
|---|---|---|---|
| 1 | — | 49 | 51 |
| 2 | — | 50 | 48 |
| 3 | 47 | 48 | — |
| 4 | — | 49 | — |
| 5 | 47 | 48 | — |
| 6 | — | 50 | 48 |
| 7 | 48 | 49 | — |
| 8 | 49 | 48 | 49 |
| 9 | — | 47 | — |
| 10 | 48 | 49 | 50 |
| 11 | — | 49 | 49 |
| 12 | 48 | 49 | 50 |
| 13 | 50 | 49 | — |
| 14 | 49 | 48 | 49 |
| 15 | 48 | — | — |
| 16 | 48 | — | — |
| 17 | 51 | — | — |
| 18 | 50 | — | — |
| 19 | 49 | 48 | 50 |
| 20 | 48 | — | — |
| 21 | 49 | 48 | 52 |
| 22 | 48 | 47 | — |
| 23 | 47 | 47 | 48 |
| 24 | 48 | 49 | 51 |
| 25 | 51 | 54 | 47 |
| 26 | 50 | 49 | 52 |
| 27 | 49 | 52 | 50 |
| 28 | 48 | 50 | — |
| 29 | 50 | 51 | — |
| 30 | 53 | 51 | — |
| 31 | 50 | — | — |
| 32 | 49 | — | — |
| 33 | 48 | 49 | — |
| 34 | 50 | 49 | 51 |
| 35 | 47 | 49 | 51 |
| 36 | — | 49 | 47 |
| 37 | 49 | 48 | 49 |
| 38 | 47 | 49 | — |
| 39 | 48 | 49 | — |
| 40 | 49 | 50 | 49 |

**CHART I (b)**

Stock Preparation

1. **Regular Testing of :**
   a) Consistency
   b) Freeness of pulp
   c) pH of stock at storage chest and consistency Regulator
2. a) Twaddle of talc.
   b) Throughout fraction
   c) Consistency of Centri-cleaner rejects.
3. a) Twaddle of Alum.
   b) Consistency of pulp in head box and wire pit.
4. **Testing of :**
   a) Back Water pH.
   b) Acidity from samples at Wire Pit.

**CHART I (c)**

Paper Machine

1. Frequent Testing of Essential Chemical Properties such as
   a) Sizing
   b) Brightness in Bleached varieties and observation of physical properties such as:
   i) Burst factor
   ii) Folds
   iii) Formation
   iv) Shade.
2. Close watch on other properties of paper and reporting the same to the concerned unit keeping in mind the relevance of the tests to the quality and end use of the product. Quality Control can do a purposeful job in this

unit by feeding back the quality informations to Paper M/cs. Stock preparation and Pulp Mill and by Volunteering information about the probable quality of the product to the Finishing Department.

**Draw Back :**

Quality Control functions in Paper Machine may wrongly be diverted to just report the results of testings and there will be a danger to weaken the significance of control by way of giving encouragement to the production target. Hence Q.C. Man should necessarily be a 'GIGANTIC AND EFFICIENT WATCH DOG' and definitely not a reporter.

**CHART I (d)**

Finishing Department

1. Application of Acceptance Sampling Plans for quality protection by segregating the converted sheets in grades as per a specified sampling procedure.

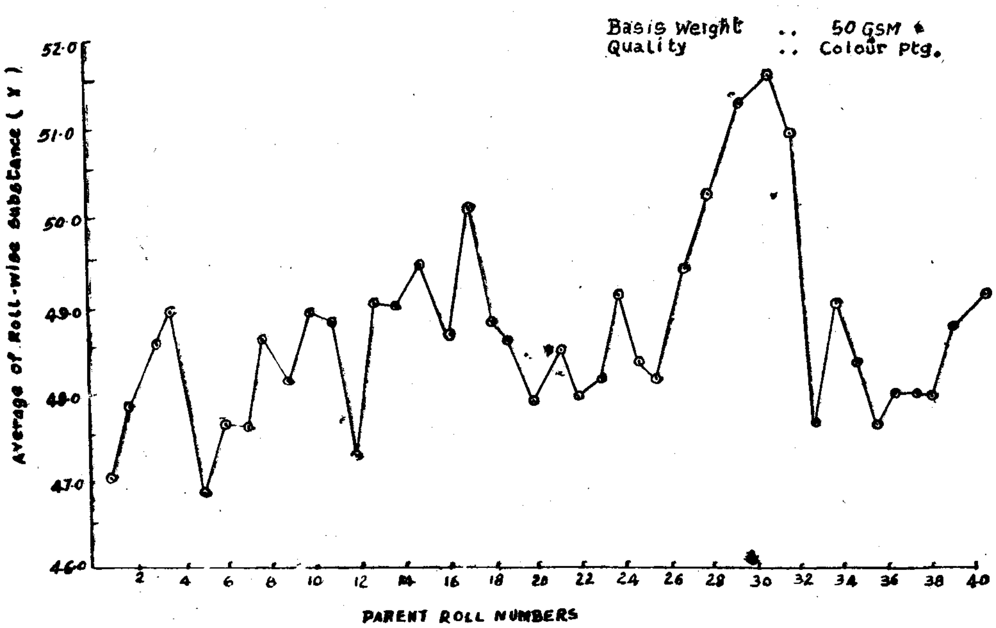
   This will help screening of incoming quality to Finishing Department.

2. Determination of Average outgoing quality (AOQ) to check abnormal or unusual departure in number of defective sheets in the finished grades for shipment.

   AOQ gives a most accurate idea about the number of defective sheets expected in Reams or Bales on an average. This serves as a point of discussion between the supplier and Purchaser.

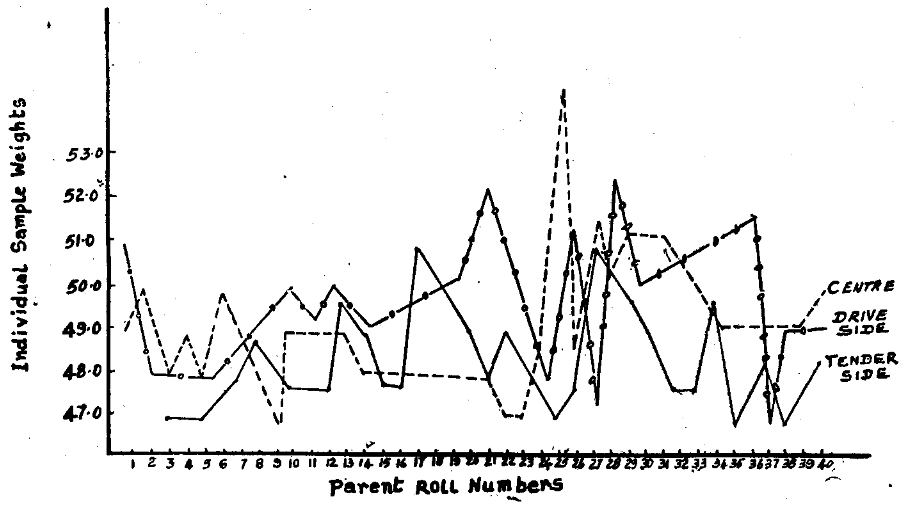
3. Determination of Finishers (or Inspectors) efficiency by keeping a clean record of their performance and using them for graphical representation: Histogram, etc.

**CHART II**



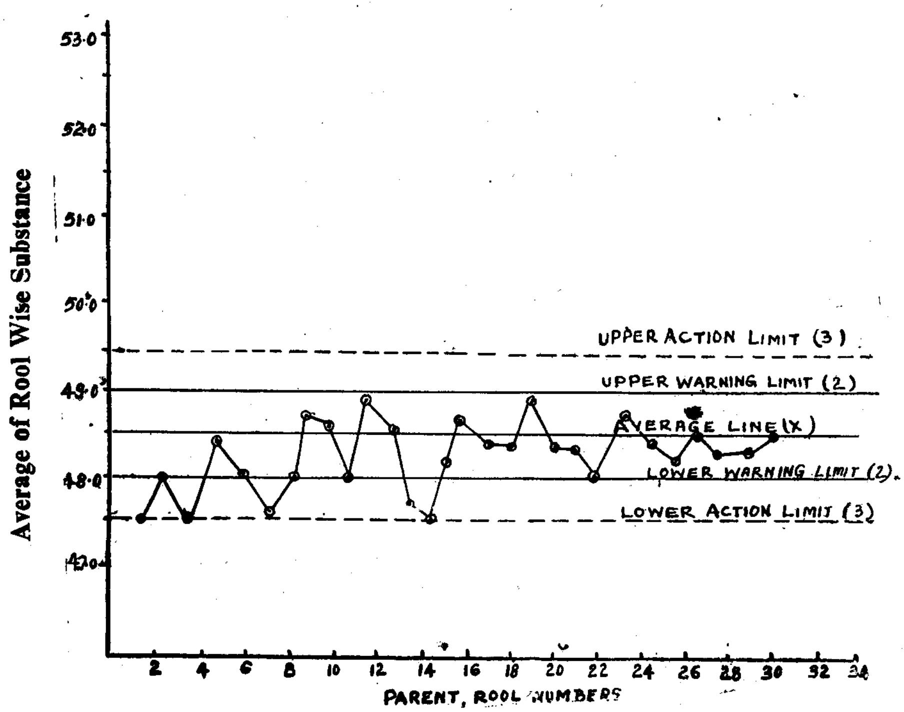

**Behaviour Pattern of Deckle-Wise Averages of Subtance**

## CHART III




**Puttern of Variation of Individual Sample Weights**

## CHART IV




**Ideal Control Chart of the Average GSM Under Statistical Control**

## REFERENCES


1. *Quality Control Handbook* by Juran, 1–3; Second Edition (1962) Mc Graw Hill Book Company, New York.

2. *Industrial Quality Control* by A. V. Feigenbaum The Challenge of Total Quality Control, Vol. 13, No. 11, pp. 17-23 (1957).

3. *Quality Control and Statistical Methods* by Edward M. Sch Rock pp 4; Second Edition (1961) Asia Publishing House, New Delhi, India.

4. *Paper Quality Control* by Fred Streit Chapter I; (1968) Lockwood Publishing Company, Inc. New York.

5. For a discussion on Organisation of *Quality Control unit and* the procedure to exercise Quality Control. *A Hand Book of Quality Control and its Techniques* (jute) by S.C. Mital and A.C. Asopa pp. 3 to 5, First Division, Vol. I (1970) Tara Publications, Agra, India.

6. *Statistical Method* from the Viewpoint of *Quality Control* by W.A. Shewart (Edited by W.E. Deming) pp. 49 The Graduate School, Department of Agriculture, washington, D.C. (1939).

7. *Statistical Quality Control* by Eugene L. Grant. pp. 6, Third Edition (1964) Mc Graw-Hill Book Company, Inc. New York.

8. *TAPPI* December 1974 Vol 57, No. 12.

   (The Use of Analysis of Variance to Characterize Paper web nonuniformities) By J.W. BURNS, St. Regis Paper co, New York.