

LITERATURE SURVEY

2.1 INTRODUCTION

The literature survey spans over 40 years of research on fluting-paper quality. This chapter begins with a discussion of the views of the different quality gurus on the definition of quality. Consequently different dimensions and parameters of quality are investigated. The author then provides a comprehensive description on paper in general, the manufacture of fluting-paper and the important technical characteristics of fluting-paper.

2.2 QUALITY**2.2.1 Definition of Quality**

Quality can be defined as “customer satisfaction” or “fitness for use” (Juran and Gryna, 1993, p3). They also explain that with increasing competitiveness, customers are becoming more aware of quality, costs and service excellence. Thus improving the manufacturing process to reduce costs or to improve the quality of the final product without consulting with the customer to understand the customers’ requirements is futile.

Deming (1982, p221-234) supports Juran and Gryna (1993,p3)in their statement that quality can only be defined in terms of customer satisfaction. The customer is seen as the most important part of the production process therefore quality must be measured by the extent to which the customer’s requirements are fulfilled. Customers require complete quality satisfaction that is affordable and that accurately addresses their needs and conditions of manufacture.

In summary from above, most experts agree that quality is customer satisfaction. This simple definition however cannot fit all applications (Symons, 1991, p87) and comprehensive views need to be taken to extend this definition. Broader views on “quality as customer satisfaction” are also provided by Deming (1982, p226), Feigenbaum (1983, p272) and Garvin (1987, p43). In these broader views, the dimensions, attributes or contributors to “quality as customer satisfaction” are proposed.

Deming (1982, p226) suggests that quality be measured by examining the following:

1. The relationship between the customer and the use of the product
2. The product
3. The service to the customer.

Seven dimensions are proposed by Feigenbaum (1983, p272) ranging from quality of shipment to quality of product operation. Garvin (1987, p43) poses a comprehensive set of eight dimensions of quality. These take into consideration all of those suggested by Deming (1982, p226) and Feigenbaum (1983, p272). The eight dimensions of quality (Garvin, 1987, p43) are indicated in Table 2.1. These eight dimensions of quality aim to classify all of the needs that a customer may desire in a product.

Table 2.1: Garvin’s Eight Dimensions of Quality (Garvin, 1987, p43)

No	Dimension	Description
1	Performance	Performance refers to the basic operating characteristics of a product that indicate the ability of the product to serve its intended purpose. This is the products fitness for use.
2	Extra Features	Extra features are the extra items or “bells and whistles” added to the basic features of a product. These features supplement the basic functioning of a product.
3	Reliability	Reliability is the probability that a product will operate properly within an expected period. This feature is more applicable to durable products, like electrical equipment, rather than products that are consumed instantly like food products.
4	Conformance	The degree to which a product meets the pre-established standards or customer needs is referred to as conformance. Customer complaints and defect rates are a measure of conformance at the customer and at the production facility respectively.
5	Durability	Durability is the measure of the product life span. Durability is used here to indicate the ability of a product to withstand certain harsh environmental or operating conditions.
6	Serviceability	Serviceability refers to the ease and speed of repairs and the courtesy and technical competency of the repair person. The nature of the service offered to resolve the customer’s problems are important in the customers’ ultimate evaluation of the quality of a product.
7	Aesthetics	The looks, feels, sounds, smells, or tastes of the product are referred to as aesthetics.
8	Other perceptions	Other perception is otherwise referred to as “perceived quality”. These are the perceptions based on brand name, advertising, and other such “soft” issues.

2.2.2 Quality Measurement for Customer Needs

The eight dimensions of quality help to define quality and provide an outline to measure quality in terms of the customer needs. These dimensions of quality can be researched using various quality measures. Gryna et al (2007, p15) and Maskell (1991, p227) suggest customer complaint analysis. Customer surveys are mentioned by Gryna et al (2007, p306) and Maskell (1991, p227) as useful in obtaining information on customer needs. In addition a tool known as quality function deployment (QFD) is widely adopted (Griffin and Hauser, 1993) and accepted for the purposes of customer needs analysis. Maskell (1991, p227) adds that measuring customer satisfaction is not a precise science and varies between companies and industries. These measures of customer satisfaction are discussed below.

Customer Complaints Analysis

Customer complaints refer to those negative comments received from customers on the performance of the product. Customer complaints give an organization an understanding of the unfavourable aspects in the product (Crosby, 1996, p45 and Juran, 1992, p82) which enables strategic decision making on the product or process.

Deming (1992, p179) indicates that study of customer complaints is necessary but can give a biased picture of product's performance. This is so because the positive feedback is often not considered in conjunction with the negative customer complaints. Furthermore it is found that only about thirty percent of unhappy customers complain when they encounter problems (Goodman and Newman, 2003, p51). Maskell (1991, p227) agrees with the negative comments surrounding customer complaints analysis mentioned above, but points out that the information is useful nonetheless. A similar view is shared by Kaydos (1991, p133) who states further that the information may be symptomatic and not very accurate but reviewing customer complaints is still worth the effort.

A customer complaint management system developed by Bosch and Enriquez (2005, p30), manipulates customer complaints data for focused improvement activities to improve competitiveness of the company. A similar process is suggested by Zairi (2000, p331) where a roadmap and audit tool are suggested for developing a culture which is not averse to handling complaints, also seen to offer competitive advantage to the company.

Customer complaints is therefore seen to give the company an understanding of the weak points in the product and service offering and this provides focus on areas in need of improvement to satisfy the customer's needs.

In the analysis of customer complaints Goodman and Newman (2003, p42) suggest six steps that can be carried out in order to understand customer complaints, integrate customer complaints data with quality assurance and to assist in determining focus areas of manufacturing in need of improvement. They suggest the following steps:

1. Evaluation of problem severity
2. Extrapolation of complaint reports to the number of incidents in the marketplace
3. Estimation of the revenue impact of not solving the problem
4. Comparison with internal measures to validate the estimate of problem severity and volume
5. Determination of the cause of the problem
6. Determination of the solution

They further suggest that in many cases all six steps are not necessary, but some may be valuable.

Customer Surveys

A survey is a research technique or study in which data is gathered from a sample of a population by asking questions on the subject being studied (Zikmund, 1997, p49). Collis and Hussey (2003, p66) explain that surveys follow a positivistic paradigm of study, where the subject is studied in an objective manner. In other words, the facts and causes of human behaviour are studied with logical reasoning. Surveys may be conducted to determine the customer needs and further allows similarities and differences among various customers needs to be drawn.

Quality Function Deployment

Akao (1990, p5), the originator of QFD, explains that QFD is a planning and problem-solving tool, useful in converting the customer's needs data into quality characteristics or the design quality of the finished product, by systematically organizing the relationships between the customer needs and the characteristics of the product. This tool allows the customer needs to be investigated and then uses these customer needs to create or improve products that are desired by customers. QFD has been successfully applied (Sharma et al, 2008; Wu, et al, 2005), to improve products and processes, fulfil customer requirements and to improve customer satisfaction in industry.

2.2.3 Quality Measurement with QFD and Garvin's Eight Dimensions

Symons (1991, p87) suggests that the use of quality function deployment is especially applicable in the paper industry, to match the needs of the customer and the production process. He explains this process can be used as a vehicle to identify common customer needs and find approaches to satisfy these customer needs. The approach and suggestion made by Symons (1991, p87) is discussed below.

Symons (1991, p87) indicates that Garvin's (1987, p43) eight dimensions of quality provide a comprehensive structure of the many aspects of quality any product might possess and is conducive to operational application. Therefore, he suggests that the customer needs may be determined using Garvin's (1987, p43) eight dimensions of quality. All dimensions may not be applicable and it is recommended that focus is placed on those that best describe the desired customer needs.

The application of the dimensions in QFD requires considerable thought and time and is best achieved by team participation. Teams of manufacturing, engineering and technical experts are recommended as best in supplying measureable variables to the customer needs. Further, it is noted that one of the reasons for the success of the application of this model is the involvement of the many teams.

One of the matrices explained by Symons (1991, p87) draws the customer needs from a market evaluation. The market evaluation assesses the customer importance of each customer needs and can also be expanded to view various other factors. These customer needs are related to the product's (technical) characteristics, in the centre of the matrix. In this way the customer needs are related to the technical characteristics of the product, and specifies final product technical characteristics. It may also be used to show whether there are gaps between the product technical characteristics and the customer needs or whether the technical characteristics of the product are reflective of the customer needs. In conclusion then, this approach suggested by Symons (1991, p87), of using Garvin's (1987, p43) eight dimensions of quality together with quality function deployment, may be used to study whether the company produces fluting-paper according to technical specifications that meet the customer needs.

2.3 PAPER

Paper is defined by Smook (1990, p187) as a “uniform felted sheet composed of fibres and non-fibrous additives that has been formed on a fine screen from a water suspension and subsequently pressed, dried and calendared.” First a discussion is provided on the classification of paper and the different paper grades. The process to manufacture paper is thereafter discussed.

2.3.1 Classification of Paper

Paper can be classified into four groups as indicated in Figure 2.1. These classifications are based on the use of the particular paper group. These four groups are:

1. Printing and writing
2. Tissue
3. Speciality
4. Paperboards

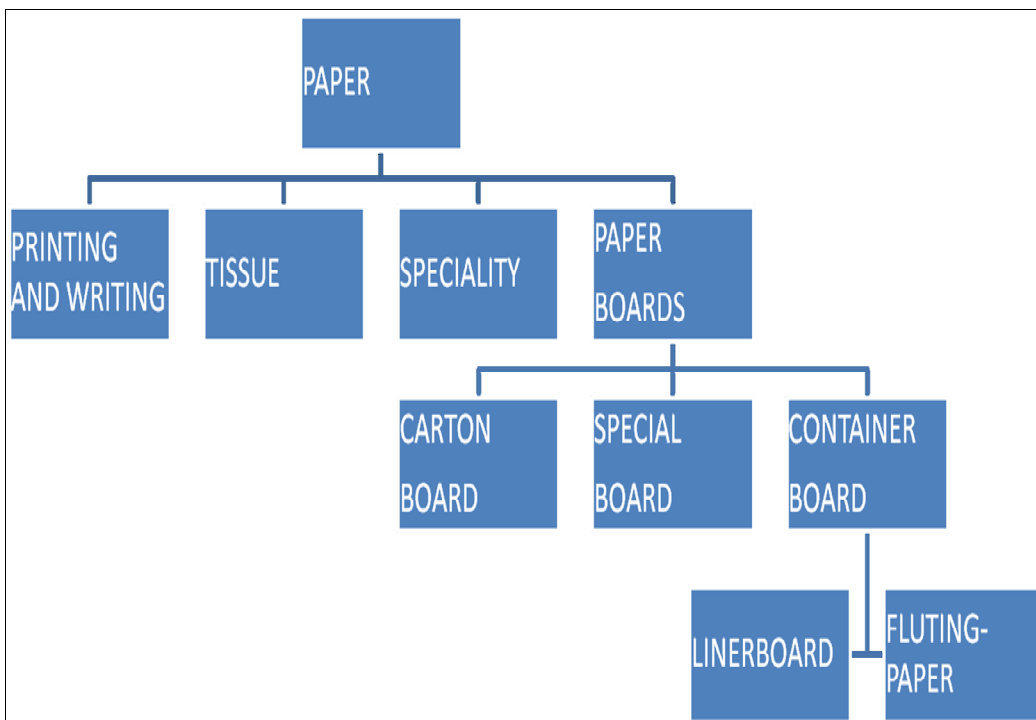


Figure 2.1: Classification of Paper (adapted from Paulapuro, 2000, p55)

Printing and Writing Papers

These papers used for printing and writing include newspapers, magazines, catalogues, books, commercial printing, copying, business forms, stationery, laser and digital printing (Paulapuro, 2000, p14). This category encompasses a wide range of paper grades that can be made of various raw material sources and various additives.

Tissue

Mark (1993, p497) describes tissue as those papers with grammages lower than fifty and that are lightly bonded, creped (formation of tiny waves in the paper to make the paper softer and more extensible). Tissue paper is mainly used for hygiene products for e.g. bathroom tissue, kitchen towels, facial tissues, etc. The important quality requirements for tissue are basis weight, absorbency, softness, thickness, tensile strength, brightness, stretch and general appearance of the product (Paulapuro, 2000, p82).

Speciality Papers

These papers are grades that do not primarily serve as information carriers, protection or as fluid absorbers, i.e. they do not fall into any of the other three grades of paper. These papers have specific features (e.g. electrical conductivity, heat resistance, chemical resistance, etc) and have specific uses (Paulapuro, 2000, p102). The specific feature has high importance for the function or quality of the paper. These papers have high costs because the paper is very specialized for their particular end use.

Paperboards

Paperboards are further categorized into cartonboards, special boards and containerboards. Cartonboards are mainly used for consumer product packaging (e.g. cigarettes, food, milk, etc). The important properties for cartonboards include strength, stiffness, bulk, porosity, cleanliness and good print quality

(Paulapuro, 2000, p55). Special boards are those board grades that are not used for packaging, for example wallpaper base paper, plaster board (used as liners for gypsum board used for wall cladding) and core board (used to make cores for paper rolls).

Containerboards are used to construct corrugated boxes/containers or simply boxes, which finds its application mainly in packaging. Containerboard is made of three or more layers of paper (refer to Figure 2.2) which are laminated together, to create a lightweight but strong composite product. The outer layers are the linerboards (liners), while the middle layer is the fluting manufactured from fluting-paper.

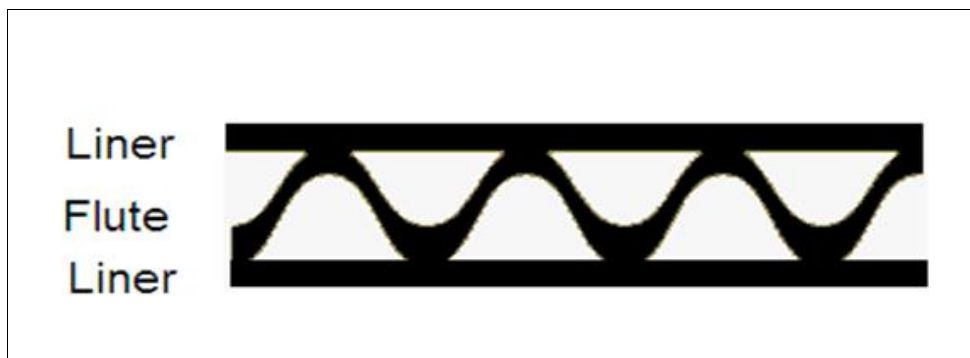


Figure 2.2: Containerboard Construction (Perkins and Schnell, 2000, p60)

2.3.2 Customer Needs

The quality of fluting-paper should be defined by customer needs, if quality is defined as customer satisfaction. Therefore to study the quality of fluting-paper, the customer needs should be determined. Customer needs and the corresponding technical characteristics are therefore investigated. According to the SABS 431 (1985, p7) there are four technical specifications for fluting paper, these are grammage, tensile strength, tear and flat crush. In addition to these specifications the SABS standard also indicates important customer needs of fluting paper, which are discussed below. Other literary sources supporting these SABS specifications as important to customers are discussed below together with

additional customer needs and fluting-paper technical characteristics. The technical characteristics and specifications of fluting paper are described in Appendix 3.2.

In addition to the SABS standard, strength has been identified by Whitsitt (1989, p137), Laakso and Rintamäki (2003), Skuratowicz (2007) and the RPA (www.rpa100.com) as an important need to the customer. The technical characteristics describing strength are tensile strength, ring crush, tear and flat crush (Mark et al, 2002, p648).

Laakso and Rintamäki (2003), Skuratowicz (2007) and RPA (www.rpa100.com), have highlighted that fluting-paper must also be able to be glued onto the liner without much difficulty. Laakso and Rintamäki (2003) indicate that the ability to be glued (glueability) is dependent on various properties of fluting-paper, of which porosity is one. Porosity has also been indicated by Komulainen et al (2007, p25) as important to several paper characteristics including glueability. Skuratowicz (2007) suggest various paper properties that influence glueability, of which grammage and

During a study conducted by Whitsitt (1987, p5) it was found that the runnability {the ability of the sheet to withstand the stresses and strains of the corrugating operation without fracture of the flutes (Smook, 1990, p233)} of fluting-paper is important to customers. The corrugator's runnability is dependent on fluting-paper properties such as tensile strength, stretch and thickness (Skuratowicz, 2007 and Mark et al, 2002, p 567). Others (Laakso and Rintamäki, 2003 and RPA (www.rpa100.com)), have also substantiated runnability as important to corrugators.

The RPA (www.rpa100.com) and Skuratowicz (2007) found that customers viewed printability (the ability to obtain good quality printing on the surface of the containerboard) as important to customers. Paper properties affecting printing include optical properties such as whiteness and brightness, moisture content,

grammage and thickness (Glassman, 1985, p295). Brightness and colour which are customer needs that are also measurable paper characteristics were determined by RPA (www.rpa100.com) as important to the customers.

Curl which is indicated as a customer need by Skuratowicz (2007 and RPA (www.rpa100.com) is also a measurable paper property, that may be inherent in the paper when manufactured or developed in the sheet during processing operations (ISO 11556:1998).

Scoreability is the ability to create a crease in the board to facilitate the folding of the panels or flaps of the board (Mark et al, 2002, p579). Scoreability is largely dependent on paper properties such as grammage, moisture and stiffness (Mark et al, 2002, p580). Scoreability of the paper was specified by the RPA (www.rpa100.com) as important.

Smoothness which is also found as important by the RPA (www.rpa100.com) is a customer need that is also a measurable paper characteristic. Cleanliness was identified as important by RPA (www.rpa100.com). The SABS standard (SABS 431, 1985, p7) also stipulates that fluting-paper must be clean and free from all impurities that may cause wear to the corrugator rolls.

These findings on the important customer needs of fluting-paper are summarized in Table 2.2, together with the literature source. These customer needs are the determinants of the quality of fluting-paper, as seen by the customer. The corresponding technical characteristics describing each customer need are shown in the last column of Table 2.2.

Table 2.2 Summary of Important Customer Needs and Technical Characteristics from Literature

<i>No</i>	<i>Customer Need</i>	<i>Source</i>	<i>Technical Characteristic</i>
1	Strength	Whitsitt(1989, p137), Laakso and Rintamäki(2003), RPA (www.rpa100.com), Skuratowicz (2007) SABS (SABS 431, 1985, p7)	Tensile strength, stretch, flat crush, ring crush, tear, grammage
2	Cracking	SABS (SABS 431, 1985)	Moisture, grammage, stiffness
3	Glueability	Laakso and Rintamäki(2003), RPA (www.rpa100.com)	Moisture, grammage, porosity, stiffness
4	Runnability	Laakso and Rintamäki (2003), Whitsitt (1987), RPA (www.rpa100.com)	Tensile strength, stretch, moisture, stiffness grammage, thickness
5	Printability	RPA(www.rpa100.com)	Brightness, colour, moisture content, grammage and thickness
6	Curl	RPA(www.rpa100.com), Skuratowicz (2007)	Moisture
7	Brightness	RPA(www.rpa100.com)	Brightness
8	Colour	RPA(www.rpa100.com)	Colour
9	Scoreability	RPA(www.rpa100.com)	Moisture, grammage, stiffness
10	Smoothness	RPA(www.rpa100.com)	Smoothness
11	Cleanliness	RPA(www.rpa100.com), SABS(SABS 431, 1985)	Dirt count

2.4 MANUFACTURE OF FLUTING-PAPER

Fluting-paper is made using the paper manufacturing process, at a mill. Smook (1997, p2) explains that modern pulp and paper mills use processes that are highly automated and often computer controlled. Further to being highly automated, papermaking is capital intensive, a high water and energy consumer and is complex.

Bolam (1965, p98) provides useful descriptions and definitions of the paper manufacturing process. The manufacture of paper is made in two stages viz. pulpmaking and papermaking. Pulpmaking is the process of converting the raw materials (fibres and chemicals) to a suspension in water. Papermaking is known as the process during which the raw materials are separated or drained from the water suspension, then pressed and dried.

Paper manufacture begins with the preparation of the pulp, or pulpmaking. Refer to Figure 2.3. Pulp used in the manufacture of fluting-paper can be made from recovered paper (those fibres that have been used in paper previously), mechanical pulp (pulp produced from wood by mechanical means such as grinding) or chemical pulp (pulp produced from wood using chemicals such as magnesium sulphite).

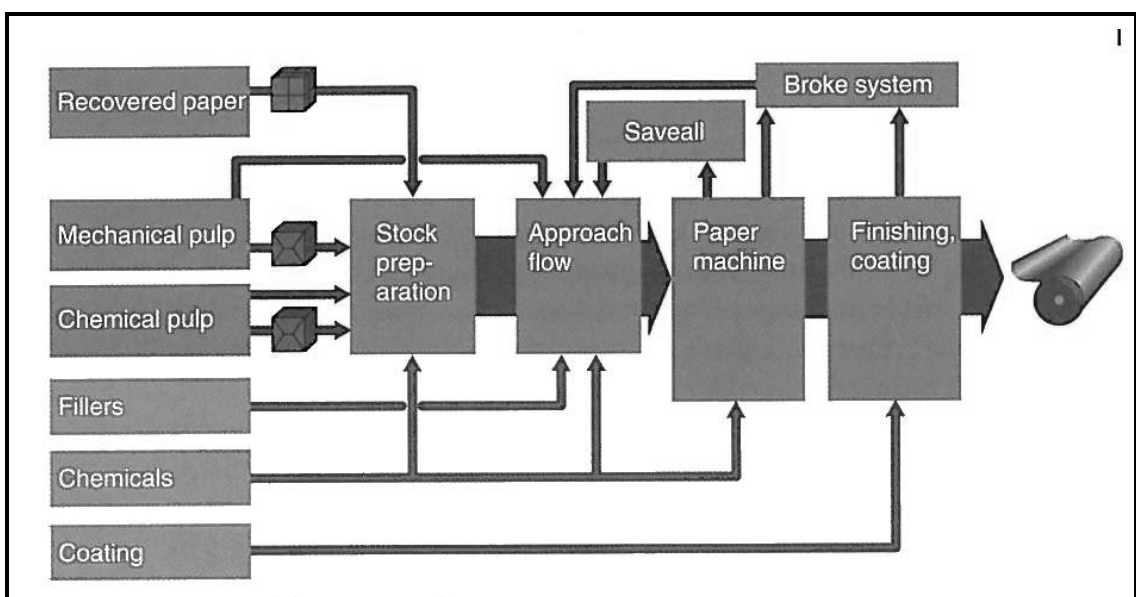


Figure 2.3: An Overview of the Papermaking Process (Holik, 2006, p5):

The overview of the papermaking process, Figure 2.4, shows the process starting with the addition of fillers (non-fibrous additives, e.g. calcium carbonate) and chemicals together with the pulp to the stock preparation stage. The pulp flows through the approach flow to enter the papermachine where a sheet of paper is formed. Finishing and coating operations process paper into forms that are more suited to the customer requirements. These processes are discussed below.

Stock Preparation, Approach Flow and Saveall

During the pulping stage, wood which is the basic raw material used in the manufacture of paper is chipped before being “cooked” in a pressurized vessel with a sodium hydroxide and sodium sulphide solution. The purpose of this is to separate the fibres, by dissolving the lignin (the naturally occurring glues in wood) holding them together, so that they may be reformed into a sheet of paper. The approach flow system connects the stock preparation to the papermachine and serves to regulate the consistency of the pulp flowing to the papermachine and ensures that the pulp is adequately and correctly dosed with the necessary fillers using a series of pumps. The saveall serves to recover the reusable fibres and fillers from the water streams by flotation or filtration methods.

Broke system

Broke is defined in the paper making terminology as partly or completely manufactured paper that is discarded from any point in the papermaking process. The broke system consists of a series of mixers and disintegrators that takes discarded paper and re-pulps it so that it can be reintroduced into the pulp mixtures and reworked into paper.

Papermachine

The papermachine is a “large scale multi-component integrated equipment for the continuous manufacture of paper from fibrous and non-fibrous materials” (Smook, 1990, p186). The papermachine consists of various pieces of equipment,

viz. the headbox, the wire section called the fourdrinier table, the press section, the dryer section, sometimes a coating section, and often a calendar (Holik, 2006, p5).

The pulp, which is mixed with chemical additives and water to form a suspension, termed “stock or furnish” enters the papermachine at the headbox at a controlled rate (refer to Figure 2.4). While flowing over the felt of the papermachine, water is drained from the pulp suspension and a sheet of paper is formed which has about eighty percent water. This part of the papermachine is known as the wet end. Before drying, the sheet of paper is pressed, between large rolls to remove as much of the water as possible, in the press section. The paper is dried to moisture contents of between 3% and 8%, while passing over drying cylinders that are steam heated, in the dryer section or dry end of the papermachine. The calendar stack is a series of heated rolls that “iron” out the paper to create a smoother sheet of paper.

Finally, at the end of the machine, the paper is wound into a large reel of paper that is the full width of the papermachine, over a spool. Once the reel has reached the desired size (mass or diameter) it is lifted off the machine and a new spool is placed in its original position.

Finishing and Coating

The full width machine spool may be the correct size required by the customer, but very often, the customer requires smaller sizes of paper rolls. Most mills have a winder, the purpose of which is to cut and wind the full width machine spool into suitable size rolls for the customer (Smook, 2002, p280). During winding the two edges of the reel are trimmed off (this is referred to as “trim”). These rolls of paper are wrapped and transported by road-truck to the customer.

On certain grades of papers, coatings are applied onto the surface of the paper. Coatings are made of pigments such as clays which serve to improve the feel of

the paper and the ability to print on the paper for applications such as magazines. There are various methods of applying coatings to paper, for example, a two-roll system known as a rod coater is a typical coater used in the paper industry.

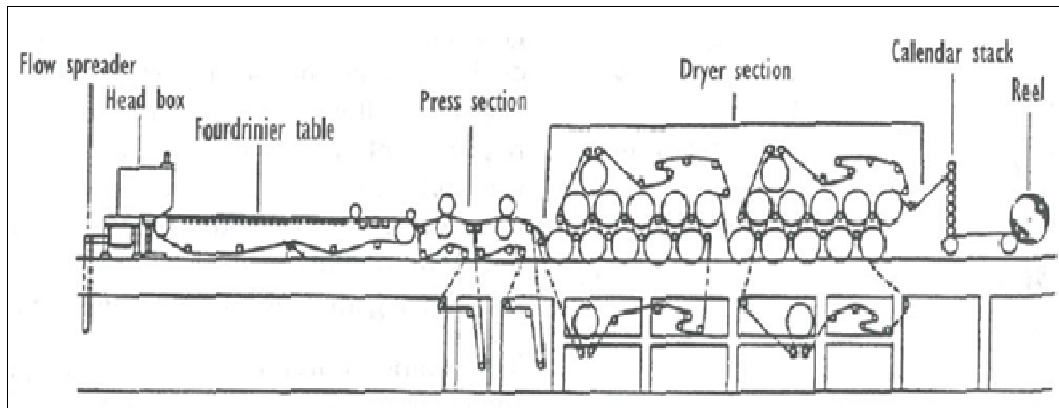


Figure 2.4: The Papermachine (Perkins and Schnell, 2000, p12)

Corrugation

The corrugation process is performed by the customers, at their plants. To make the fluting used in the construction of containerboard, fluting-paper is purchased by the customers from mills. The fluting-paper is pre-heated and steamed to about 100°C to soften the cellulose and to enable easier formation of “waves”. The softened sheet of paper is drawn between a pair of gear like cylinders (refer to Figure 2.5) called corrugating rolls to shape the paper into a series of precise “waves”. The “wave” shape provides the very high compression resistance and strength characteristics important to the containerboard. Linerboards are then glued to the peaks of the fluting-paper with starch to produce a product composed of a linerboard, flute, and linerboard. This is the basic composition (refer to Figure 2.2.) of a containerboard used in the manufacture of corrugated boxes.

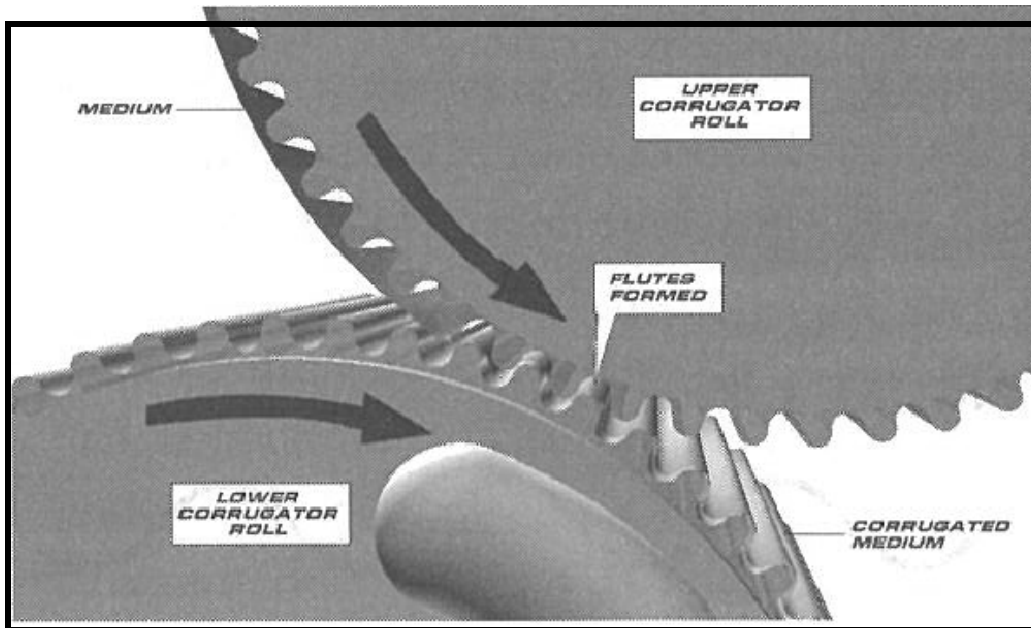


Figure 2.5: Flute Formation (Perkins and Schnell, 2000, p60)

2.4.1 Technical Specifications of Fluting-Paper

Customers are not always aware of the characteristics needed to satisfy their demands (Mark, 1993, p2). Testing of the technical characteristics of products is often needed to describe the functional requirements or customer needs made on the product. The starting point of controlling quality is a specification which reflects the customer needs (Kaydos, 1991, p105 and Burge, 1990, p7)). The testing of the product also enables tangible specifications of the product to be established. This is often used as quality assurance checks to ensure certain characteristics of the product are within the target range or meets the technical specifications as desired by the customer. The technical specifications as indicated by the South African Bureau of Standards are shown in Table 6.2 and those set by the company are shown in Table 6.3. These technical specifications provide target values for the technical characteristics of grammage, tensile strength, tear, flat crush, moisture, thickness, ring crush, porosity and water flotation. Quality assurance testing of fluting-paper is done at the mills to provide quantitative values to the technical characteristics of the product to ensure that these are characteristics equal or better than the specifications. A brief discussion is made on the tests performed on fluting-paper to quantify these technical characteristics in Appendix 3.2.

2.5 PROCESS MEASUREMENT: CULL

Gryna et al (2007, p172) emphasise that quality measurement is central to the process of quality control as this may be an early warning of problems, help in diagnosing problems, quantify product and process capabilities and from strategic point assist in providing input for setting goals.

Reese (2005, p61), conducted a papermachine performance analysis, and provides knowledge on the operating characteristics and major concerns of papermachines. Some of these characteristics form the quality measurements which are central to quality control of the process. The operating characteristics indicated in the survey as important to quality include amongst others grammage, downtime, efficiencies, yield, percent first quality, and cull.

Several examples of quality measurements in manufacturing are proposed by Gryna et al (2007, p423). These include amongst others, number of defects, percentage of output shipped under waiver of specifications, amount of scrap, rework and yield. According to Gryna et al (2007) the amount of rework in terms of quantity, cost or percentage is a useful unit of measure of quality. Rework is an indication of poor quality paper produced on the machine that does not meet specifications.

Cull is defined as paper that does not meet manufacturing specifications and is returned to the papermaking process for reprocessing. Cull is in essence the term used in the pulp and paper industry for rework. Fluting-paper must meet the nine specifications (SABS and company specifications) of grammage, tensile strength, tear, flat crush, moisture, thickness, ring crush, porosity, and water flotation before it is passed by the quality assurance department. Paper not meeting these technical specifications is culled. In addition to the technical specifications; mills also cull paper for other reasons such as cracking, poor winding, during starting up of the machine and poor aesthetics of the paper.

Gryna et al (2007, p172) also further explain that measurements should emphasize customer-related measurements that are useful. Customer requirements need to be reflected in the product design and manufacture. So, besides reducing cull to reduce costs and improve efficiencies paper needs to be reworked for the correct reasons, i.e. for reasons relating to customer needs. A comparison of cull to the technical specifications, to the customer needs and customer complaints can therefore provide meaningful information to determine if the company produces fluting-paper consistently according to technical specifications that meet the customer needs.

2.6 SUMMARY OF THE QUALITY OF FLUTING-PAPER

The definition of quality points out that quality is defined by the customer and the customer requirements are critical when considering the quality of a product. Garvin's (1987, p43) eight dimensions of quality provide eight attributes of a product that contribute to satisfying the customer. These dimensions of quality can be used together with customer surveys and quality function deployment as measures of customer satisfaction. Customer complaints are also widely promoted as a measure of customer satisfaction (Crosby, 1996, Juran, 1992, Kaydos, 1991 and Maskell, 1991).

The customer needs of fluting-paper may be described by the technical characteristics of fluting-paper as determined by quantitative product testing. There are existing technical specifications for fluting-paper which are set by the company and by the SABS. The fluting-paper must therefore be manufactured such that it meets these specifications. Should the paper not meet the technical specifications, the paper is reworked or culled. There are several reasons in addition to these technical specifications for which paper is culled at mills.

It therefore is a starting point that fluting-paper quality can be measured by the interaction with the customer in terms of surveys, QFD and customer complaints. These customer needs and complaints must then meet the technical specifications

in order to satisfy the customer. It must also be ascertained as to whether paper is culled for the correct reasons, and whether the reasons for cull correspond with the customer needs and technical specifications to ensure that the customer receives paper that meets the technical specifications and that the customer is satisfied.