Total Quality Management

'L' Scheme Syllabus

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TOTAL QUALITY MANAGEMENT

PREFACE

This book covers all the topics in a clear and organized format for the Second year Diploma in Printing Technology students as prescribed by the Directorate of Technical Education, Chennai, Tamilnadu. It is confidently believed that this book furnishes the students the necessary study material. The topics covered were neatly illustrated for better understanding of the students.

The book's step-by-step lessons in large, eye pleasing calligraphy make it suitable for both direct one-to-one tutoring and regular classroom use. The book is prepared in normal everyday English and is free from professional jargon characteristic of so many reading instruction books.

All of the lesson pages were carefully designed to eliminate distraction and to focus the pupil's full attention on the work at hand.

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UNIT - I – INTRODUCTION

1.1 DEFINITION:

Quality is sometimes defined as "meeting the requirements of the customer."

The term **quality assurance** describes any systematic process for ensuring quality during the successive steps in developing a product or service.ISO 9000 is a standard for ensuring that a company's quality assurance system follows best industry practices.

Quality in business, engineering and manufacturing has a pragmatic interpretation as the non-inferiority or superiority of something; it is also defined as "fitness for purpose". Consumers may focus on the specification quality of a product/service, or how it compares to competitors in the marketplace.

There are five aspects of quality in a business context:

- Producing - providing something.
- Checking - confirming that something has been done correctly.
- Quality Control - controlling a process to ensure that the outcomes are predictable.
- Quality Management – directing an organization so that it optimizes its performance through analysis and improvement.
- Quality Assurance – obtaining confidence that a product or service will be satisfactory. (Normally performed by a purchaser)

Meaning of the term – quality

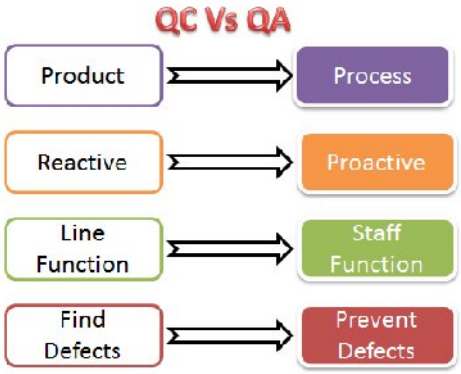
Quality has many meanings – many of them are subjective, such as the term "excellent" or "outstanding" quality. In the quality management field, quality has a more specific meaning.

"According to ISO 9001:2008, quality is defined as "the degree to which a set of inherent characteristics fulfills requirements".

The very favorable experience of the client of a business when they have received a good or service that significantly surpasses what they had initially anticipated.

A marketing department can use instances of customer delight to a company's advantage by requesting referrals and obtaining testimonials from delighted customers that can help attract new customers.

Definition: Quality assurance refers to the processes and procedures that systematically monitor different aspects of a service, process or facility to detect, correct and ensure that quality standards are being met.



Assurance: The act of giving confidence, the state of being certain or the act of making certain.

Quality Assurance: The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.

Control: An evaluation to indicate needed corrective responses; the act of guiding a process in which variability is attributable to a constant system of chance causes.

Quality Control: The observation techniques and activities used to fulfill requirements for quality.

Customers demand high-quality print jobs without variations or defects. Specifications, measurements, and controls must be established in every department to ensure predictable, reliable printing and a quality finished product. Quality controls facilitate the superior and consistent results you expect and that your customers demand.

Definition: Process control refers to the methods that are used to control process variables when manufacturing a product. For example, factors such as the proportion of one ingredient to another, the temperature of the materials, how well the ingredients are mixed, and the pressure under which the materials are held can significantly impact the quality of an end product. Manufacturers control the production process for three reasons:

- Reduce variability
- Increase efficiency
- Ensure safety

What is Total Productive Maintenance (TPM)?

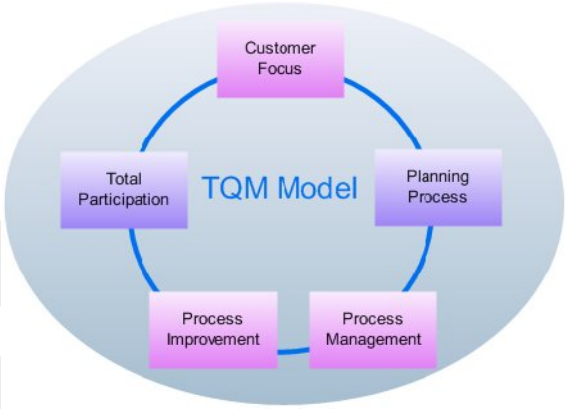
Total productive maintenance (TPM) is the systematic execution of maintenance by all employees through small group activities.

Analyzing the three words of T, P, M we have

- Total – all encompassing maintenance and production individuals working together.
- Productive – production of goods and services that meet or exceed customers' expectations.
- Maintenance - keeping equipment and plant in as good as better than the original condition at all times.

What is Total quality management (TQM)?

TQM is a set of systematic activities carried out by the entire organization to effectively and efficiently achieve company objectives so as to provide products and services with a level of quality that satisfies customers, at the appropriate time and price.



TQM – Definition "Explanation of key terms"

- Systematic activities – Planned, strong leadership, Mid and long term vision, strategies and policies
- Entire organization – everyone at all levels, across functions
- Effective and efficient – achieve planned results with least resources
- Quality – usefulness, reliability, safety

A scientific, systematic, companywide activity "in which a company is devoted to customers through its products and services.

Focuses on customer satisfaction – the only guarantee for long term survival assured "quality" in every process is the objective of TQM.

What is ISO?

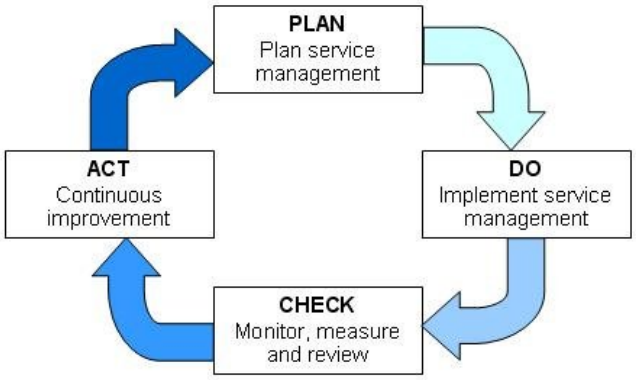
ISO (International Organization for Standardization) is the world's largest developer of voluntary International Standards. International Standards give state of the art specifications for products, services and good practice, helping to make industry more efficient and effective. Developed through global consensus, they help to break down barriers to international trade.

What we do?

ISO develops International Standards. We were founded in 1947, and since then have published more than 19 500 International Standards covering almost all aspects of technology and business. From food safety to computers, and agriculture to healthcare, ISO International Standards impact all our lives.

PDCA – The cycle of management

- Plan
  - Establish your objectives
  - Make plans
    a) Analyze your organization's situation
    b) Establish your overall objectives
    c) Set your targets
    d) Develop plans to achieve them
- DO
  - Implement your plans
- Check
  - Measure your results
- Act
  - Correct and improve you plans and how put them into practice



1.2 QUALITY CONTROL PROCESS:

A system for maintaining desired standards in a product or process by inspecting samples of the product.

Maintenance of standards of quality of manufactured goods.

Quality is the key element in every stage of the production process from raw materials to finished product. Every manufacturer is faced with the problem if maintenance of the quality of his product. The term "Quality Control" is used to coordinate all those activities which are directed for defining controlling and maintaining quality.

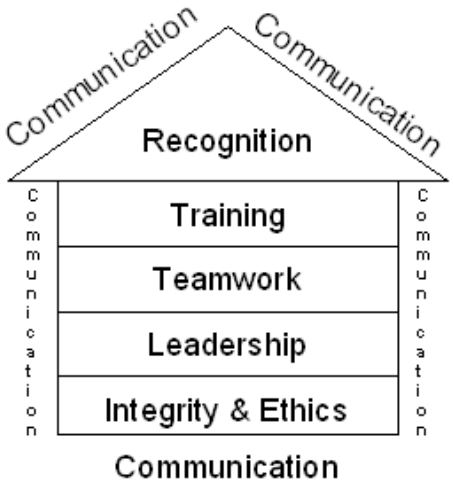
Definition – Quality Control is systematic control by management of the variables in the manufacturing process that affect goodness of the end product.

Quality control may be defined as that technique or group of techniques of the industrial management by means of which products of uniform acceptable quality are manufactured.

The Eight elements Quality Control Process:

To be successful implementing TQM, an organization must concentrate on the eight key elements:

1. Ethics
2. Integrity
3. Trust
4. Training
5. Teamwork
6. Leadership
7. Recognition
8. Communication



These elements can be divided into four groups according to their function. The groups are:

I. Foundation – It includes: Ethics, Integrity and Trust.

II. Building Bricks – It includes: Training, Teamwork and Leadership.

III. Binding Mortar – It includes: Communication.

IV. Roof – It includes: Recognition.

1. Ethics

Management draws up a business code of ethics to which all personnel should adhere. Sometimes an external company is contracted to help produce a document.

2. Integrity

Clients expect to find integrity in an organisation. Integrity encompasses morals, values, fairness, honesty and sincerity. If somebody makes a mistake, they should feel comfortable in admitting their error.

3. Trust

TQM cannot work without trust. It is essential for both the clients and the individual participants at all levels of the company. When workers are trusted to make decisions, they start to take pride in the organisation for which they work.

4. Training

Workers can only be highly productive when they receive appropriate training. Training can focus on areas such as interpersonal skills, working in a team, problem solving or performance analysis. Training should be on-going and given as the need arises.

5. Teamwork

The *Total* in TQM refers to the total involvement of an organisation's staff. People working in a team are more likely to make creative suggestions than those working in isolation.

6. Leadership

Leadership does not only refer to top management. In the case of TQM leadership is found at all levels. Workers need to be guided by leaders with a clear vision of the company's goals.

7. Communication

Communication is the vital link between all of the organisation's elements. Information needs to be shared regularly and constantly. Communication takes place in three directions: downwards from top management to employees; upwards where workers provide management; and sideways where communication crosses over between different departments and to external suppliers and customers.

8. Recognition

Individuals and teams should have their efforts, ideas and achievements recognised. Recognition increases self-esteem and this, in turn, increases productivity. Recognition should come as soon as possible after the act that is being recognised.

Key role of process management:

1. Establishment of the quality standards which are acceptable to the customer and economical for the manufacturing operations to maintain.
2. Location of flaws in the raw materials or in the processing of that material which will cause trouble at subsequent operations.
3. To analyze the trend and extent of quality deviation in a part or product during manufacturing process.
4. Determination of the cause of such deviation where it is not due to chance variables.
5. Taking the necessary corrective steps to keep the quality of the product from dropping below the tolerance limits.
6. To segregate defective goods and ensure that customers will receive only products of acceptable quality.

Process management, in turn, must be:

- effective by meeting at least minimum customer expectations and strive to delight the customer;
- efficient by producing required output at minimum cost;
- Adaptable by maintaining effectiveness and efficiency as customer requirements change the strategic period.

Steps for Process Management

There are 7 steps or stages to business process management and they are:

Stage 1: Evaluation

- Determine the process for improvement.
- Form the Process Management team.
- Define the roles & responsibilities of the team members.
- Identify process goal, objectives and expected outcomes.

Stage 2: Identify the Stakeholder

- Identify all stakeholders impacted by the process.
- Identify stakeholder requirements from the process.

Stage 3: Describe the Current Process

- Define the current performance of the process.
- Flowchart the current process.

Stage 4: Measure the Process

- Measure the current performance of the process.
- Identify qualitative and quantitative measures.

Stage 5: Identify Blockages and Barriers

- Identify the blockages and barriers preventing you from immediately realizing your goal.
- Apply a problem solving technique to identify all possible blockages and barriers that may be preventing you from realizing the customer requirements.

Stage 6: Root Cause Analysis

- Delve into the source of every identified blockage.
- Explore the causes of every identified barrier.

Stage 7: Develop Solutions and the Implementation Plan

- Develop solutions.
- Prioritize solutions.
- Describe the new process:
- Identify the impact on internal and external customers.
- Re-organize the structure according to plan.
- Pilot the new process.
- Measure the new process capabilities.

1.3 Basic Elements of TQM

1. Focus on customer (internal and external)
2. Involvement of the entire printing organization
3. Requires a team effort
4. Empowerment of employees of the printing company
5. Develop a mind-set for process improvement
6. Benchmark for process improvement
7. Partner with suppliers and customers
8. Re-engineer where needed

1. Focus on customer (internal and external)

The customer is usually viewed as the one who purchases the printed product produced by the printing company - e.g. brochure, book, magazine, label, package, etc. These customers are referred to as **external customers**. However, there are customers who are part of the process e.g., sales request, estimate, artwork, assembled image, color separation, printing plate, printing, and finished product or - the delivery of this product. These customers are referred to as **internal customers.** These needs must be translated into specifications that can be met or exceeded on a consistent basis.

2. Involvement of the entire printing organization

When a job is rejected or the customer requests a price reduction or even worse if the customer goes to your competitor for new or remake work, it is never because the job is defective in every way possible but because some specific defect (or defects) is not acceptable to the customer. Any one department can do a bad or good job and it does not matter; it is the entire job that is accepted or rejected. TQM is putting together all the small elements so that the entire job is excellent and the customer is satisfied.

3. Team Effort

Teams must be trained in how to function, and they must be given the tools needed to work together effectively. Members must be able to offer suggestions and resolve particular problems in a timely and cost-effective manner. Teams can not be set up without being given the proper time to train, time allocations for results, and financial support to sustain their efforts.

4. Empowering Employees

The empowerment goal is to improve quality, productivity, and service. To empower the work force means more than listening to requests for changes in materials, working procedures, equipment, training, communication systems, and other areas that will assist the employee in doing the job more effectively. Empowerment means encouraging and training

the work force to take responsibility for making decisions relating to quality, productivity, and service to the customer.

5. Mind set for Process improvement

Process improvement requires a mind-set for change. Process improvement requires that you understand each step in the total operation of your organization and how these steps are interconnected. Processes involving more than one person should be done by the entire group involved in that particular process. It is necessary to first determine what is being done presently before working on process improvement steps.

6.Benchmark for Process Improvement

Benchmarking is the process of measuring your company's performance in each function and comparing that level of performance with the level of performance achieved by successful leaders. There are three types of benchmarking:

- Internal benchmarking,
- Competitive benchmarking
- Generic (world-class) benchmarking

Benchmarking can and should be in all areas of your organization including, but not limited to, the primary areas of manufacture as well as the areas of marketing, sales, billing, training, maintenance, and inventory control.

7. Partnering with Suppliers and Customers

Partnering means working together for the common good. When companies purchase their printing materials and supplies by price alone, the ultimate cost may far and away exceed choosing suppliers for their service, quality, and price. These are the suppliers that will suggest new and different materials and procedures and will offer an overall more intimate working relationship. What is true of supplier partnerships is also true of customer partnerships. To maintain customer partnerships requires that you have an intimate knowledge of the business needs of your customer.

8. Re-engineering the Printing Organization

Re-engineering is radical change, while process improvement is incremental in nature. Finding faster or more user friendly prepress films is process improvement. The moves from dark room compositing to a daylight environment or from lith chemistry to rapid-access chemistry for film development were process improvements. However, when we bypass the entire darkroom process and go from design concept, generated in digital form on a computer and scanner, directly to press with this digital information, that is re-engineering.

1.4 WHAT IS STATISTICAL PROCESS CONTROL (SPC)

Statistical Process Control, commonly referred to as SPC, is a method for monitoring, controlling and, ideally, improving a process through statistical analysis.

Statistical process control (SPC) is a method of quality control which uses statistical methods. SPC is applied in order to monitor and control a process. Monitoring and controlling the process ensures that it operates at its full potential. At its full potential, the process can make as much conforming product as possible with a minimum (if not an elimination) of waste (rework or trash).

SPC is a practical statistical approach to resolving problems. If you do any type of measurement to help gather information and find a solution.

Purpose

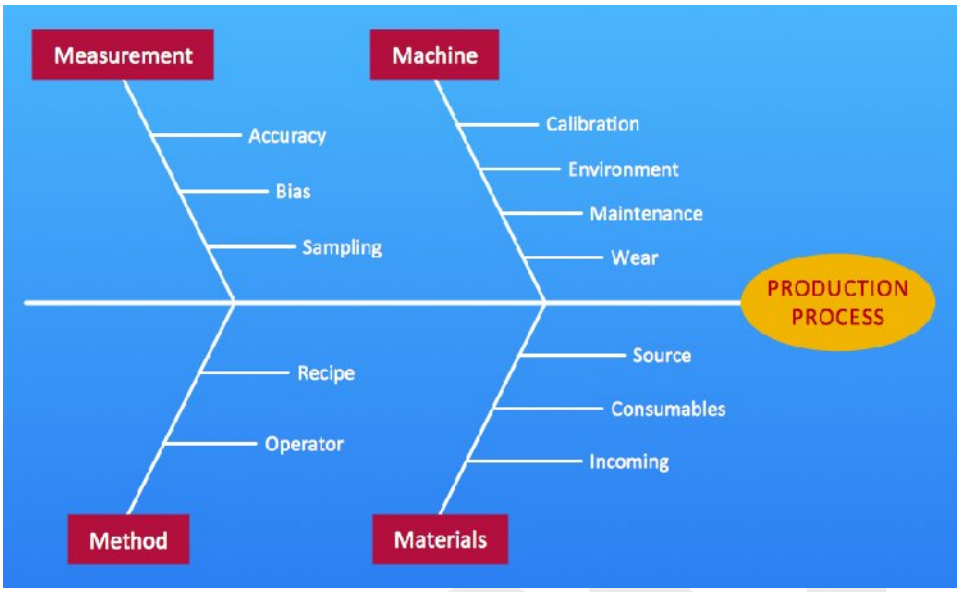
1. Prevent rather than detect defects
2. Indicate the need for corrective action
3. Continuous monitoring of the printing process
4. Direction for process improvement
5. Quantitative proof of quality
6. Identify the sources of variation
7. Determine process capability

Statistical Process Control (SPC) Tools:

1. Cause and effect diagram
2. Check sheet
3. Flow diagram
4. Pareto analysis
5. Histogram
6. Run chart
7. Control chart

1) Cause-and-Effect Diagrams

One analysis tool is the Cause-and-Effect (or Fishbone) diagram. These are also called “Ishikawa diagrams because Kaoru Ishikawa developed them in 1943. They are called fishbone diagrams since they resemble one with the long spine and various connecting branches.



The fishbone chart organizes and displays the relationships between different causes for the effect that is being examined. This chart helps organize the brainstorming process. The major categories of causes are put on major branches connecting to the backbone, and various sub-causes are attached to the branches. A tree-like structure results, showing the many facets of the problem.

The method for using this chart is to put the problem to be solved at the head, then fill in the major branches. People, procedures, equipment and materials are commonly identified causes.

2) Check Sheet

A check sheet is a sheet or form used to record data. It is one of the simplest method for collecting data and determining trends. The recording can be used to determine the occurrence of events such as non-conformity.

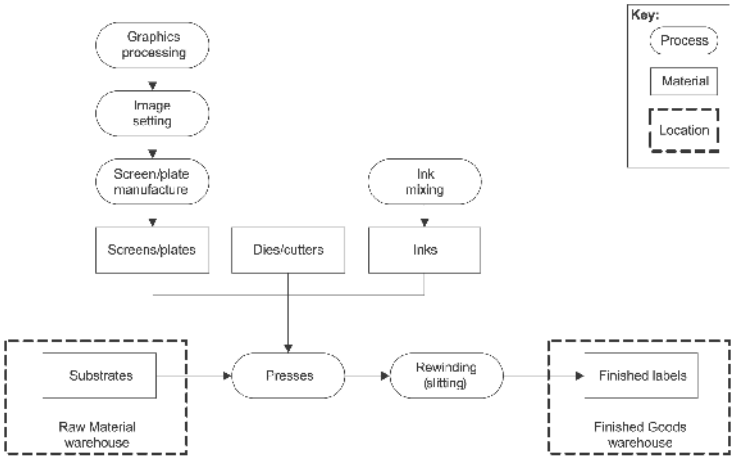
It is a way of collecting and classifying data so that it can be easily presented or analyzed. It is particularly useful at the start of a problem-solving process for data gathering. It can also be used for monitoring performance once change has been implemented.

Types of check sheet:

1. Production process distribution check sheet
2. Defective item check sheet
3. Defect location check sheet
4. Defect cause check sheet
5. Confirmation/inspection checklist

3) Flow diagram

Flow diagrams or charts (also known as **P*rocess map***) are used to assist in systemically breaking down the organizational process into a step by step picture of each component. Symbols are used to indicate activities, decisions, beginning and ending points and the flow that the process takes.

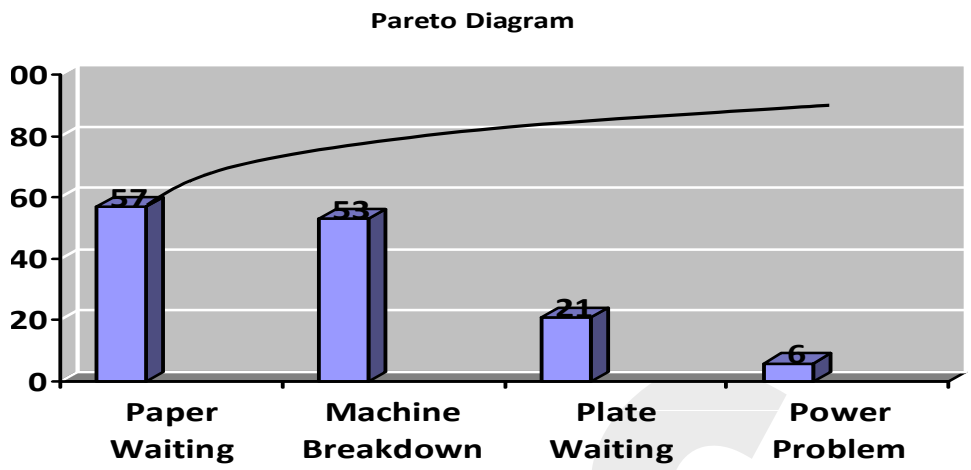


After a process has been identified for improvement and given high priority, it should then be broken down into specific steps and put on paper in a flowchart. This procedure alone can uncover some of the reasons a process is not working correctly. Other problems and hidden traps are often uncovered when working through this process.

4) Pareto Analysis

Pareto analysis is developed around the basic concept that 80% of a specific effect is due to 20% of the cause (80-20 rule). The Pareto chart can be used to display categories of problems graphically so they can be properly prioritized.

Defect	Weekly Total	% Total	Cum. %
Paper waiting	57	41.61	41.61
Machine breakdown	53	38.69	80.30
Plate waiting	21	15.33	95.63
Power problem	6	4.37	100.00
TOTAL	137	100.00	-

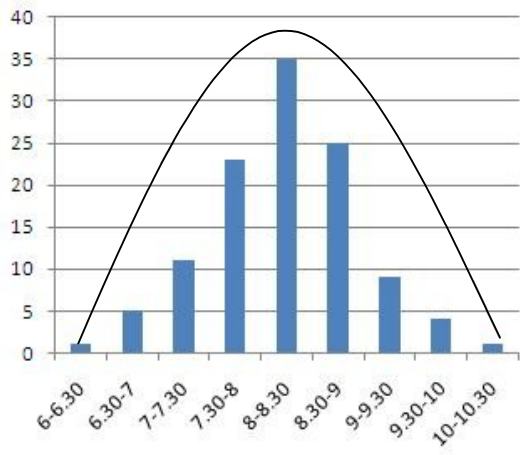


There are often many aspects of a process or system that can be improved, such as the number of defective products, time allocation, or cost savings. A Pareto chart or diagram indicates which problem to tackle first by showing the proportion of the total problem that each of the smaller problems comprise. ***This is based on the Pareto principle: 20% of the sources cause 80% of the problem.***

A Pareto chart is a vertical bar graph displaying rank in descending order of importance for the categories of problems, defects or opportunities. Generally, you gain more by working on the problem identified by the tallest bar than trying to deal with the smaller bars.

5) Histogram

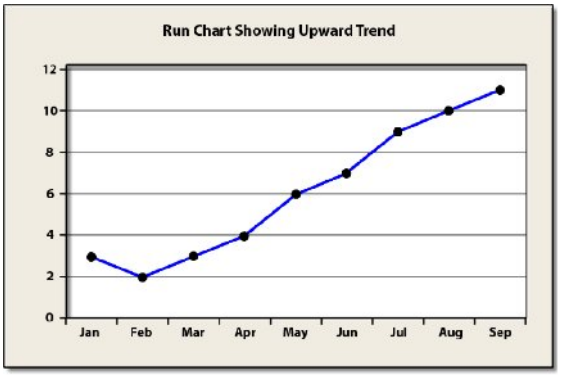
Histogram is used for illustrating the frequency and the extent in the context of two variables. Histogram is a chart with columns. This represents the distribution by mean. If the histogram is normal, the graph takes the shape of a bell curve.



Now you can put the data from the check sheets into a histogram. A histogram is a snapshot of the variation of a product or the results of a process. It often forms the bell-shaped curve which is characteristic of a normal process.

The histogram helps you analyze what is going on in the process and helps show the capability of a process, whether the data is falling inside the bell-shaped curve and within specifications.

6) Run Chart

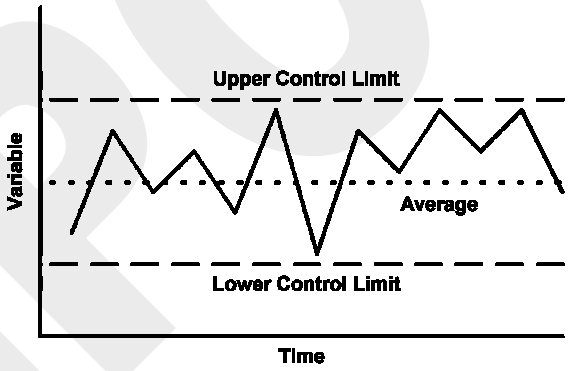


Run charts visually display the variation in a process over time. The run chart displays an average line taken from the data and will have data points and lines connecting them. In this manner the user can readily see how each data point varies from the average.

Run charts can also be used in most of a printing company to plot events over time. Some of these areas include sales calls per month, completed jobs per week, estimates per week, ink density per job and customer complaints.

7) Control Chart

Control charts typically display the limits that statistical variability can explain as normal. If your process is performing within these limits, it is said to be in control; if not, it is out of control.



Control chart is the best tool for monitoring the performance of a process. These types of charts can be used for monitoring any processes related to function of the organization.

These charts allow you to identify the following conditions related to the process that has been monitored.

- Stability of the process
- Predictability of the process
- Identification of common cause of variation
- Special conditions where the monitoring party needs to react

1.5 KAIZEN (OR CONTINUOUS IMPROVEMENT)

Japanese term for a gradual approach to ever higher standards in quality enhancement and waste reduction, through small but continual improvements involving everyone from the chief executive to the lowest level workers.

Kaizen, or ***'Continuous Improvement'*** is a policy of constantly introducing small incremental changes in a business in order to improve quality and/or efficiency.

Kaizen can be roughly translated from Japanese to

mean "good change." The philosophy behind kaizen is often credited to ***Dr. W. Edwards Deming.*** Dr. Demming was invited by Japanese industrial leaders and engineers to help rebuild Japan after World War II.

The five main elements of kaizen

- Teamwork
- Personal discipline
- Improved morale
- Quality circles
- Suggestions for improvement

Key features of Kaizen:

1. Improvements are based on many, small changes rather than the radical changes that might arise from Research and Development
2. As the ideas come from the workers themselves, they are less likely to be radically different, and therefore easier to implement
3. Small improvements are less likely to require major capital investment than major process changes
4. The ideas come from the talents of the existing workforce, as opposed to using R&D, consultants or equipment – any of which could be very expensive
5. All employees should continually be seeking ways to improve their own performance
6. It helps encourage workers to take ownership for their work, and can help reinforce team working, thereby improving worker motivation

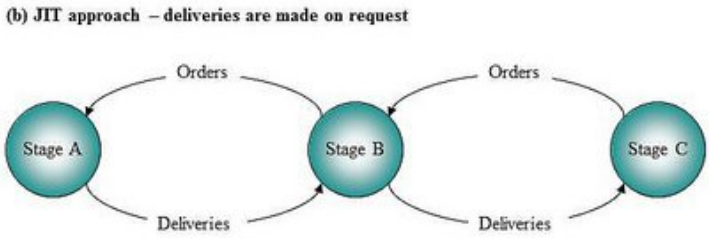
Benefits

The goal of kaizen is to eliminate waste in the process

- Making job easier
- Making job safer
- Making job more productive
- Removing donkeywork from the job
- Removing irritation from the job
- Improving product quality
- Saving time and cost

Just In Time (JIT)

An inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs.



Just-in-time (JIT) is an inventory strategy that strives to improve a business's return on investment by reducing in-process inventory and associated carrying costs. This saves warehouse space and costs. However, the complete mechanism for making this work is often misunderstood.

Just-in-time manufacturing was a concept introduced to the United States by the **Ford motor company.**

Main benefits of JIT include:

- Reduced setup time.
- The flow of goods from warehouse to shelves improves.
- Employees with multiple skills are used more efficiently.
- Production scheduling and work hour consistency synchronized with demand.
- Increased emphasis on supplier relationships.
- Supplies come in at regular intervals throughout the production day.
- Minimizes storage space needed.
- Smaller chance of inventory breaking/expiring.

5S

"5S" was invented in Japan, and stands for five (5) Japanese words that start with the letter 'S':

1. Seiri – Sort
2. Seiton - Set (in place)
3. Seiso - Shine
4. Seiketsu - Standardize
5. Shitsuke – Sustain

Japanese Term	English Equivalent	Meaning in Japanese Context
Seiri	Tidiness (Sort)	Throw away all rubbish and unrelated materials in the workplace

Seiton	Orderliness	Set everything in proper place for quick retrieval and storage
Seiso	Cleanliness	Clean the workplace; everyone should be a janitor
Seiketsu	Standardization	Standardize the way of maintaining cleanliness
Shitsuke	Discipline	Practice 'Five S' daily - make it a way of life; this also means 'commitment'

The 5S Process, or simply "5S", is a structured program to systematically achieve total organization, cleanliness, and standardization in the workplace. A well-organized workplace results in a safer, more efficient, and more productive operation. It boosts the morale of the workers, promoting a sense of pride in their work and ownership of their responsibilities.

1) Seiri

The first step of the "5S" process, seiri, refers to the act of throwing away all unwanted, unnecessary, and unrelated materials in the workplace. Even the number of necessary items in the workplace must be kept to its absolute minimum. Because of seiri, simplification of tasks, effective use of space, and careful purchase of items follow.

2) Seiton

Seiton, or orderliness, is all about efficiency. This step consists of putting everything in an assigned place so that it can be accessed or retrieved quickly, as well as returned in that same place quickly. The correct place, position, or holder for every tool, item, or material must be chosen carefully in relation to how the work will be performed and who will use them. Every single item must be allocated its own place for safekeeping, and each location must be labeled for easy identification of what it's for.

3) Seiso

Seiso, the third step in "5S", says that 'everyone is a janitor.' Seiso consists of cleaning up the workplace and giving it a 'shine'. Cleaning must be done by everyone in the organization, from operators to managers. No area should be left uncleaned. Everyone should see the 'workplace' through the eyes of a visitor - always thinking if it is clean enough to make a good impression.

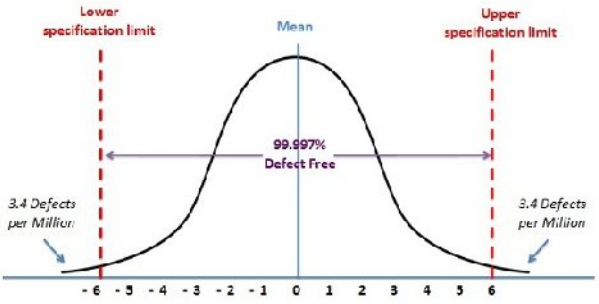
4) Seiketsu

The fourth step of "5S", or seiketsu, more or less translates to 'standardized clean-up'. It consists of defining the standards by which personnel must measure and maintain 'cleanliness'. Personnel must therefore practice 'seiketsu' starting with their personal tidiness. Visual management is an important ingredient of seiketsu. Personnel are trained to detect abnormalities using their five senses and to correct such abnormalities immediately.

5) Shitsuke

The last step of "5S", Shitsuke, means 'Discipline.' It denotes commitment to maintain orderliness and to practice the first 4 S as a way of life. The emphasis of shitsuke is elimination of bad habits and constant practice of good ones. Once true shitsuke is achieved, personnel voluntarily observe cleanliness and orderliness at all times, without having to be reminded by management.

Six Sigma



Six Sigma seeks to improve the quality of process outputs by identifying and removing the defects (errors) and minimizing variability in manufacturing and business processes.

It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Champions", "Black Belts", "Green Belts", "Yellow Belts", etc.) who are experts in the methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

Six Sigma is a set of strategies, techniques, and tools for process improvement. Six Sigma is a management philosophy developed by Motorola in 1981 that emphasizes setting extremely high objectives, collecting data, and analyzing results to a fine degree as a way to reduce defects in products and services. The ***Greek letter sigma*** is sometimes used to denote ***variation from a standard.*** The philosophy behind Six Sigma is that if you measure how many defects are in a process, you can figure out how to systematically eliminate them and get as close to perfection as possible.

Methods

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV.

1. DMAIC is used for projects aimed at improving an existing business process.
2. DMADV is used for projects aimed at creating new product or process designs.

DMAIC

The Six Sigma process is called Sigma DMAIC, which stands for "define, measure, analyze, improve, control." This set of steps scrutinizes existing processes that are known to fall short of Six Sigma requirements.

DMAIC is a tool for ***improving an existing process***. The steps can be summarized as follows.

- **Define:** State the problem, specify the customer set, identify the goals, and outline the target process.
- **Measure:** Decide what parameters need to be quantified, work out the best way to measure them, collect the necessary data, and carry out the measurements by experiment.
- **Analyze:** Identify gaps between actual and goal performance, determine causes of those gaps, determine how process inputs affect outputs, and rank improvement opportunities.
- **Improve:** Devise potential solutions, identify solutions that are easiest to implement, test hypothetical solutions, and implement actual improvements.
- **Control:** Generate a detailed solution monitoring plan, observe implemented improvements for success, update plan records on a regular basis, and maintain a workable employee training routine.

DMADV

DMADV is a process defined by Motorola as part of their Six Sigma management philosophy. DMADV is applied to ***new processes*** to make sure that they achieve Six Sigma quality. Six Sigma sets extremely ambitious goals to minimize the occurrence of flaws in products and services.

Those steps can be summarized as follows.

- **Define:** State the problem, specify the customer set, identify the goals, and outline the target process.
- **Measure:** Decide what parameters need to be quantified, work out the best way to measure them, collect the necessary data, and carry out the measurements by experiment.
- **Analyze:** Identify performance goals and determine how process inputs are likely to affect process outputs.

- **Design:** Work out details, optimize the methods, run simulations if necessary, and plan for design verification.
- **Verify:** Check the design to be sure it was set up according to plan, conduct trials of the processes to make sure that they work, and begin production or sales.

Six Sigma key roles for implementation

Six Sigma identifies several key roles for its successful implementation.

- **Executive Leadership** includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements.
- **Champions** take responsibility for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts.
- **Master Black Belts,** identified by champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist champions and guide Black Belts and Green Belts. Apart from statistical tasks, they spend their time on ensuring consistent application of Six Sigma across various functions and departments.
- **Black Belts** operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their valued time to Six Sigma. They primarily focus on Six Sigma project execution and special leadership with special tasks, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.
- **Green Belts** are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts.
- **Yellow Belts,** for employees that have basic training in Six Sigma tools and generally participate in projects and **"White belts"** for those locally trained in the concepts but do not participate in the project team. **"Orange belts"** are also mentioned to be used for special cases.

TPM (Total Productive Maintenance)

TPM is referred to as ***total productive maintenance*** but Toyota increasingly replace "productive" with professional. The aim is to have zero breakdowns with the use of systematic maintenance techniques. The maintenance team progressively strive to guarantee that equipment will be available for 100% of the required time.

The six basic principles upon which TPM is founded are -

1. Minor defects must be eliminated from all equipment

2. Correct planned maintenance can prevent nearly all unexpected machine failures
3. The use of cross functional teams will resolve problems far more effectively than a single department approach
4. Continuous improvement is by continuously learning and changing
5. Machines with preventive maintenance programmes produce far more products (on time and to cost) than machines that "just break down"
6. Machines with planned maintenance programmes enable key resources to be freed up to concentrate on the continuous improvement activities

Quality Circle

A quality circle is a volunteer group composed of workers (or even students), usually under the leadership of their supervisor (or an elected team leader), who are trained to identify, analyze and solve work-related problems and present their solutions to management in order to improve the performance of the organization, and motivate and enrich the work of employees. When matured, true quality circles become self-managing, having gained the confidence of management.

TOTAL QUALITY MANAGEMENT – QUESTION BANK

Unit - I

1 Mark Question

1. What is TQM?

   TQM is a set of systematic activities carried out by the entire organization to effectively and efficiently achieve company objectives.

2. Define Quality.

   Meeting the requirements of the customer

3. What is JIT?

   Just-in-time (JIT) is an inventory strategy that strives to improve a business's return on investment by reducing in-process inventory and associated carrying costs.

4. What is Quality Assurance?

   Quality assurance refers to the processes and procedures that systematically monitor different aspects of a service or process.

5. What is process control?

   Process control refers to the methods that are used to control process variables when manufacturing a product.

6. Define Quality Control

   Quality control may be defined as group of techniques of the industrial management by means of which products of uniform acceptable quality are manufactured.

7. What is 5M?

   Men, Machine, Money, Method & Materials

8. What is Kaizen?

   'Continuous Improvement' is a policy of constantly introducing small incremental changes in a business in order to improve quality and/or efficiency.

9. What is TPM?

   Total productive maintenance (TPM) is the systematic execution of maintenance by all employees through small group activities.

10. What is 5s?

    Seiri, Seiton, Seiso, Seiketsu & Shitsuke

11. What is benchmarking?

    Benchmarking is the process of measuring your company's performance in each function and comparing that level of performance with the level of performance achieved by successful leaders.

12. What is Pareto analysis?

    Pareto analysis is developed around the basic concept that 80% of a specific effect is due to 20% of the cause (80-20 rule).

13. Write other name for cause and effect diagram.

    Fishbone diagram or Ishikawa diagram

14. Define SPC.

Statistical Process Control, commonly referred to as SPC, is a method for monitoring, controlling and, ideally, improving a process through statistical analysis.

15. Mention any two statistical process control tools?

Cause and effect diagram, Check sheet, Flow diagram, Pareto analysis

6 Mark Question

1. What do you mean by quality control Process?
2. State the purpose of TQM in print quality improvement?
3. What are the basic elements of Quality Management?
4. What are the 5s?
5. Explain the purpose of JIT.
6. Explain the use of kaizen in printing industry.
7. What is six sigma?
8. Write short notes on TPM.
9. Write short notes on statistical control tools.
10. Write short notes on flow chart.
11. Explain the fishbone diagram.

12 Mark Question

1. Explain in detail about Quality control process system for graphics arts industry.
2. What are the basic elements of TQM and explain each of them in detail?
3. Explain about steps for process management.
4. Explain all the seven statistical control tools with diagram.
5. Explain pareto charts and histogram with neat diagram.
6. Explain in detail about Kaizen and explain 5s in detail.
7. Explain the quality concepts adopted in printing industry.
8. Explain in detail six sigma concepts adopted in printing industry
9. Explain in detail about Six Sigma key roles for implementation.
10. Write short notes on 1) JIT 2) TPM 3) ISO

UNIT - II – MATERIAL INSPECTION AND TESTING

2.1 VISUAL INSPECTION

Before accepting paper shipments, printers should inspect all -paper for transit damage. They should also enter all damages and shortages on the carrier's delivery receipt and have the damage acknowledged by the carrier's agent. In addition, the printer should retain a signed copy of the inspection report and inform the paper manufacturer and shipper of any transit damage, such as that caused by improper loading or inadequate packaging.

Before settling a damage complaint, the shipper or papermaker must have supporting evidence that damage occurred during shipment, not after being received by the printer. Photographs showing the conditions of paper before and after unloading are therefore helpful in substantiating damage claims and in reporting the damage. To be certain that photos of the damage are taken before the paper is moved, the Graphic Arts Technical Foundation (GATF) recommends that an instant-photography camera be used.

Before the paper is placed in storage, all damaged wrapping should be repaired, taped, or, if necessary, replaced. In addition, broken skid bands should be replaced to maintain compactness and protect the paper.

Storage and Handling of Substrates and Chemicals

Handlers should use proper procedures to minimize damage to rolls, skids, and cartons during unloading and storage. Rolls are particularly susceptible to costly handling damage. Bumping, tipping, or dropping a roll only a few inches can flatten it or cause it to become starred or bruised at its edges.

The floors on which rolls are stored and moved about should be clean and free of sharp objects like nails, stones, and splintered wood. Rolling paper rolls over rough floors or sharp objects can damage the outside layers. Resting the end of a roll on sharp objects or protruding surfaces can cause even greater harm.

Nicks, gouges, and other results of improper roll handling may render large portions of the roll unusable. Correcting this damage may require the removal of large slabs of paper.

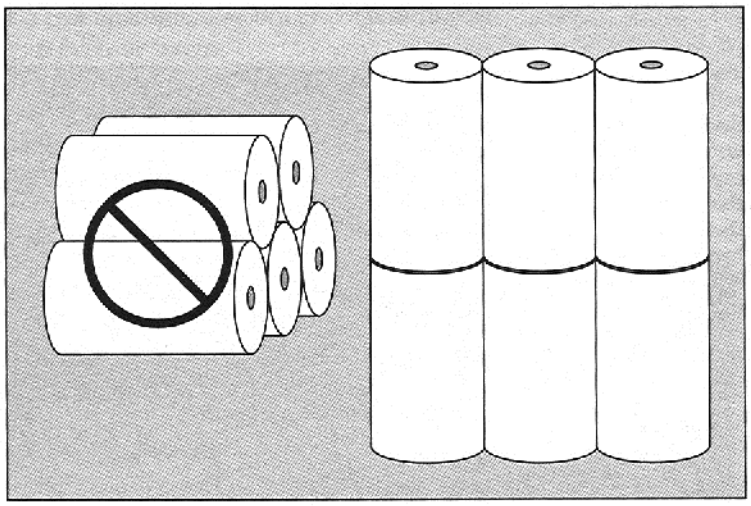
Since moving paper to locate specific items increases the likelihood of handling damage, paper should be warehoused and stored in a manner that minimizes its movement and handling. A good roll storage system provides for inventory rotation to insure that paper is used in the order in which it is received. This type of inventory system also prevents the accumulation of old paper stock.

Rolls should be stored on their ends, because rolls stored on their sides will become flat and out of round. If rolls are stored on their ends in too many tiers, however, the excessive weight can flare the ends of the rolls as the bottom.

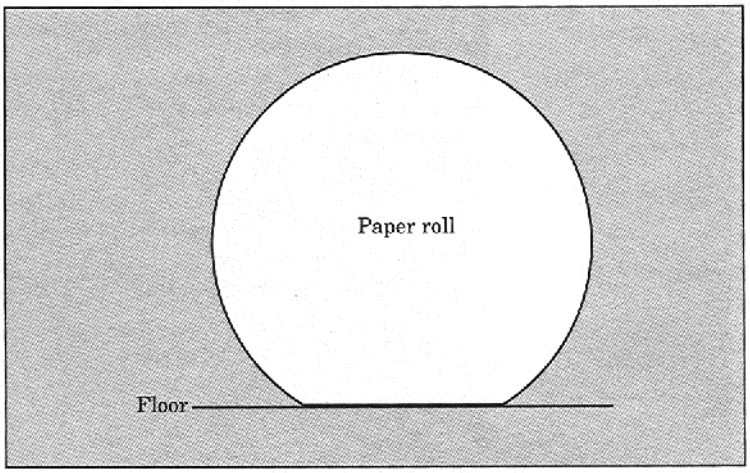
Paper should never be stored in direct contact with concrete or damp basement floors because of moisture absorbed from damp floors will distort or otherwise damage the paper. Platforms or racks should be used to keep the paper from contacting damp floors. In

addition, paper should never be stored next to cold walls, radiators or other heated objects, or areas subject to sudden drastic changes in temperature.

Rolls should be stored on their ends. They will become flat if stored on their sides.



Storing rolls of paper on their sides can cause them to become out-of-round.



Chemical Storage tips

1. Control your inventory – only keep minimum amounts – don't squirrel chemicals
2. Label shelves and cupboards with the segregation scheme so that chemicals can be put away in the right place quickly
3. Remove all cardboard and other packing from storage area
4. Keep the outside of containers scrupulously clean and the area tidy
5. Ensure the store area is lockable and kept locked
6. Do not store liquids above solids in case of contamination in the event of a breakage

7. Limit the size of containers on open shelves to ≤ 5 L/kg, otherwise use a storage cabinet
8. Always store corrosives on spill trays – kitty litter trays are inexpensive and ideal
9. Don't overload shelves – sagging is a danger sign
10. Never store flammable liquids in fridges/freezers unless they have been modified (i.e. spark proof)
11. Do not store containers on the floor
12. Inspect the area regularly and dispose of outdated chemicals including all portable LPG cylinders that are not in test (i.e. 10 years).
13. Use secondary containment at all times

Protecting Paper from Moisture

Paper that contains too much or too little moisture may cause press runnability and register problems, as well as difficulty in folding and binding. It is essential, therefore, that paper be protected from the time it leaves the mill until it serves its intended purpose. Paper mills use wrappers and cartons to prevent moisture from entering or leaving the paper. Paper handlers should keep these original wrappers intact until the paper is needed.

Effect of Humidity and Temperature on Paper

The ability of paper fibers to easily gain or lose moisture can result in runnability and register problems and has the greatest impact on sheetfed papers. Printers therefore should know how moisture behaves and how to measure and control it.

The ratio between what moisture the air has and the amount it could contain is called its relative humidity (RH). Relative humidity is the ratio of the quantity of vapor present in the air to the maximum amount the air could hold at a given temperature. When the relative humidity is 50%, the air contains only 50% of the moisture it could contain at that specific temperature.

Humidity, or water vapor, in the air can be measured with such instruments as hygrometers or sling psychrometers.

Maintenance of data sheets of materials

Printers are responsible for getting the job out on time, meeting customer needs, and recovering any losses associated with problems caused by paper or other input materials. Paper merchants and papermakers are responsible for meeting the needs of printers and their customers and, if necessary, replacing any defective material and providing compensation for losses that are directly related to paper.

Reporting and Verifying Paper Problems

The first action a printer should take when a paper problem arises is to notify the merchant or mill representative. This early warning of a potential problem gives the paper

supplier an opportunity to provide input before waste and lost press time is incurred. If a decision must be made to continue the job with the paper that is causing a problem, it should be made in cooperation with the paper supplier. Continuing to use problem paper without informing the paper supplier or allowing for input may lead to disagreements that frustrate later attempts at a financial settlement.

Complaint handling process

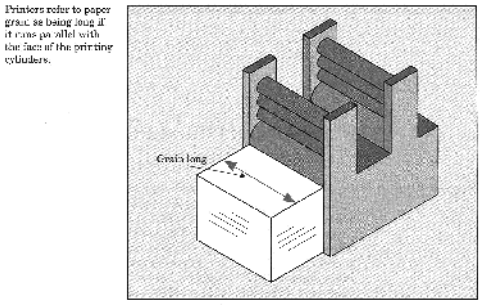
It is in the printer's best interest to have a complaint handling process that makes it easy to collect the appropriate samples, data, and information needed to support a claim. Following is a brief outline of a complaint handling system, including some general procedures that should be followed in collecting evidence at the time of printing.

- Establish a process to report complaints, collect samples, and assemble evidence of paper problems.
- Educate everyone involved in production on the importance of collecting vital information and train them to use the proper collecting procedures.
- For a problem involving press sheets, collect and staple together twelve consecutive sheets from the feeder; for roll problems, strip three to four wraps from the roll when the problem occurred. Immediately label the samples. Collect twelve consecutive sheets or signatures (showing the problem) from the delivery and immediately staple and label these samples.
- Collect ink and fountain solution samples from the trays and immediately label the containers. Use plastic bottles with watertight lids for the fountain solution and plastic or metal cans with lids for the ink. Don't use paper cups for samples! Paper cup containers will absorb water and solvents and may tear and leak.
- If the problem stems from blanket contamination, pull samples of the debris from the blanket using tape. Don't fold the tape back onto itself or attach it to paper. Instead, attach the tape to a piece of clear plastic.
- Because the debris may be carried in with the paper, it is important to collect twelve consecutive sheets from the feeder, Again, staple and label the sheets.
- Set aside any unused problem paper, cover the paper with a moisture-barrier material, and label it as complaint paper, with job name and paper mill identification numbers.

2.2 TESTING PROCEDURE FOR PAPER AND BOARD

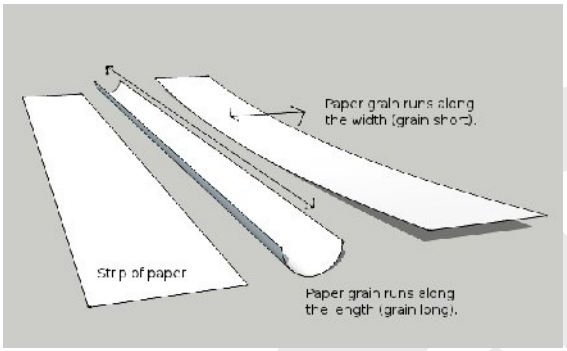
Paper Grain

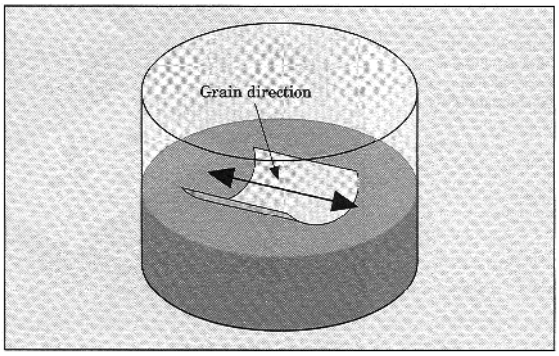
Paper grain, a function of fiber orientation and drying stresses, runs In the direction that paper travels through the paper machine Papermakers refer to fiber orientation as being either in the machine direction (grain direction) or cross-machine direction. Printers, on the



other hand, refer to grain direction as being grain-short (or cross grain) and grain-long (or with the grain). Paper is referred to as being grain-long if the grain runs parallel to the press cylinders.

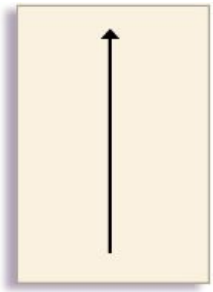
One way to determine the grain direction of paper is to gently place a piece of paper on the surface of water (it is important to keep the top side of the paper dry). As the paper floats on the water, the side in contact with the water will begin to wet and the paper will start to curl. The grain direction of the paper runs parallel to the curl.





The grain of the paper refers to the direction of the fibers in a sheet of paper. Long grain paper refers to paper in which the fibers run in the same direction as the longest measurement of the paper. On rolls of paper for web presses, the grain runs along the length of the web. Short grain paper refers to paper in which the fibers run in the same direction as the shortest measurement of the paper.

When paper is torn, it will tear easier and straighter when torn parallel with the grain. It will also fold easier parallel to the grain and produce a cleaner fold than if folded across the grain. Laser printers require long grain paper for the best results. Short grain paper may not feed properly into a laser printer and the heat produced by a laser printer may result in the sheets curling as they come out of the printer.



Long grain direction on an 8 1/2" x 11" sheet

Long grain direction on a roll of paper

GSM

GSM stands for grams per square meter. It gives an idea as to thickness of a paper and it is a common term used in paper industry. GSM Tester / Substance Indicator

measures and directly indicates substance of paper and paper boards in terms of grams per sq.meter.

GSM stands for 'Grams per Square Metre', It's a measurement of paper quality which allows for printers to be far more precise than they could be with wooly terms like 'thick', 'thin' and 'kinda in the middle'. As the name suggests, it tells you how much a square metre of the paper or card you're using would weigh (in grams, believe it or not).

Weight Calculation

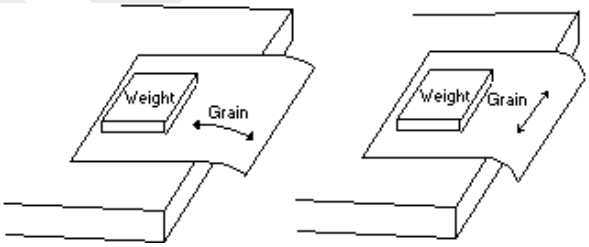
This Paper Calculator (GSM) Calculator is used to calculate the weight of a reel of paper in grams per square meter where the substance of the paper in kilograms, the total length of the paper in meter and the reel width is known.

Weight of Paper Calculation Formula

$$\text{Substance in gsm} = \frac{(\text{Weight of reel in kgs} * 100000)}{(\text{Length of paper on meter} * \text{reel width in cms})}$$

Stiffness

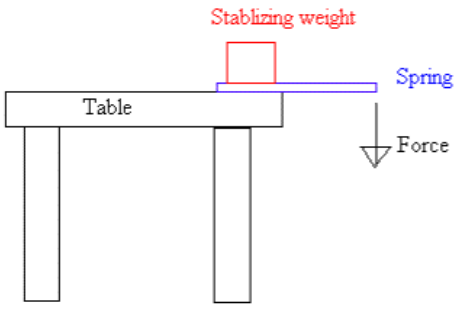
Paper stiffness is the ability for a sheet of paper to resist bending. Stiffness is influenced by the thickness and basis weight of the sheet.



Stiffness can vary from machine direction (MD) to cross machine direction (CMD). Paper stiffness is typically stiffer across the grain due to the resistance of the paper fibers to bend across themselves.

Measuring Paper Stiffness

Stiffness can be measured using number of different testing devices. A common device is the Gurly stiffness tester. The Gurly testeer uses its own units and is governed by the TAPPI T 543 paper standard.



A property of paper to resist bending and its ability to support its own weight when handled. The stiffness of the paper affects its feeding ability and its ability to avoid distortion due to the pull of the ink during the printing process. The stiffness is important to the converting operations for forms and envelopes.

Paper Stiffness Tester is used to determine stiffness properties such as flexural rigidity of most paper or tape and other flexible materials. The principle of Cantilever Test method is used in it.

Stiffness (Taber): A measure of flexural rigidity, Stiffness is the bending moment (g-cm or mNm) required to deflect the free and of a 1.5 in wide vertically clamped sample 150 from its center line when load is applied 50 mm away from the clamp; measured in MD &CD.

The procedural standards are explained in TAPPI T 489 and ISO 2491.

Droop Rigidity CD: Droop rigidity measures the stiffness of the paper or board, more often applied to lighter weight grades. CD refers to cross direction, and MD to machine direction, Droop rigidity is higher in the machine direction. The higher the value the stiffer the paper.

Bending Resistance/ Stiffness (Lorentzen &Wettre): It is a measure of the resistance offered to a bending force by a rectangular sample, expressed in mN (milli Newtons). The standards are as per TAPPI T 556.

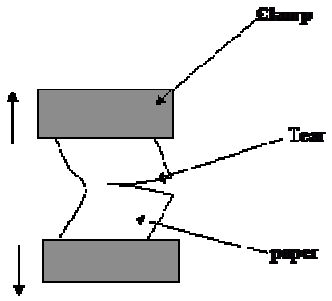
The inter relationship of stiffness, grain direction and runnability is given under the discussion of grain direction, which follow in this chapter. Adequate stiffness is essential for file folders, index cards, and posters, which must support their own weight, and for the rapid transporting of tab card, checks, and documents through their processing equipment. High stiffness is important paperboard used to make cartons and containers. Low stiffness ~~ required for paper tissue, toweling, and napkin for the easy opening and turning of pages in a book, and for music paper.

Stiffness is measured in arbitrary units as determined by several different types of testing equipment. The **Taber, Clark, and burley stiffness testers** are commonly used. Each has its own unit of measurement.

Tensile strength

The ability of the paper to withstand the stress and strain applied to it before breaking down and pulling apart.

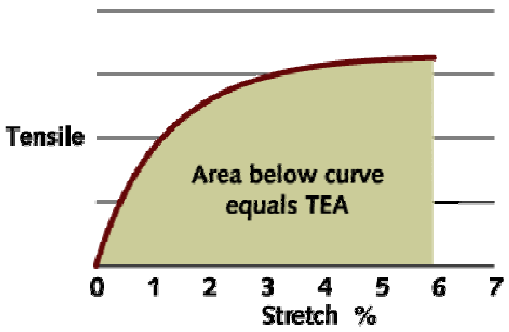
The tensile force required to produce a rupture in a strip of paperboard, measured in MD &CD, expressed in kN/m. Tensile strength is indicative of fiber strength, fiber bonding and fiber length. Tensile strength can be used as a potential indicator of resistance to web breaking during printing or converting. The procedural standards are explained in TAPPI T 494.



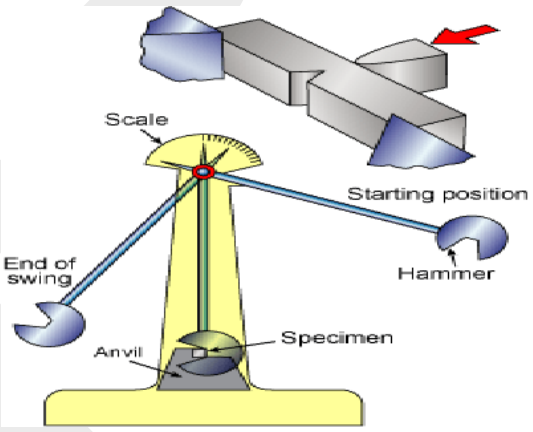
Tensile Tester

Tensile Energy Absorption (TEA): TEA is the Tensile Energy Absorption, i.e. the amount of work required to break the sheet under tension.

Z Direction Tensile Strength: Or **internal bond strength** provides an indication of strength of board in relation to glue bonding at carton side seams and possible

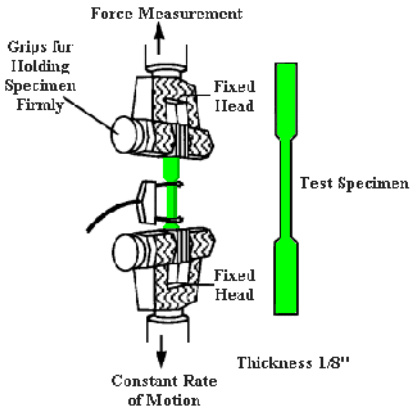


A property of paper that indicates its ability to withstand a stretching force without breaking. The paper's maximum elongation due to tensile stress is expressed as a percentage of its original length. Paper has greater tensile strength in its grain direction.



Tensile strength and elongation are measured with either of two types of testers. The **pendulum type of tester** for TAPPI Standard T 404 applies a gradually increasing tension to a paper strip of specified width and length between two jaws. One jaw is moved downward and the other swings a pendulum away from its plumb, or starting position, by the pulling force of the paper strip. As the pendulum is pulled upward, an increased tension is applied to the paper strip until it breaks a number of strips are tested and their values averaged for each direction. Tensile breaking strength may be reported in different units: kilograms per 15-mm-width strip, pounds per inch -width strip, or kilonewtons per meter.

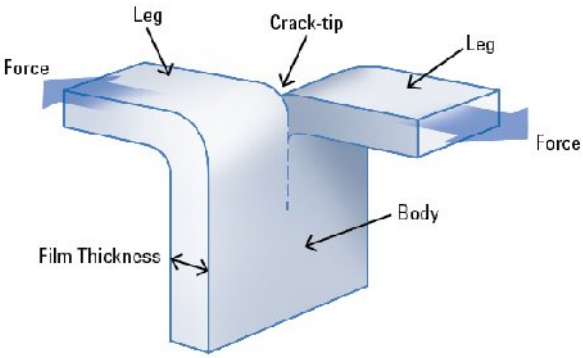
The second type of tester **strains, or elongates,** the paper at a constant rate between a fixed lower clamp and an upper one that moves upward at a constant rate, as described in TAPPI standard T 494.



Tensile strength is influenced by refining, wet-pressing on the paper machine, fiber length, furnish, basis weight, and moisture content. Increased refining, greater wet-pressing, higher basis weight, and increased fiber length raise tensile strength. Increasing the percentage of filler lowers tensilestrenght. Tensile strength is an indicator of durability for papers like wrapping bag, creasing, gummed tape, cable wrap, and twisting. it relates to the stresses applied to paper as it is pulled through sheetfed presses by the grippers, to web travel, to breaks in printing and converting, and to the deleaving and perforation strength of business forms.

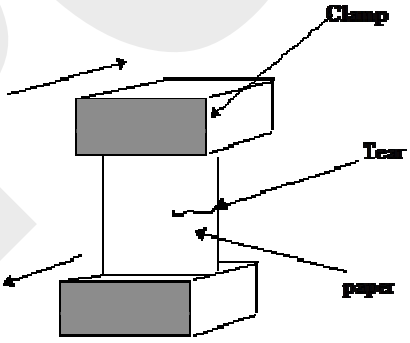
Tearing Resistance

Paper's ability to resist tearing while going through various stages of production such as printing, folding, book binding and miscellaneous bindery operations.



General paper property that takes into account two measures of a paper's ability to withstand being torn. **Internal tearing resistance** refers to the work required to tear a paper sample through a specified distance once the tear has been started.

Edge tearing resistance refers to the work required to tear a paper sample by starting the tear at the edges of the sheet. Lighter papers are more susceptible to edge tears than to internal tears, so the latter measurement is frequently the more useful one. Measure of the resistance of paper to tearing when folded over a V-notch beam and loaded in a tensile testing machine. Results are re-ported in lb or kg.

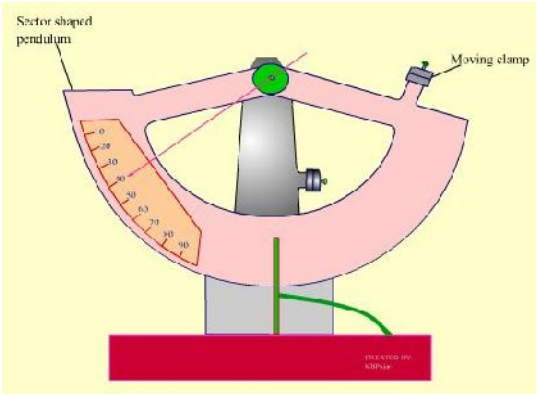


Tear Tester

Tearing resistance indicates the behaviour of paper in various end use situations; such as evaluating web runnability, controlling the quality of newsprint and characterising the toughness of packaging papers where the ability to absorb shocks is essential. fibre length and interfibre bonding are both important factors in tearing strength. The fact that longer fibres improve tear strength is well recognised. The explanation is straight forward; longer fibres tend to distribute the stress over a greater area, over more fibres and more bonds, while short fibres allow the stress to be concentrated in a smaller area.

Elmendorf Tear Strength Tester

The Elmendorf Tearing Testers are accurate, low-cost and high quality falling pendulum tear testing Instruments with analog and digital display for the determination of the average force required to propagate a single-rip tongue-type tear starting from a cut in paper.



Lift the pendulum up to a certain height to give it an initial potential energy. The pendulum tears the specimen while swinging down. Computer calculates the decreased energy caused by tearing to obtain the required force for tearing.

Tearing resistance is dependent upon fiber length and strength. Longer fibers give greater tearing resistance. Some fibers produce greater resistance to tearing than do others. Greater fiber to fiber bonding from added reining increases tearing resistance. However, added refining resulting in fiber cutting and a reduction of-i fiber length will reduce tearing resistance even- though fiber to fiber bond strength increases. The addition of fillers reduces tearing resistance.

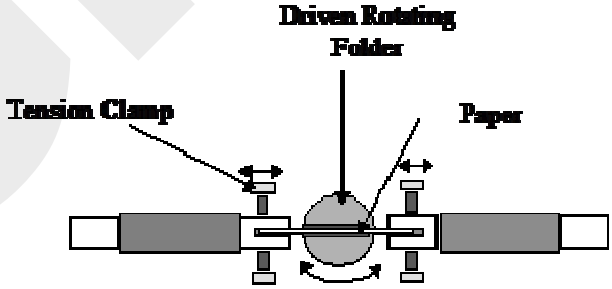
Folding Endurance

The ability of the paper to hold up to multiple foldings before breaking.

Folding endurance is the paper's capability of withstanding multiple folds before it breaks. It is defined as the number of double folds that a strip of 15 mm wide and 100 mm length can withstand under a specified load before it breaks. It is important for printing grades where the paper is subjected to multiple folds like in books, maps, or pamphlets. Fold test is also important for carton, box boards, ammonia print paper, and cover paper etc. Folding endurance is a requirement in Bond, Ledger, Currency, Map, Blue Print and Record Papers.

A paper property that refers to the ability of a paper to be folded repeatedly without tearing. The number of folds it can withstand before it breaks is its folding endurance. Folding endurance varies according to grain direction, and is greater against the grain. In the **Schopper method,** a metal blade repeatedly folds a strip of paper back and forth between several rollers until it breaks.

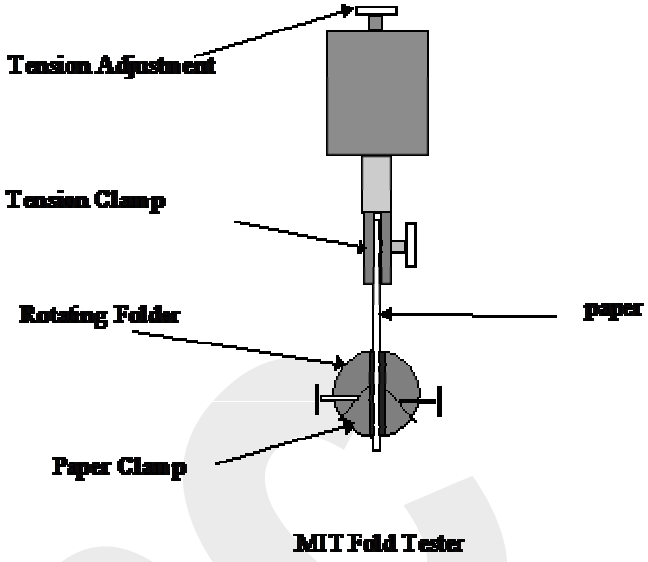
In the schopper method (TAPPI Standard T 423), a strip of paper is held under tension while a slotted reciprocating blade catches the strip in its middle and folds it back and forth between four rollers, folding it first toward one side, then toward the other side. The number of double folds the paper withstands before breaking is its folding endurance.



Shopper Fold Apparatus

In the MIT method, an oscillating folding head repeatedly folds a paper sample back and forth until it breaks. The MIT method allows greater variability in the paper samples, and the tension can be adjusted based on the thickness of the sample.

In the MIT method (TAPPI Standard T 511), a strip is clamped under tension between a spring-loaded jaw and an oscillating folding head. As the folding head oscillates an exact number of degrees on each side of its starting position, the paper is alternately folded toward each of its two sides. The average result for a number of double folds endured is reported for both the machine and cross-machine directions.



Folding endurance is enhanced by increased paper fiber refining, being a function of the interlacing of the bonds between the paper fibers. Non-fibrous additives such as fillers, sizing, and coatings to the papermaking furnish or finished paper surface reduce folding endurance. Moisture loss also considerably decreases folding endurance. The degree of folding endurance desired depends on the end-use requirements of the paper. The procedures that increase folding endurance also work to the detriment of other, perhaps more desirable paper properties.

Smoothness

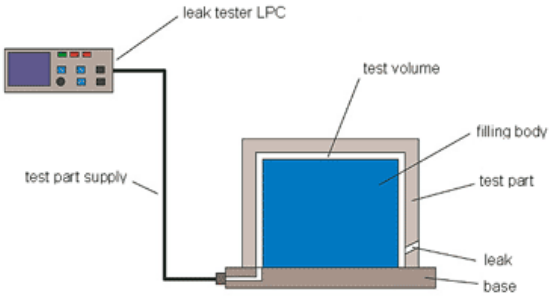
The even and consistent continuity of the paper"s surface. How the paper receives the ink is affected by the smoothness of the surface.

Smoothness is concerned with the surface contour of paper. It is the flatness of the surface under testing conditions which considers roughness, liveliness, and compressibility. In most of the uses of paper, the character of the surface is of great importance. It is common to say that paper has a "smooth" or a "rough" texture.

Measure of the evenness or lack of contour of a paper's surface. In terms of basic printability, a surface as free as possible of irregularities is desirable, but smoothness is also a function of the interrelationship of other paper properties, and varies with assorted manufacturing processes. Smoothness tends to be characterized by a wild formation, which is dependent on the degree of fiber refining, the extent of wet pressing, the extent of calendering and supercalendering, the use of coatings, and the desired paper finish.

*A measure of paper smoothness is made using an **air leak tester**, which determines the time it takes for a volume of air to seep between a smooth glass plate and the paper sample.*

Smoothness can also be measured using a **Bekk Smoothness Tester or a Gurley Smoothness Tester, Sheffield Smoothness Gauge and Bendtsen Smoothness Tester**. All these devices utilize rates of air flow over a paper surface as an indicator of smoothness.

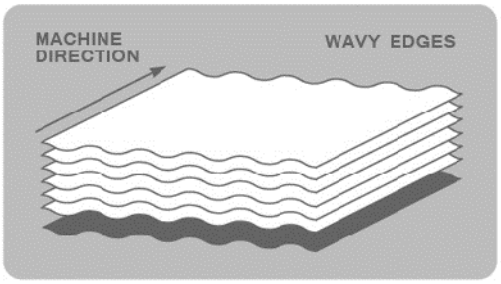


Smoothness is commonly measured by and air-leak tester. One way is to measure smoothness as the time it takes, in seconds, for a given volume of air to leak between a smooth glass test plate And the paper surface under a specified air pressure. The method for measuring smoothness by this principle, as described in TAPPI standard T 479, is used for the Bekk and the Gurley smoothness testers.

Relative Humidity (RH)

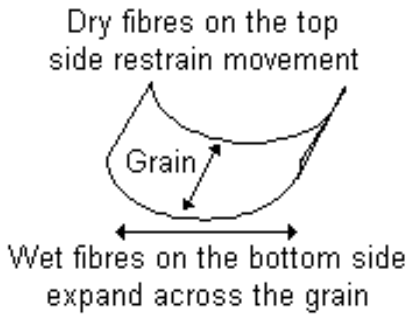
The level of moisture in the air. The humidity will affect the paper and other printing products, which may cause problems in the printing process.

A measure of the amount of water vapor present in the air expressed as a percentage of the total amount of water vapor the air could hold at the same temperature and pressure.



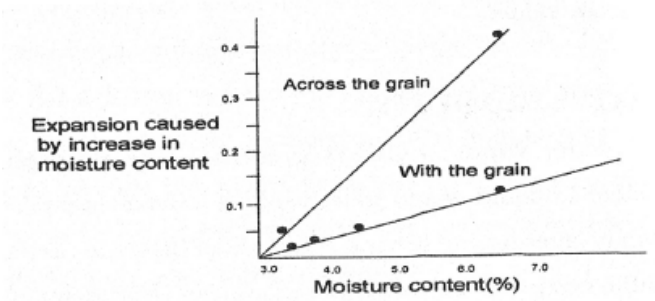
Relative humidity of the atmoshpère 75%
Relative humidity of paper 50%

Relative humidity is an important consideration in printing and in papermaking, as paper's hygroscopic tendency makes it absorb and lose water readily, which affects several paper properties, not the least of which is its dimensional stability. Most paper produced in India is manufactured at 35:50% relative humidity. Many pressrooms have humidity control, and maintain the relative humidity within that range, to prevent as much water loss or gain as possible, so the paper remains flat before, during, and after printing. When printing jobs that require more than one pass through the press (such as multi-color work), paper should have a relative humidity 5:8% higher than the relative humidity of the room, so that its rate of moisture loss to the atmosphere will be offset by its rate of water absorption from the press dampening system.



In some pressrooms, varying levels of humidification—adding moisture to the atmosphere—or dehumidification—removing moisture from the atmosphere—may have to be

performed to ensure that paper and pressroom are of congruent moisture content.



Conditioning of paper is also of importance in many printing and converting operations. In addition to the effect of moisture content on physical properties, it also determines the build up of static of the paper sheet subjected to pressure and to friction. The tendency for paper to develop static becomes greater with increasing dryness. Cellulosic fibres are hygroscopic i.e. they are capable of absorbing water from the surrounding atmosphere. The amount of absorbed water depends on the humidity and the temperature of the air in contact with the paper. Hence, changes in temperature and humidity, even slight changes, can often affect the test results. So, it is necessary to maintain standard conditions of humidity and temperature for conditioning.

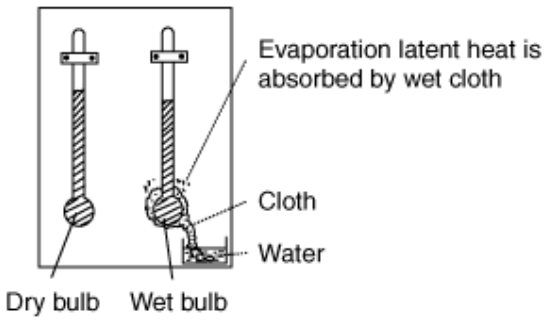
Testing for Relative Humidity

The amount of water vapor in the air at any given time is usually less than that required to saturate the air. The relative humidity is the percent of saturation humidity, generally calculated in relation to saturated vapor density.

$$\text{Relative Humidity} = \frac{\text{actual vapor density}}{\text{saturation vapor density}} \times 100\%$$

A **hygrometer** is used to measure the level of humidity. The usual type that you can buy is typically made from a fibre (originally horse hair) that changes length with changes in humidity. Because the fibre hygrometer can be affected by many different conditions, it should be calibrated quite regularly. They are especially quite inaccurate at very high and low humidities.

A simple way to get a value for the relative humidity is to use a wet-and-dry bulb hygrometer (psychrometer). The value can then be used to calibrate a "hair" hygrometer. To make one is relatively simple. First you need a thermometer (two would be better) shaped such that you can wrap a small piece of tissue or cloth around the bulb. First measure the air temperature. Next wrap a small piece of tissue around the bulb and wet it. Wait about ten minutes until the temperature stabilizes - it will be lower due to evaporation.



A more permanent setup would use two thermometers and a small water reservoir. The thermometers would be fixed on a card. One thermometer would have a piece of cloth wrapped on the bulb with the end dipping into a small reservoir of water

similar to the image left.

2.3 pH

The degree of acidity or alkalinity of the paper or solution. Also, pH is measured in the fountain solutions that are used when printing the paper on the press. Measured on a scale of 0 to 14, pH7 being neutral, pH above that is alkaline and below that is acidic.

The measure of the acidity or alkalinity of a material. Paper with a pH below 7.0 is considered acidic; paper with a pH above 7.0 is considered acid-free, or alkaline.

We typically talk about acid-base reactions in aqueous-phase environments -- that is, in the presence of water. The most fundamental acid-base reaction is the dissociation of water:

$$H_2O \longleftrightarrow H^+ + OH^-$$

In this reaction, water breaks apart to form a hydrogen ion (H+) and a hydroxyl ion (OH-).

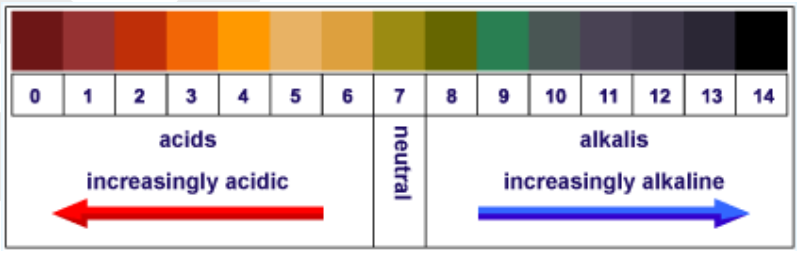
1. [H+] is the molar concentration of hydrogen
2. [OH- is the molar concentration of hydroxide

Water actually behaves both like an acid and a base. The acidity or basicity of a substance is defined most typically by the pH value, defined as below:

$$pH = -\log[H^+]$$

pH measurement:

Acidic and basic are two extremes that describe chemicals, just like hot and cold are two extremes that describe temperature. Mixing acids and bases can cancel out their extreme effects. The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic, and a pH greater than 7 is basic. Each whole pH value below 7 is ten times more acidic than the next higher value.



Pure water is neutral, with a pH of 7.0. When chemicals are mixed with water, the mixture can become either acidic or basic. Vinegar and lemon juice are acidic substances, while laundry detergents and ammonia are basic.

pH Meter

The most accurate common means of measuring pH is through a lab device called a a pH meter. The meter consists of a glass electrode through which a small voltage is passed. The meter, a voltmeter, measures the electronic impedance in the glass electrode and displays pH units instead of volts. A pH meter typically has to be calibrated before each

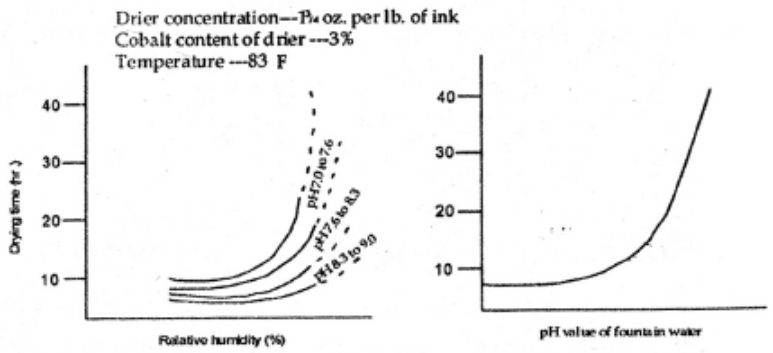
use with two standard liquid solutions of known pH. Measurement is made by submerging the meter in the liquid until a reading is registered by the meter.

Litmus Paper

Litmus paper is a small strip of paper that has been dipped in a **combination of dyes** that change color according to the pH of the medium in which they are contained. **Acidic liquids** (pH below 7) turn the paper **red** while **alkaline liquids** (pH above 7) change it to **blue or purple**. Litmus paper is good for roughly estimating the relative pH of liquids, but not for precise readings. Measurement is made by briefly dipping the end of an unused strip in the liquid and allowing it to dry.

Field Kit

A field kit consists of a clean, empty vial into which a sample liquid can be placed, and a bottle of indicator solution. A few drops of the solution are placed in the sample, and the pH is determined by the change in color of the liquid. Because different indicator solutions perform better at certain pH levels, a variety of kits is available for different ranges. The accuracy of the field kit depends on the narrowness of the indicator solution's range.



Conductivity of a Dampening Solution:

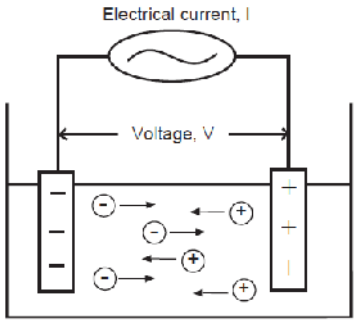
Conductivity describes how electricity is conducted through a liquid; impurities in the dampening solution allow conductivity to increase. Conductivity varies depending on the water and additives. The temperature, and the concentration of alcohol also influence conductivity. By increasing Isopropanol (IPA), conductivity declines. Modern conductivity gauges also measure for temperature. It is important that the conductivity gauge in the central dampening solution be regularly cleaned and recalibrated.

1000 µs/cm, this should be taken as a signal that it is time to change the dampening solution. In order to guard against printing problems, it is recommended that the dampening solution be renewed every 14 days.

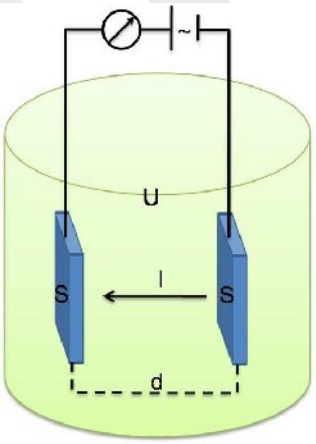
Conductivity is used as a measure of water purity, or hardness. Pure water has an electrical conductivity of close to 0 micromhos (µmhos). As the amount of dissolved solids in water increases, so does its electrical conductivity, in direct proportion to the concentration of total dissolved solids. So-called "soft water" has a conductivity of 0:225 µmhos, "hard water" having a conductivity greater than 450 µmhos. Average water straight from one's faucet may have a conductivity of 200 µmhos or greater. A relationship exists among concentration of the solution, the pH, and the electrical conductivity, all of which need to be

How is conductivity measured?

Conductivity may be measured by applying an alternating electrical current (I) to two electrodes immersed in a solution and measuring the resulting voltage (V). During this process, the cations migrate to the negative electrode, the anions to the positive electrode and the solution acts as an electrical conductor.in balance when mixing an effective fountain solution.



If the conductivity of different amounts of dampening solution concentrates in water is known, it is easy to measure the strength of a solution by measuring its conductivity. The following procedure can be used to develop a graph that plots conductivity and pH against concentration.



- Measure the conductivity and pH of the water normal, used to make the dampening solution. Place water in a clean 1-gal. (3.8) bottle.
- Add 1 oz. (29.6 ml) of fountain solution concentrate. Remeasure both conductivity and pH. Record these values.
- Add another ounce (2 oz. total) fountain solution concentrate and remeasure both conductivity and pH. Repeat this process until the amount of fountain solution concentrate added exceeds the manufacturer's recommendations.
- Plot these values on a graph that has concentration (oz./ gal.or ml/L) on the horizontal axis and conductivity and pH on the vertical axis.

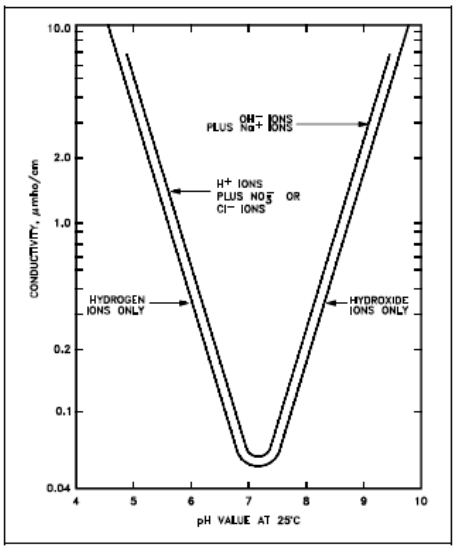


Figure 5 Theoretical Conductivity as a Function of pH

The most important factor in preparing dampening solution is to make sure that it is the proper concentration. Most acidic dampening solutions are buffered so that, as the amount of concentration increases, the pH drops initially but then levels off, while the solution's conductivity is better than pH for determining the amount of concentrate in the dampening solution. However the pH must still be measured, because the pH

must be between 4.0 - 5.5 for good printing.

With neutral dampening solutions and neutral (pH 7) water, the pH of the solution is constant, regardless of concentration. Therefore, conductivity must be used to measure the concentration of neutral must be used to measure the concentration of neutral or slightly alkaline dampening solutions.

2.4 VISCOSITY

The degree to which ink resists flow when it is under force, such as in the roller train of a printing press. If ink does not flow easily, it has a high viscosity, and if it flows easily, its viscosity is low.

The property of a fluid, such as a printing ink, that describes the degree of its resistance to flow, or its ability to adhere to a surface. A fluid that is highly viscous, such as molasses, is sticky and glutinous, and does not flow easily. A fluid that is not very viscous, or "inviscid," such as water or alcohol, flows freely. In ink terminology, viscosity refers to the extent to which ink will resist flowing. The viscosity of an ink will depend on the printing process it is designed for, and the nature of the substrate to which it will adhere. An ink's viscosity is a component of its body. The viscosity of a particular ink can vary according to the stresses to which it is subjected.

Viscosity is measured in a metric unit called a poise, which is equal to the viscosity of a fluid in which one dyne per square centimeter is required to maintain a difference in velocity of one centimeter per second between two parallel planes in the fluid that lie in the direction of flow and are one centimeter apart.

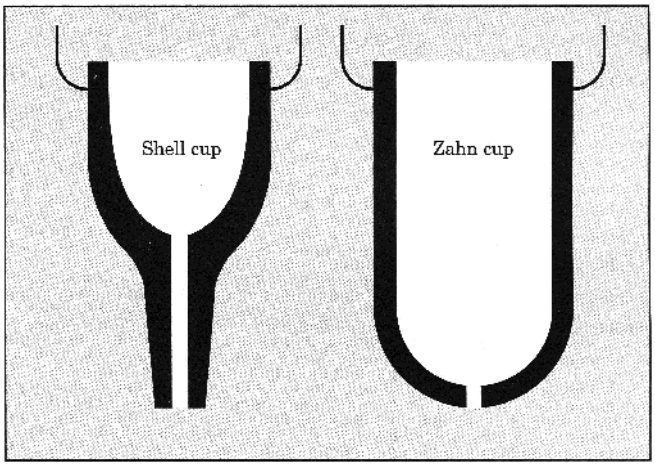
Working Principle of Viscometer

Ink viscosity is a measure of internal resistance to flow. It affects ink properties such as mileage, color strength, trapping, drying rate and fill-in. Low viscosity inks are extremely mobile and tend to flow on the printed substrate. Too low a viscosity can cause fill-in of fine reverses and growth in size of halftone dots. Too high a viscosity can cause plugging in fine reverses and excessive ink consumption.

Efflux Measuring Cups

Ink viscosity is measured during press run using efflux cups. An efflux cup is a container that holds an established amount of ink and has an accurately sized and shaped hole in its bottom. The time (measured in seconds) required for the ink to drain through the hole gives a measure of ink viscosity.

Two types of efflux cups are used with flexographic inks: the **Zahn cup** and the **Shell cup** (see figure below). The Zahn cup is a simple container with a circular hole of precise dimensions in its bottom. In the Shell cup, a 1” tube is attached to the drain hole. The size and shape of the cups and the drain openings are critical.



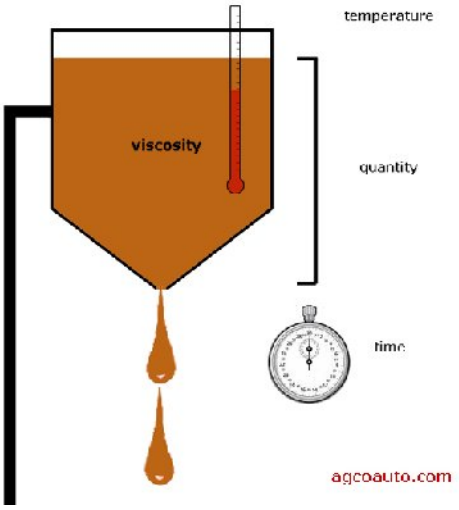
efflux cups

Shell cups are more accurate than Zahn cups and can detect smaller changes in viscosity.

Shell cups are also slightly easier to use, as the moment at which ink flow stops is usually clearly apparent.

Both Shell and Zahn cups are manufactured in a number of sizes. Cups should be selected that will empty within 20-40 seconds.

Viscosity Test Procedure



1. Use a clean efflux cup of appropriate size and an accurate stopwatch.
2. Be sure ink is warmed to working temperature.
3. Stir ink well, or circulate ink through the delivery system.
4. Lower the cup into the ink at an angle, allowing the cup to fill without trapping ink.
5. Hold the submerged cup in one hand and the timer in the other. Simultaneously, lift the cup vertically out of the ink and start the timer.
6. Watch the ink flow out of the bottom of the cup. When a break occurs in the stream of ink, stop the timer.
7. Read and record the elapsed time in seconds.
8. Clean the cup.
9. If the ink viscosity needs adjustment, add fresh ink to raise viscosity or dilutent to lower viscosity. Add slowly and in small amounts. Allow sufficient mixing time before testing viscosity again to confirm that it is correct.

Why Does Viscosity Change with Temperature?

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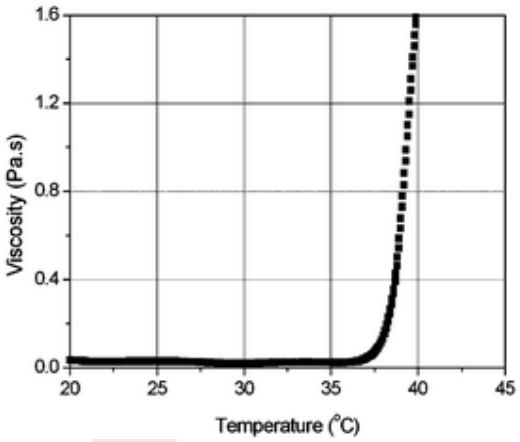
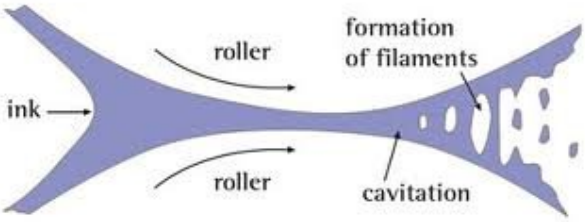


Viscosity is a liquid's inability to flow properly. A liquid's resistance to flow decreases as it changes state, for example, when a liquid melts and as a result flows more. When the temperature of the liquid changes, the viscosity tends to decrease.

Tack

The stickiness of ink required to adhere properly to the type of substrate being printed on. To much tack can cause the fibers to be pulled off the paper causing picking.

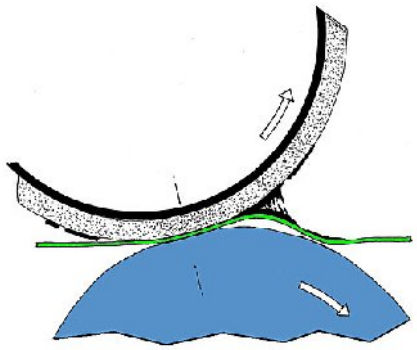


A property of printing inks that describes the cohesion that exists between particles of the ink film, the force required to split an ink film or, in other words, its stickiness. An ink with a high degree of tack (or a tacky ink) requires more force to split than does a less tacky film. Offset lithographic inks require tackier inks than do other printing processes so as to avoid excessive emulsification of the ink by the fountain solution, and to print sharp halftone images. Tacky inks, however, do not print solids very well.

The tack of the ink should not exceed the surface strength of the paper, or picking, splitting, and tearing of the paper will occur. In multi-color printing, the first ink printed must have greater tack than the ink that will be printed on top of it, or the latter will not trap on the first ink. The tack of an ink can be measured with an Inkometer or a Tackoscope.

Working Principle of Inkometer

A device used to measure the tack, or stickiness, of a printing ink by means of determining the torque produced by a series of rotating inked rollers. Inkometers are frequently used to compare and contrast the tack of various inks to be used in wet multi-color printing processes, where the tack of the first ink printed must exceed that of the ink printed on top of it. An Inkometer is also called a Tackoscope.



The inkometer is made up of three rollers. The center roller is a temperature controlled brass roller, the bottom roller is an oscillating rubber distribution roller. The top roller is attached to a load cell which measures the tack at a given press speed (i.e. 800 feet per minute for a web press or 15000 sheets per hour for an offset press)

The Inkometer consists of an upper composition covered roller, a vibrator composition covered roller and a temperature controlled roller. The Upper roller is available for testing conventional inks and UV inks. The temperature is controlled by circulating water through it. The control unit is free-standing and utilizes a refrigerated bath circulator with stainless steel reservoir.

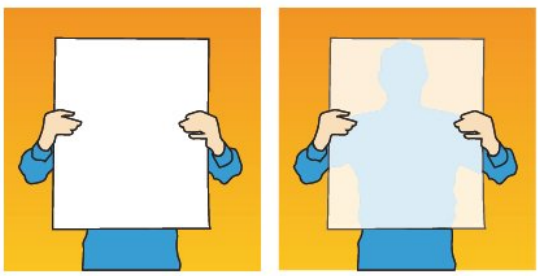
Simulating the dynamic conditions that occur in the printing process, the Inkometer provides reliable data on ink tack. It measures the integrated forces involved in ink film splitting and the effects of speed, film thickness, temperature and solvent evaporation on these forces.

The test results are numerical values (in gram-meters) for the torque required to "work" the ink film at known rates, with predetermined film thickness and temperature. These torque readings are actually measurements of the tack of the ink.

The Electronic Inkometer simplifies ink testing with push-button operation and a digital display of temperature, tack, RPM and test time. It operates at fixed speeds of 150, 400, 800, 1200 and 2000 RPM and has variable speeds up to 3000 RPM (4000 RPM optional). Tack readings are displayed, printed and transmitted at either 10, 30 or 60 seconds. A built-in printer automatically prints the results of a 10-minute ink stability test.

Opacity

A measure used to describe how much the paper will block the ink from showing through the sheet.



The term opacity also refers to the extent to which a printed ink will permit or prevent the transmission of light through it, either blotting out or allowing to be seen what is beneath it. Opaque pigments do not allow light to pass through them, instead reflect it

back, and are used to print solid colors. Transparent pigments allow varying amounts of light to pass through them, revealing the background printing or substrate. Transparent pigments are used to reduce color strength of more opaque inks, aid dispersion of color pigments, and "extend" a quantity of more expensive pigments. Ink opacity is also referred to as its **covering power.**

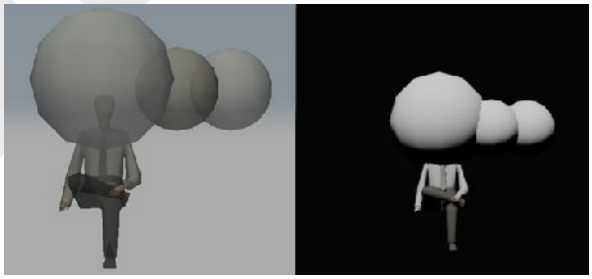
Working Principle of Opacimeter

A device used to determine the opacity of the paper or the level of "show through".

A device used to measure the opacity of a paper by gauging how much light is being reflected back through paper, using either the ***diffuse opacity method or the contrast ratio method***.

Opacimeter is a convenient, self-contained instrument for measuring the percentage opacity and whiteness of printing ink paper and plastics in a research and production environment. A microprocessor inside the unit compares the diffuse reflectance of the sample against black and white references to display opacity

Diffuse Opacity Method



A means of measuring a paper's opacity by backing a paper sample with a black sheet of paper, measuring how much light is reflected back through the sample, then backing the sample with a thick pile of the paper to be tested and measuring how much light is reflected off the top of the backing pile and back through the sample. The ratio of these two figures is the paper sample's diffuse opacity. It is believed that the diffuse opacity method is more effective than the contrast ratio method in estimating potential show through.

Contrast Ratio Method

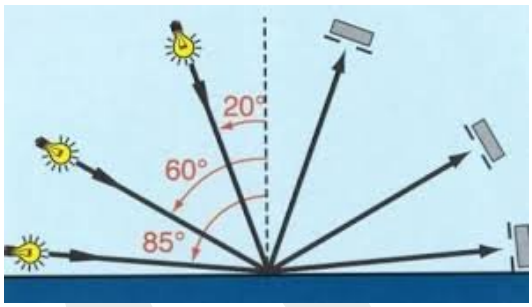
A means of measuring a paper's opacity by backing a paper sample with a black sheet of paper, measuring how much light is reflected back through the sample, then backing the sample with a white reflecting surface, and measuring how much light is reflected off the top of the white backing and back through the sample. The ratio of these two figures is the paper sample's contrast opacity. It is believed, however, that the diffuse opacity method is more effective than the contrast ratio method in estimating potential show through.

Gloss Ink

An ink that contains extra varnish, which makes the ink appear glossy when printed.

The term gloss also refers to the degree of shine of a printed ink. Certain inks, such as high-gloss inks, dry to a high degree of gloss. The key to glossy inks is the maximization of ink holdout, as it is premature absorption of the ink vehicle into the paper before it can dry by oxidation that decreases gloss.

Working Principle of Glossmeter



A device used to measure the amount of gloss possessed by a paper, expressed as the ratio of the amount of the paper sample's reflected light to the light falling on it as compared to a gloss standard (polished black glass) of 100 "gloss units." Gloss is measured at a determined angle from the paper's surface; for coated papers, it tends to be 15º from the paper's surface (for extremely glossy papers, best results can be obtained at 20º from the paper's surface).

The glossmeter shines a light of known intensity on the paper and calculates the amount reflected back at the chosen angle of reflectance. Gloss can differ with grain direction, so readings in both the grain and cross-grain direction are typically taken.

Gloss is determined using a gloss meter, which directs a beam light (which has a similar wavelength range as the human eye) at a specific angle to the test surface and measuring the amount of reflection.

Easy to use, place the gloss meter on the surface to be measured, press the read button and the gloss reading will appear on the display, releasing the button will hold the reading the instrument will automatically switch off when not in use.

Long life tungsten halogen lamp closely conforming to CIE illuminant C for International standard compliance is fitted in the star gloss meter.

2.5 Working Principle of Moisture meter

The ability of a material to resist taking on moisture and breaking down when exposed to it.

The amount of moisture present and measurable in paper. The amount of moisture in a sheet of paper will vary according to the surrounding conditions and to the amount of moisture that is added during manufacturing and during the printing process. The moisture content of the paper can affect its runnability, printability and its physical strength. Generally, a range of 3% to 7% is average for the moisture content present in paper stock.

There are two groups of paper moisture meters: **Absolute paper moisture meters and Relative paper moisture meters.** Both groups show humidity results in % however their range of application is different. Absolute paper moisture meters are maiPaper Moisture Meters for a quick and accurate measurement or humidity in paper with a strong probenly used by the manufacturer directly in rolls of paper-making machines (these are not mobile so they never take measurements from roll papers when they are moving) or by the printer during the input control in the printing office.

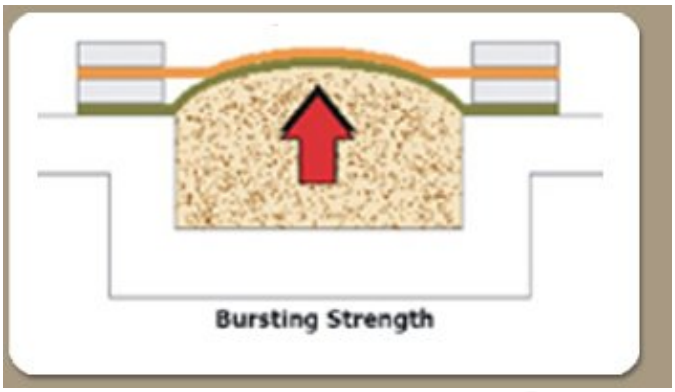
The control of humidity in paper is especially important during its production process due to the fact that an excess of moisture may block the rotary machine and create undue warming of the paper rolls. On the other hand, it is very important to take into account that the physical properties of any paper are determined by the content of humidity. Humidity in paper will change depending on the relative environmental humidity owing to its hygroscopic properties. Relative humidity testers of paper are only used in paper manufacturing plants or by technical specialists if there is a customer's complaint.

Working Principle of Mullen Tester

A test used to measure the bursting strength of paper.

Bursting Strength - The amount of uniform pressure required to pull a sheet of paper apart.

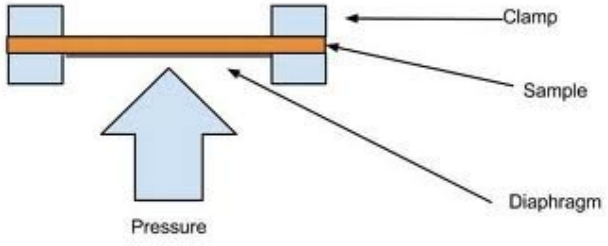
A property of paper or paperboard used in packaging that measures its resistance to rupturing, defined as the hydrostatic pressure needed to burst a paperboard sample when it is applied uniformly across its side. Bursting strength is a function of various processes performed in the papermaking process. The increased use of fillers decreases bursting strength, while the increased use of longer fibers and surface sizing increases a paper's bursting strength.



Bursting strength is measured utilizing a rubber diaphragm that is expanded hydraulically against the paper sample. A bursting test is also known as a Mullen test or pop test, and a minimum bursting strength is required for cartons used for shipping. Bursting strength has little application to printing papers.

Mullen Test

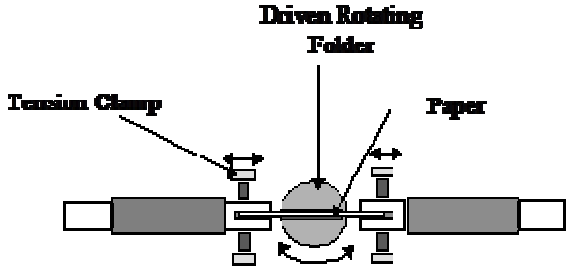
A test performed to measure the bursting strength of paper or paperboard. In a Mullen test (also called a pop test), the paper sample is placed between two ring-like clamps in a device called a Mullen tester, and hydraulic pressure is used to inflate a rubber diaphragm, which expands against the sample stretching it.



The measure of the total hydraulic pressure expanding the diaphram at the time the sample ruptures (usually expressed in either pounds per square inch or kilopascals) is its bursting strength. Mullen tests are performed for each side of a paper or paperboard, and the bursting strength can be expressed as the average of both sides. Bursting strength expressed as a percentage is called the percent Mullen. Mullen tests are typically performed on papers and boards designed for use in packaging, bags, and envelopes. It is rarely performed on printing or writing papers.

Working Principle of Folding Endurance Tester

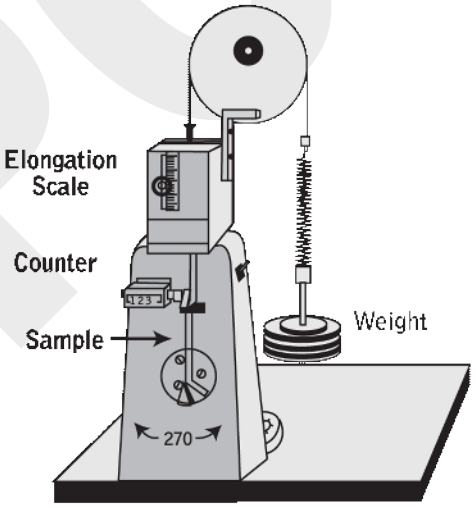
A paper property that refers to the ability of a paper to be folded repeatedly without tearing. The number of folds it can withstand before it breaks is its folding endurance. Folding endurance varies according to grain direction, and is greater against the grain. In the **Schopper method,** a metal blade repeatedly folds a strip of paper back and forth between several rollers until it breaks.



Shopper Fold Apparatus

In the **schopper method** (TAPPI Standard T 423), a strip of paper is held under tension while a slotted reciprocating blade catches the strip in its middle and folds it back and forth between four rollers, folding it first toward one side, then toward the other side. The number of double folds the paper withstands before breaking is its folding endurance.

In the **MIT method,** an oscillating folding head repeatedly folds a paper sample back and forth until it breaks. The MIT method allows greater variability in the paper samples, and the tension can be adjusted based on the thickness of the sample.



In the MIT method (TAPPI Standard T 511), a strip is clamped under tension between a spring-loaded jaw and an oscillating folding head. As the folding head oscillates an exact number of degrees on each side of its starting position, the paper is alternately folded toward each of its two sides. The average result for a number of double folds endured is reported for both the machine and cross-machine directions.

Working Principle of Weather-O-meter

A device utilized to evaluate a paper or ink's ability to retain its properties when exposed to inclement weather, basically consisting of a Fade-Ometer's **lightfastness-measuring equipment** supplemented with a water jet that intermittently sprays the test sample with water, to simulate the effects of weather.

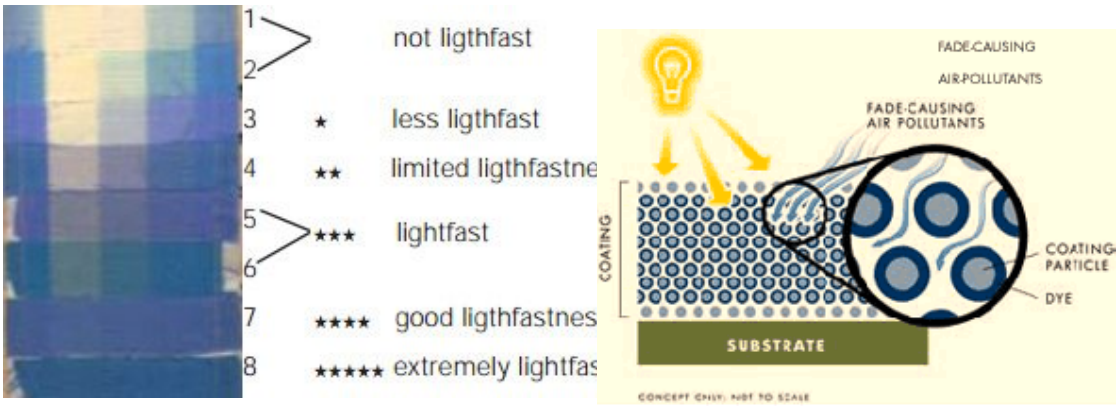


Figure 2: Porous Coating

The term l**ightfastness** also refers to a printing ink's ability to retain its color strength and resist fading upon exposure to light. Tests to gauge an ink's lightfastness are performed in a manner similar to measures of a paper's lightfastness.

A device used to measure a paper's lightfastness, or its ability to resist yellowing and fading upon exposure to light, by exposing the paper to light radiation produced from a carbon arc or xenon tube. A Fade-Ometer is also used to measure the fading resistance of inks and other pigments.

Unit - II

1 Mark Question

1. What is pH?

   The degree of acidity or alkalinity of the paper or solution

2. What is GSM?

   GSM stands for grams per square meter. It gives an idea as to thickness of a paper.

3. What is RH?

   The level of moisture in the air

4. What is viscosity?

   The degree to which ink resists flow when it is under force, such as in the roller train of a printing press.

5. What is tack?

   The stickiness of ink required to adhere properly to the type of substrate being printed on.

6. What are the two directions of paper?

   Long grain direction & Short grain direction

7. Name instrument measure the humidity.

   Hygrometers or psychrometers

8. What is TEA?

   TEA is the Tensile Energy Absorption, i.e. the amount of work required to break the sheet under tension.

9. Mention name of the instrument measure tear strength.

   Elmendorf Tear Strength Tester

10. Define stiffness

    Paper stiffness is the ability for a sheet of paper to resist bending.

11. Name two paper testing instruments.

    Mullen tester, GSM tester, stiffness tester, tensile strength tester.

12. Define Folding endurance.

    The ability of the paper to hold up to multiple foldings before breaking.

13. What is the optimum value of pH to be maintained in fountain solution?

    4.5 to 5.5

14. Mention the uses of mullen tester?

    A test used to measure the bursting strength of paper.

15. What is conductivity?

    Conductivity describes how electricity is conducted through a liquid; impurities in the dampening solution allow conductivity to increase

6 Mark Question

1. What is purpose of inspection?
2. Why do we need to maintain the incoming paper records in ware house?
3. What do you mean by proper handling of paper?
4. Write short notes on stiffness.
5. What is tensile strength of paper?
6. Why do we test folding endurance for packaging materials?
7. What is smoothness of paper and how it is tested?
8. Explain the relation between pH and Conductivity.
9. Explain the use of inkometer.
10. What is viscosity and tack?

12 Mark Question

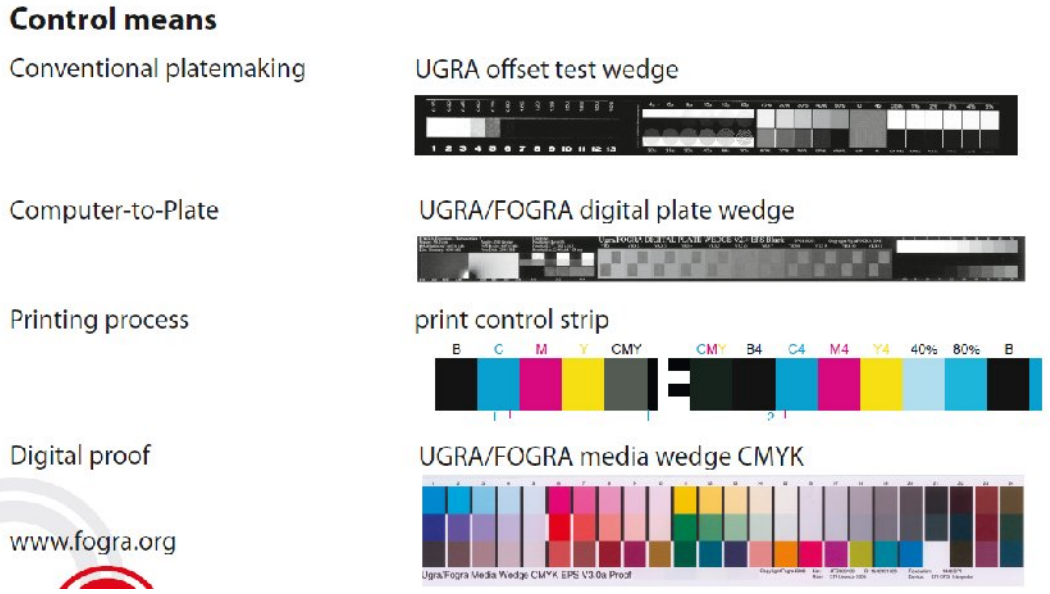
1. Explain the importance of proper material handling and maintenance of data sheet of materials in printing industry.
2. Discuss the testing property of inspection of incoming materials in the printing industry.
3. Explain in detail about the pH and conductivity of dampening solution with neat sketch.
4. Explain the procedure for testing of ink viscosity by using viscometer with neat sketch.
5. Discuss about importance of tensile strength for incoming materials in packaging industry?
6. What is tack? and explain in detail how to measure it with neat sketch.
7. Explain about tearing resistance tester and folding endurance tester in detail.
8. State the various paper and board property and explain any one in detail with neat diagram?
9. Explain about glossmeter and opacimeter in detail.
10. State various ink tests and explain any one in detail with neat diagram?
11. Write short notes on:
    a) Stiffness b) RH c) Smoothness d) Grain direction e) Tearing resistance
12. Explain about Moisture meter and weather o meter in detail.

UNIT - III – PROCESS CONTROL

3.1 QUALITY CONTROL TARGETS

The Quality and Process Control Product Line has been divided into five categories:

- **Quality Control Devices** include light indicators, color vision testing products, color correction products for photographers, color tolerance tests, and images to check color consistency.
- **Process Control Targets** include control wedges for imagesetters and platesetters, proof control devices and scales, and digital PostScript control targets.
- **Color Control Bars** include single and dual-tiered color bars in multiple lengths that contain neutral-gray patches, solids, tints, total area coverage patches, RGB overprint patches and Star Targets.
- **Test Forms** include measurement forms for sheetfed, web, and digital printing as well as diagnostic forms in sizes from 8.5”x11” to large format.
- **Custom Products** include special “made to order” color bars, test forms, targets, or film-based products with your company’s logo.



Registration mark

Registration marks in printing are alignment marks made at the surface of a paper before printing. This lines help in ensuring that the paper to be printed is properly aligned.

You may have the most accurate CtP, the best and newest offset press, however, you are still covering

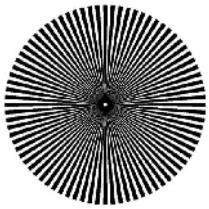
absorbent paper with ink and water and squeezing under pressure in the press. The result is that there will always be a chance of misregistration in the presswork.

The little circle with a cross through it is printed using every colour of the four-colour printing process. If they're being printed accurately, they should overlap precisely so the mark looks entirely black. Therefore if any of the colours are slightly offset (out of register) then they'll be displayed, showing the job isn't being printed correctly.

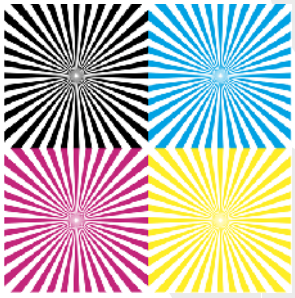
In multicolor printing, when all the layers of inks are in perfect register, one is not aware of the individual ink layers, only the image created by their combination. However, if one or more of the individual ink layers begins to move out of register, the image begins to appear softer, with lower detail definition. Color and tone may subtly shift. And if the ink layers continue to move further out of register, color fringes begin to appear at the edges of detail, and finally the color image breaks up.

Star target

The star target appears along with the color bar and helps the pressman detect any irregularity in the ink spread.



The star target consists of a circle formed of alternating positive and negative pie-shaped wedges tapering toward the center at a known angle. Having many stars across the field of view allows the best focus across the field of view to be determined while simultaneously analyzing horizontal and vertical information at a variety of resolutions.



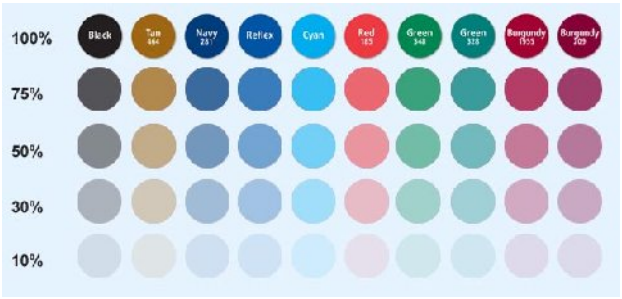
Slurring and doubling are print defects that occur when halftone dots and type blur as a result of a slight second contact or movement between press cylinders or the paper and blanket. There are many different styles of slur and doubling detection targets. Every halftone dot or letter character on the printed sheet will reveal slur and doubling, however the targets in the color bar signal the defect easier and quicker.

The Star Target amplifies the effect of gain, slur, doubling, paper movement, so that small distortions in print can be easily seen by the operator. The indicator is visual; there is no way to quantify the result.

Ink coverage target

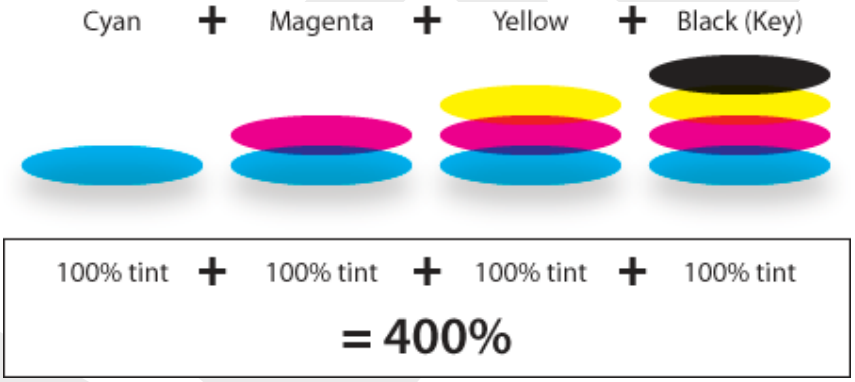
The amount of ink printed on a sheet. Generally indicated by percentage.

In printing, any non-uniformity in the density of a printed image, resulting from fading, discoloration, incomplete ink coverage, or other causes.



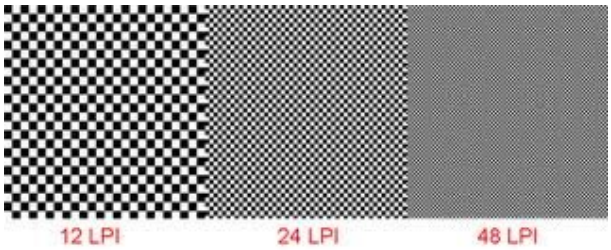
In imaging, density range refers to the gamut of tones in an original (or reproduction), expressed as the difference between the area of maximum density (the darkest portions of an image) and the minimum density (the lightest tones). Also known as tonal range. For example, the density of a shadow area can be calculated as, say, 2.5. The density of ahighlight area can be calculated as 0.10. Thus, the density range for the image as a whole would be 2.4.

The amount of ink that may be printed in a single pass depends on the number of inks set up for the job. A two ink press can only ever give 200% ink coverage in any single space, but a 10 ink press can max out at 1000%, where each ink has a 100% tint applied. Most jobs are printed in CMYK process colors and therefore can range to 400% ink coverage (see graphic below). Which is still too much for most papers to cope with. So it's important to understand the implications of the ink sliders in Illustrator's Color panel.



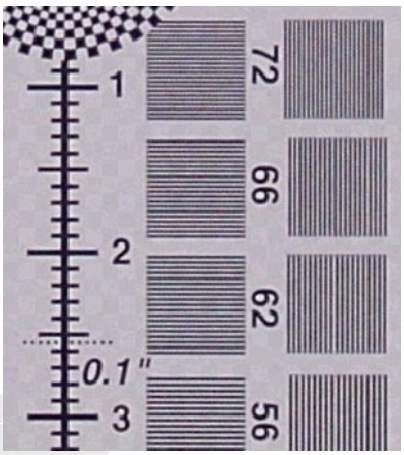
Two other considerations of ink coverage are drying time (the speed at which a print press can run as each printed sheet is laid on top of the other) and the volume of ink used. Both have cost implications, usually for larger print runs, but could also impinge on the speed of turn-around from the printers.

Line resolution target



A transparent screen which has been etched with fine lines. It is used to convert a picture or photograph into a halftone dot pattern so that it can be printed.

A measurement of the number of lines of type in an inch, determined by measuring from baseline to baseline. Example: 6 LPI indicates that 6 lines of type would fit in one inch. 2. The number of lines of dots per inch in a halftone screen or linescreen. A screen with a higher lpi, such as 200 lpi has many smaller dots which provide finer detail and a sharper image clarity. The LPI of a halftone screen is also called frequency.



LPI Stands for "Lines Per Inch." LPI is used to measure the resolution of images printed in halftones. Because halftone images are printed as a series of dots, the higher the LPI number, the more dense the dots can be, resulting in a finer resolution.

Newspapers are typically printed in a resolution of 85 lpi, while magazines may use 133 lpi or higher. Because the naked eye can distinguish halftone dots up to about 120 lpi, you are more likely to notice the dots in newspaper print than in magazines. Of course, if you look closely enough, you may be able to see the dots in images printed in 150 lpi or more. But, in normal viewing, it is natural to see the dots as a continuous image even at 85 lpi.

Print control Patches (Print control strip)

Color bars are also referred to as color control bars, color control strips, or proofing bars. Color bars are rows of different colored patches printed in the trim area of the press sheet. They are used by proofers and press operators to control the trapping, ink density, dot gain, and print contrast of the proof or the printed sheet.

Since a finished printed image generally consists of the overprint of the four halftone screens, it is very difficult to isolate each of the various components affecting the reproduction of the original image.

To overcome this problem, a series of test elements can be printed along with the image, and each element can be designed to highlight a particular aspect of the printing process. While some of these test targets can be evaluated by eye, others require the use of a densitometer.

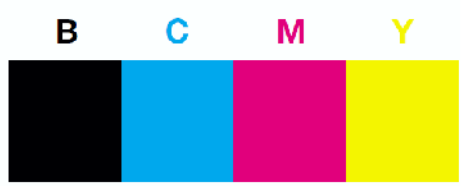
The usual form of these test elements is a strip across the edge of the press sheet, although in boxboard and label work these elements may be interspersed with the images. These test strips, called **print control strips or color bars,** are available commercially from FOGRA, BRUNNER, etc. and consist of strips of film containing the various test elements for each of the four colors. In some cases six color versions are available when special colors might be used.

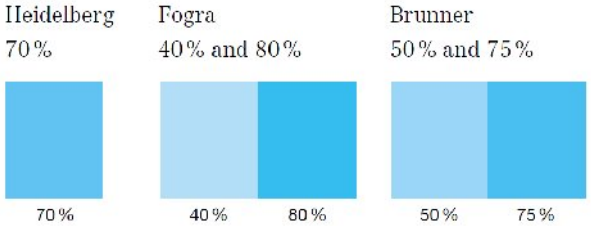
- Print control strip – the most important control tool mean for printing

The usual densitometric targets in a color bar are: Solid Ink Density, Dot Area/Gain of the quarter, half and three-quarter tints, Contrast and the Trapping of ink overprints.

1) Solid patches

Solid patches enable the uniformity of the inking to be checked. It is advisable to use one solid field per printing ink spaced at the distance of the ink fountain zone width (32. 5 mm for Heidelberg). This makes it possible to use solid fields for the automatic calorimetric control of solids.

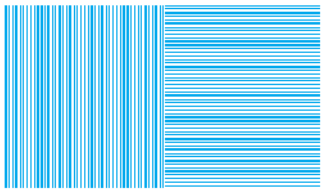




2) Halftone patches

Depending on the manufacturer, halftone fields may contain different type on halftone values.

From the measured data of the halftone and solid patches the dot gain and print contrast are calculated.



3) Slur/doubling patches

Line gratings of different screen angling allow the pressman to visually and densitometer check for slur or doubling faults.

4) Grey balance patches

One has to distinguish between solid and halftone contour balance fields. In solid patches, the superimposition of cyan, magenta and yellow must result in an approximately neutral black. For purposes of comparison, a black solid field is printed next to the overprint field.

Given correct ink film thickness, standardized colour sequence and normal dot gain, the superimposition of cyan, magenta and yellow produces an approximately neutral gray. Different halftone values are used by manufacturers for the type of the various colours.

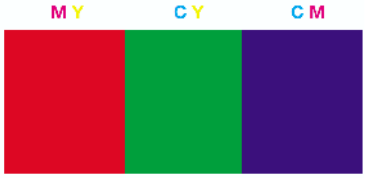
Colour balance patches are also used for the automatic gray balance control of cyan, magenta and yellow.

Heidelberg:	70% cyan	60% magenta	60% yellow
FOGRA:	28% cyan	21% magenta	19% yellow
Brunner:	50% cyan	41% magenta	41% yellow

Offset CMY Gray Balance				Black Tint Equivalent
C	M	Y	K	K
25%	18%	18%	0%	25% (Quartertone)
40%	30%	30%	0%	50% (Midtone)

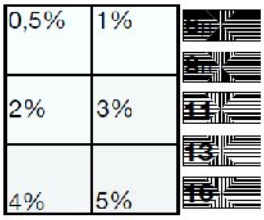
5) Solid overprint patches

These elements are designed for the visual and densitometric assessment of the ink trapping performance.



6) Plate exposure control patches

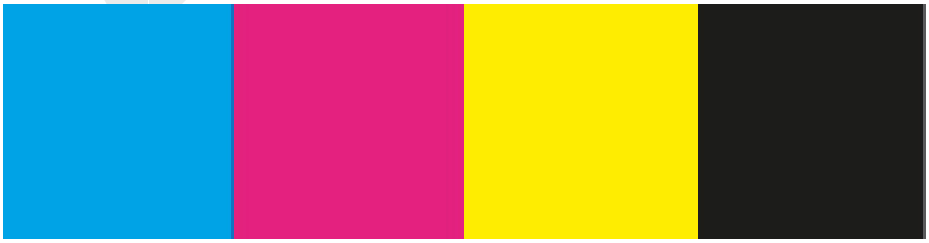
Plate exposure control fields are designed for visual monitoring of the plate exposure. The control elements shown contain microlines and micro reverse lines as well as fields with dots.

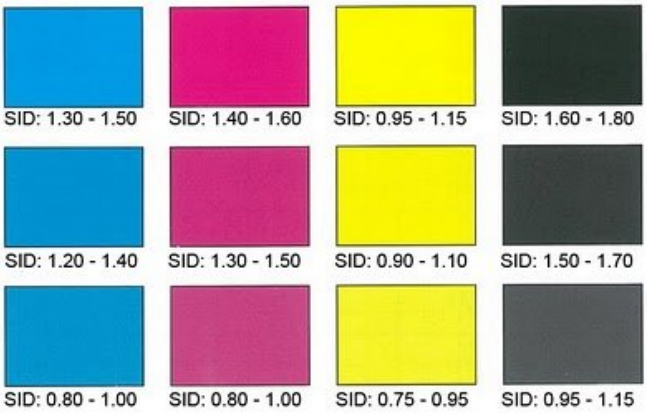


3.2 ANALYSIS OF PRINT ATTRIBUTES

Solid Ink Density (SID)

Density is the ability of a material to absorb light. Generally, the darker a process color is to the eye, the higher the density. Density measurements of solid ink patches are used to monitor the ink film thickness applied during a press run. In comparing two printed sheets, density readings should be within .05 units, when measured on a densitometer, for meaningful print quality assessment.





Dot gain, print contrast and apparent trap are directly affected by this solid ink density. Generally, these values will vary as the solid ink density changes. Therefore, monitoring solid ink density during a press run is essential when comparing any printed material in terms of quality. There are various publications that list target densities for printing on newsprint stocks.

The readings of a solid area, are referred to as solid density. It is measured on a print control strip, which is printed on the sheet at right angles to the print direction. Besides other control elements the print control strip contains solid fields for all four process colours and, if necessary, for additional colours.

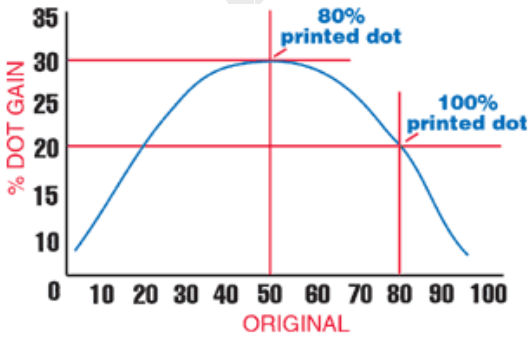
The solid density value allows a regular ink film thickness to be checked and maintained (within a certain tolerance) throughout the whole sheet width and print-run.

Therefore, for most press operators, the minimum requirement for a color bar is that it contains solid patches of the inks that will be printing since solid ink density is the only thing on press that an operator can adjust while the press is running.

Those solid patches are then repeated over the width of the press sheet so that each ink zone is represented by at least one complete set of patches - containing one patch for each color being printed.

Dot gain

Dot gain is the difference between the halftone values in the screen film and in print. Deviations result both from geometrical dot variations and from the effect of light entrapment.

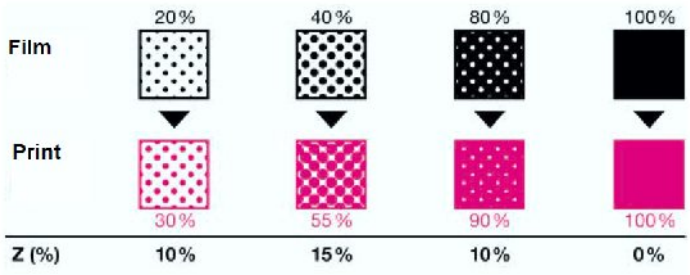


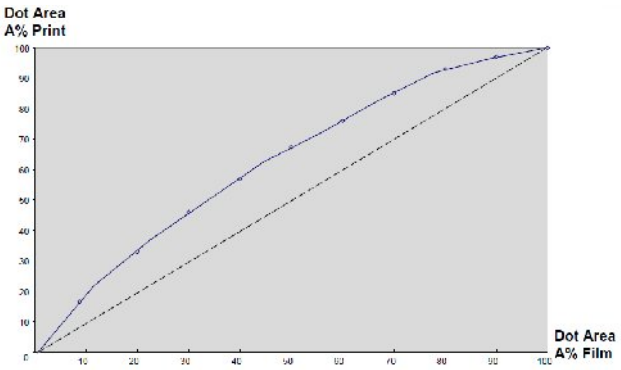
The dot gain Z (%) is obtained from the difference between the measured halftone value in print F_D and the known halftone value in film F_F.

$$Z\ (\%) = F_D - F_F$$

Dot gain refers to a characteristic of halftone printing whereby reflectance of the printed material is less than would be expected

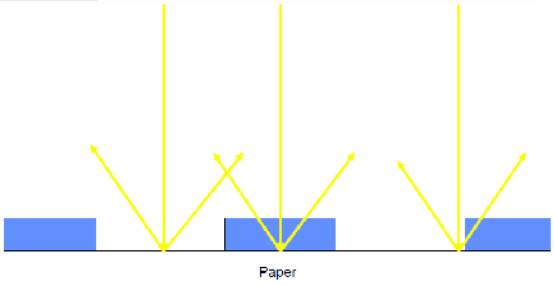
from the percentage area coverage of the dots set on film by the imagesetter, or the percentage area coverage expected from a digital code value in the digital representation of the image.





The major component of dot gain is Optical Dot Gain, by which light scatters in the printing substrate. Dot gain may also be contributed by dot spreading, press gain, slurring, or doubling.)

Dot LOSS is also an issue of dot gain. This is where a dot is so small that it disappears. A 1% screen of any color will not show up on a press. A 2% screen probably won't, and a 3% screen will be tough to hold on the press.



Mechanical Dot Gain

An aspect of Dot Gain associated with physical increase in the area coverage of a halftone dot when printed, compared to the area of the dot on the imagesetter film.

Optical Dot Gain

Contribution to dot gain caused by light scattering and absorption in the substrate, and absorption of light on the underside of a printed dot, thereby increasing the density in those areas.

Print Contrast

A method of evaluating and optimizing the density of the ink deposited on the substrate during printing. The ink strength—or print contrast—is determined to take into account the solid ink density, the density of the ink in shadowareas of the image, and the dot gain. Print contrast is calculated by measuring the ink density of a solid area and the ink density in a 75% tint.

1 2 3 4 5 6 7 8 9 10

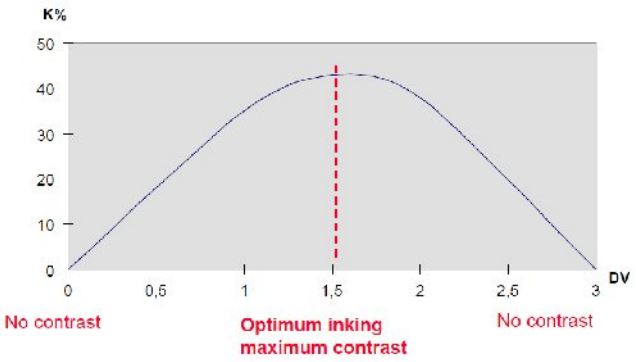
Figure 6

$$\text{Print contrast} = \frac{\text{Density of solid - Density of tint}}{\text{Density of solid}} \times 100$$

–

s

The relative print contrast is also calculated from the readings of the solid ink density Ds and the screen (or tint) ink density D_t. The Dt value here is best measured in the three-quarter tone (ie.e 75% of tint). The print contrast is calculated according to the formula:



$$\mathbf{K(\%) = \frac{Ds - Dt \times 100}{Ds}}$$

A print should have a contrast as high as possible. This means that the solids should have a high ink density, but the screen should still print open (optimum halftone value difference). When the inking is increased and the ink density of the dots rises, the contrast is increased. However, the increase in ink feed is only practicable up to a certain limit. Above that limit the dots tend to exhibit gain and, especially in three-quarter tone, to fill in. This reduces the portion of paper white, and the contrast decreases again.

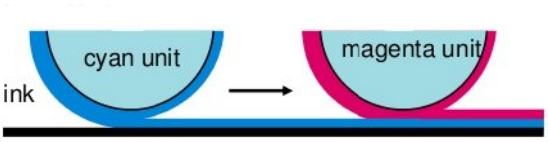
If there is no measuring device available with a direct contrast display, the relative print contrast can be calculated or determined on the basis of the FOGRA PMS.

If the contrast value deteriorates during a production run in spite of constant ink value in solid DV, this may be a sign that the blankets need washing.

If the solid density is correct, the contrast value can be used to assess various factors which influence the print result such as

- rolling and printing pressure,
- blankets and underlays,
- dampening,
- printing inks and additives.

Since the contrast value, unlike the dot gain, depends to a large extent on the solid density it is not suitable as a variable for standardisation. This is why in the recent past its importance has decreased significantly.

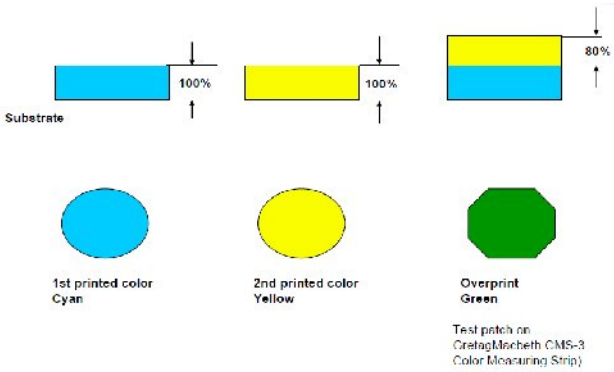


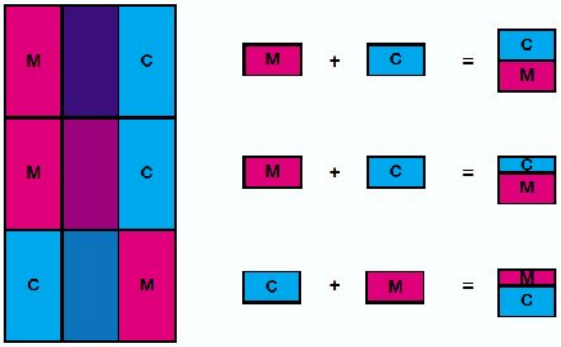
Ink Trapping

It indicates how well an ink is accepted when printed onto another ink as compared to when it is printed onto the printing stock.

A distinction has to be made between wet-on-dry and wet-on-wet printing.

The term "**wet-on-dry" printing** is used when an ink is printed directly onto the printing stock or another, dry ink. If, on the other hand, an ink is superimposed on a wet colour, one uses the term **"wet-on-wet".** For multicolour presses, the term "wet-on-wet" printing is generally used.





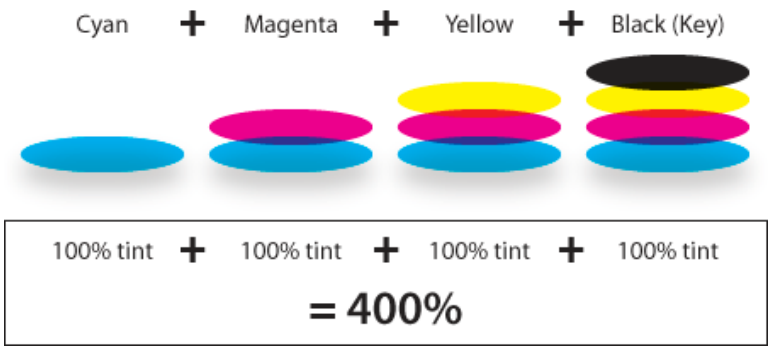
The term trapping refers to the action of printing an ink film on top of another ink film, as in process color printing. Proper trapping results in well-printed materials, while poor trapping results in successive inks that do not adhere properly and bead or rub off readily.

Wet trapping refers to trapping performed in wet multi-color printing, where one ink is laid down on top of a previously printed, still-wet ink. If the second ink has greater tack than the first ink, poor trapping will occur.

Dry trapping is a multi-color printing process in which one ink is laid down on top of a dry ink.

Maximum ink coverage

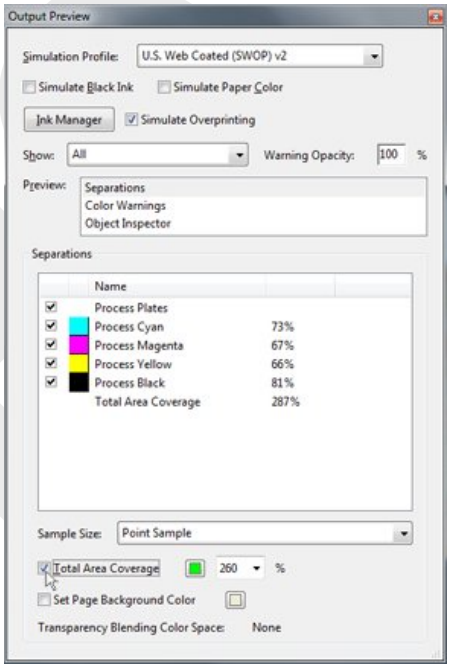
The amount of ink layered on a page (colors printed on top of each other as in 4-color process printing) is the ***Total Ink Coverage(TIC) or Total Area Coverage (TAC)*** for a document. The printing method and type of paper are two key factors in determining the maximum ink coverage that is acceptable.



TIC is the sum of the cyan, magenta, yellow, and black (CMYK) values for any part of an image. For example,

C40 M30 Y20 K15 is 40+30+20+15 = 105% TIC.

C50 M50 Y50 K100 would be 250% TIC.



Even if most of your page uses just 100% black text, if there is an area that contains more layers of ink, such as a color photograph, it determines the total ink coverage for that page. If you have overprint areas, that also adds another layering of inks that would increase the amount of ink used for that portion of your layout.

If the maximum TIC for a specific printing method and type of paper is exceeded the layers of ink added last in the print run may not adhere properly to the underlying layers of ink resulting in inaccurate colors, slow ink-drying with possible rub-off of ink, wrinkling of the paper, and ink bleeding through the paper. Too much ink can result in photos with muddy colors or dirty brown instead of a nice neutral black or a loss of detail in the shadows from the excessive ink.

ICC profiles contain a great deal of color management information including total ink coverage settings for specific printing conditions. Some desktop publishing software will allow you to set a certain total ink limit and alert you to those areas of a design that exceed that limit. In the illustration on this page, areas of a design that exceed a specified limit (in this case, 300%) are shown in red in an InDesign document.

The acceptable amount of ink coverage depends on several factors. Coated paper can usually accept a higher ink coverage than uncoated paper, for instance. However, the following list provides some generalities. This list refers to offset lithography printing:

Types of Paper	Method of Printing	Total Ink coverage (TIC)
Coated paper	Sheetfed offset	320% to 340%

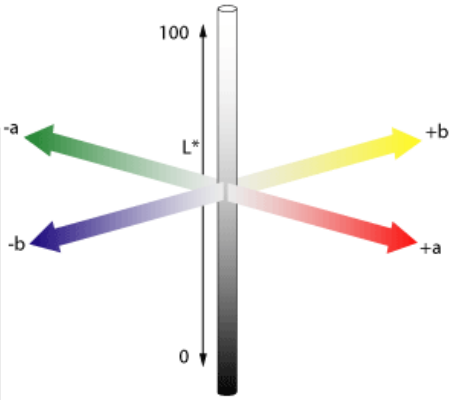
Uncoated paper	Sheetfed offset	240% to 260%
Coated paper	Heat-set Web offset	300% to 320%
Uncoated paper	Cold-set Web offset	240% to 260%

CIE Lab

CIE - International Commission of Illumination. This is the organization responsible for setting the world-wide color measurement standards.

An organization called CIE (Commission Internationale de l'Eclairage) determined standard values that are used worldwide to measure color.

The values used by CIE are called **L*, a* and b*** and the color measurement method is called CIELAB.

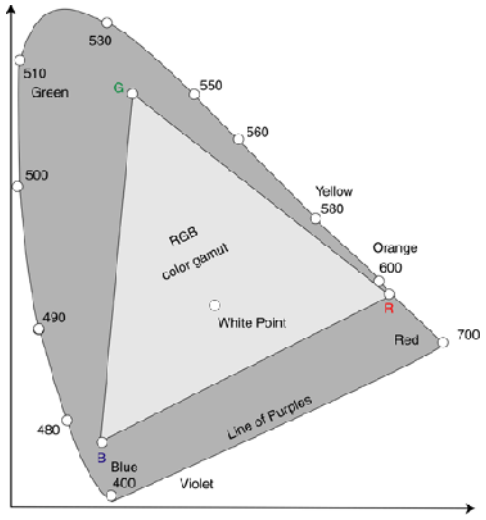


- L* represents the difference between *light (where L*=100) and dark (where L*=0).*
- a* represents the difference between *green (-a*) and red (+a*), and*
- b* represents the difference between *yellow (+b*) and blue (-b*).*

Using this system any color corresponds to a place on the graph shown in Figure 3.

CIE Chromaticity Diagram & Colour Gamut

Since the human eye has three types of color sensors that respond to different ranges of wavelengths, a full plot of all visible colors is a three-dimensional figure. However, the concept of color can be divided into two parts: **brightness and chromaticity.** For example, the color white is a bright color, while the color grey is considered to be a less bright version of that same white. In other words, the chromaticity of white and grey are the same while their brightness differs.



The CIE XYZ color space was deliberately designed so that the Y parameter was a measure of the brightness or luminance of a color. The chromaticity of a color was then specified by the two derived parameters x and y, two of the three normalized values which are functions of all three tristimulus values X, Y, and Z.

These Co-ordinates are used to show the spectrum visible to humans in a Chromaticity Diagram. They are used to map a device's colour gamut showing the range of colours that can be reproduced against the visible spectrum.

The co-ordinates are calculated from ratios of the XYZ tristimulus values. The two axes are: x which is horizontal, and y which is vertical. The x and y are lower-case. Unfortunately it cannot show luminance. In order to show luminance, Y (upper-case) from CIE XYZ may be used. In this case it becomes known as 'xyY'. Colours in the chromaticity diagram are not perceptually uniform.

In its 1931 recommendation, the CIE adopted the average R, G, and B data for a small number of observers as the experimental definition of the CIE 1931 standard observer. It was considered important to eliminate negative numbers among the tristimulus values. Therefore a mathematical transformation of the standard observer data was made, representing a change from the original red, green, and blue primaries to a new set, which cannot be produced by any real lamps, called the X, Y, and Z primaries. The tristimulus values of the equal-power spectrum colors in the CIE X, Y, Z system provide the definition of the 1931 CIE standard observer in its most used form.

Color Difference – Delta E

The difference between two colour samples is often expressed as Delta E, also called DE, or ΔE. 'Δ' is the Greek letter for 'D'.

The colour difference is a measure of the distance between two colour locations in the colour space (e.g. between original and printed sheet).

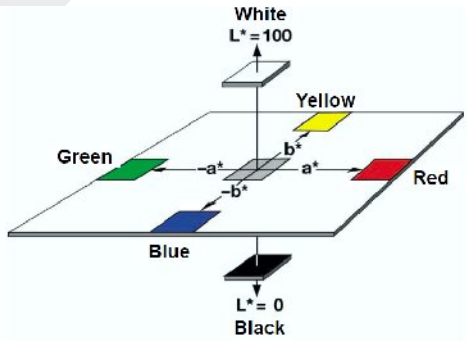
The colour differences are calculated using the following formula:

$$\Delta L^* = L^*_{act} - L^*_{ref}$$

$$\Delta a^* = a^*_{act} - a^*_{ref}$$

$$\Delta b^* = b^*_{act} - b^*_{ref}$$

$$\Delta E^*_{ab} = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$



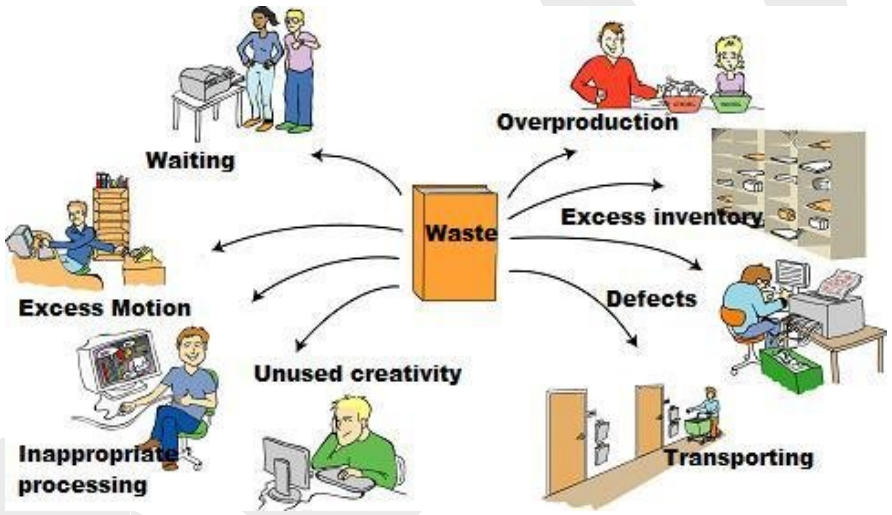
This can be used in quality control to show whether a printed sample, such as a colour swatch or proof, is in tolerance with a reference sample or industry standard. The difference between the L*, a* and b* values of the reference and sample will be shown as Delta E (ΔE). The resulting Delta E number will show how far apart visually the two samples are in the colour 'sphere'.

ΔE between 0 and 1	In general, this deviation cannot be perceived.
ΔE between 1 and 2	Very small deviation; only perceivable by an experienced eye.
ΔE between 2 and 3.5	Medium deviation; perceivable even by an unexperienced eye.

ΔE between 3.5 and 5	Large deviation
ΔE exceeding 5	Massive deviation

3.3 WASTAGE MINIMIZATION

1. Reduction of waste from over production
2. Inventory
3. Defects
4. Waiting time and delay
5. Accumulation of work in process
6. Transport (logistic)
7. Motions



1. Overproduction:

Producing more than is needed. Any resources expended unnecessarily are considered waste, and producing product when it is not needed is a common waste in manufacturing. This can occur due to poor production planning and control, or it may result from improper incentive systems that reward overproduction.

2. Inventory:

All idle resources are wasteful, and inventory is one of the most common. Raw materials, WIP and Finished Goods inventories require significant capital investments, but add no value to the product. Some may argue that having product on hand so it can ship immediately adds value to the customer. Short lead times add value, but holding inventory does not. The goal of lean is to achieve the value desired, such as short lead times, without any waste, such as high inventory levels.

3. Wait Time:

Whenever materials, people or machines are sitting idle. Waiting occurs when queues are built within processes, or when the time required for workers or machines to conduct a value added process is out of sync with each other. In these situations, one of the resources is waiting, and waste is occurring. Ideally, every resource would be put to productive use 100% of the time it is required. Any time a resource spends idle represents lost capacity and productivity, and increases lead time to the customer.

4. Transportation:

Material movement that does not move the product to the customer. The definitions of waste and value vary within the lean community. There are some who consider all transportation costs as waste. Others consider some transportation as value added since a product is more valuable to a customer once it is delivered to the customer. Regardless of the view on transportation, minimizing transport costs is a goal of lean.

5. Processing:

Excessive processing includes any activity that provides no additional value to a product or service. Often, excessive processing occurs when an individual processing operation can be combined with other processes or can be eliminated all together. For example, packaging processes do not add any value to a product.

6. Motion:

Any movement, of people, machines or materials that does not add value to a product. The elimination of motion was one the major drivers that led to the development of cellular manufacturing techniques. With these techniques, production is completed in a small work cell combining multiple operations with little to no movement between each operation, and without excess motion expended by the worker.

7. Defects:

Poor quality drives up costs both in wasted materials and labor. Lean manufacturing draws heavily on total quality techniques and seeks to ensure every activity delivers value. Defects disrupt this process, causing materials and labor to be lost. More recently, reducing waste and eliminating defects have taken a major step forward with the development of six sigma techniques. Six sigma tools compliment the lean framework, and many practitioners describe the combination as Lean Six Sigma.

Unit - III

1 Mark Question

1. Name two quality control targets.

   Registration mark, star target, ink coverage target & line resolution target

2. What is SID?

   Solid ink density

3. What are the two types of ink trapping?

   Wet on wet and Wet on dry

4. What is Grey balance?

   The superimposition of cyan, magenta and yellow must result in an approximately neutral black compared with normal solid black.

5. Name the types of dot gain.

   Mechanical dot gain & optical dot gain

6. Define Delta E.

   The colour difference is a measure of the distance between two colour locations in the colour space

7. What is print contrast?

   A method of evaluating and optimizing the density of the ink deposited on the substrate during printing.

8. Expand CIE.

   CIE - International Commission of Illumination.

9. What is the purpose of minimize the wastage?

   Help to protect the environment, its saves money, create safer working conditions for employee and protects human health and environment.

10. What is TIC?

    The amount of ink layered on a page (colors printed on top of each other as in 4-color process printing) is the Total Ink Coverage

11. What is meant by dot loss?

    It is where a dot is so small that it disappears. A 1% screen of any color will not show up on a press.

12. Define slurring/doubling.

    It is an error in the printed product of offset printing which manifests itself through changes in geometry of the image elements.

13. What is star target?

    The star target appears along with the color bar and helps the pressman detect any irregularity in the ink spread.

14. Mention any two name of color control bar.

    FOGRA, BRUNNER, Heidelberg

15. Mention any two factors affect print result.

    Rolling and printing pressure, blankets and underlays, dampening & printing inks and additives.

6 Mark Question

1. List down the quality control products for prepress operations.
2. Explain briefly about SID.
3. Explain briefly about Dot gain.
4. What is print contrast?
5. Write short notes on ink trapping.
6. Explain Ink coverage target.
7. Explain Delta E.
8. List down the patches in color control bar.

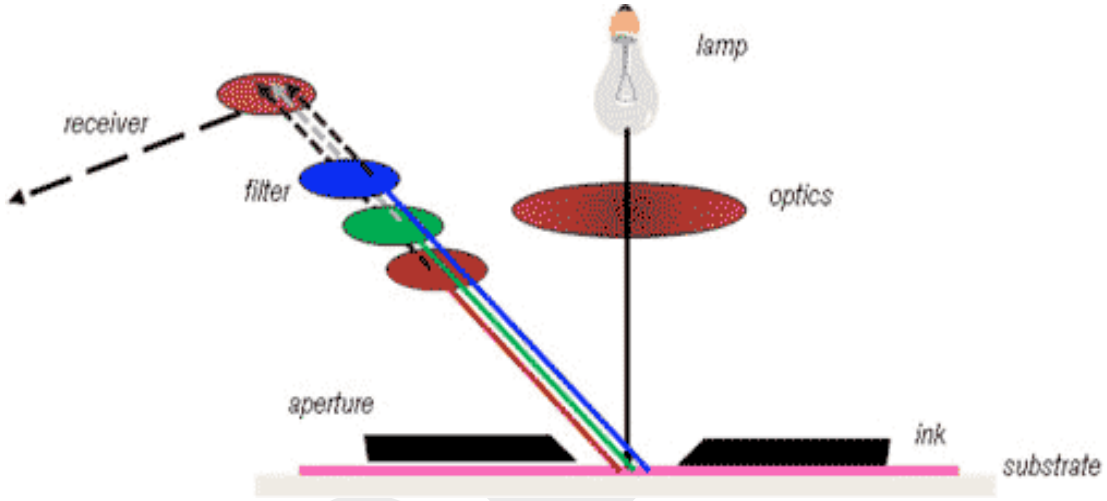
12 Mark Question

1. Explain in detail quality control target with neat diagram.
2. Explain about print control strip in four color printing with neat diagram
3. Explain in detail about various analysis of print attributes applied to maintain quality in printing.
4. Explain in detail about CIE Lab with neat diagram.
5. Explain in detail about wastage minimization in printing industry.
6. Write short notes on 1) Registration mark 2) Star target 3) SID 4) Dot gain.

UNIT - IV – CALIBRATION OF INSTRUMENTS AND PROFILE

4.1 DENSITOMETERS

Densitometry is the cheapest and most widespread measuring method in the field of repro work and printing.

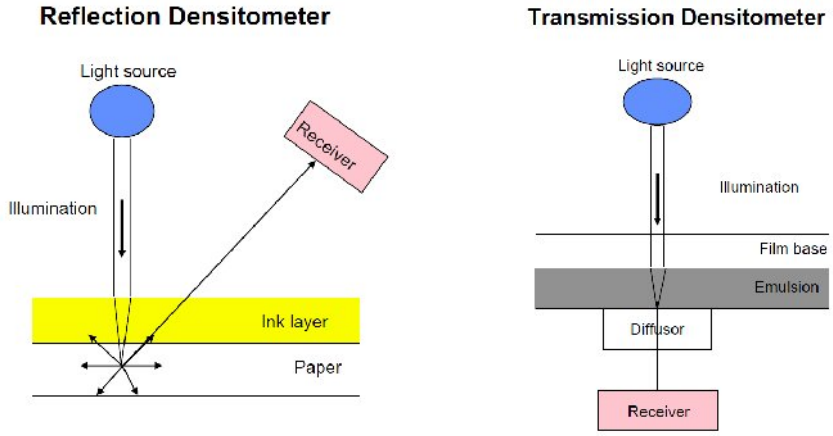


A densitometer is an instrument having a light-sensitive photoelectric eye for measuring the density of colored ink to measure and control the optical density of color inks on the substrate. ***Densitometers measure the degree of light absorption or opacity of the image.*** A darker image absorbs more light which corresponds to a higher optical density. A densitometer does not measure color as the eye sees it, but instead as the substrate responds to it.

Densitometer are used for measuring color saturation by print professionals, and calibrating printing equipment. They are also used for making adjustments so outputs are consistent with the colors desired in the finished products.

Types of Densitometers

- **Reflection -** A reflective densitometer is used to measure opaque surfaces. Reflection densitometers use red, green and blue colored filters to measure printed surfaces
- **Transmission** - A transmission densitometer is used to measure transparent surfaces. Color transparencies, film negatives and positives are some examples of common transparent surfaces measured.
- **Combination** - A densitometer capabile of both tranmission and reflection densitometric measurements.



Uses for Densitometers

Densitometers are use for process control of density, dot gain (TVI), dot area, and ink trap. Densitometer readings will different for different types of substrates.

Measuring principle of a reflection densitometer

In reflection densitometry the ink to be measured is illuminated by a ***light source***. The light ray passes through the transparent (glazing) ink layer and is partly absorbed.

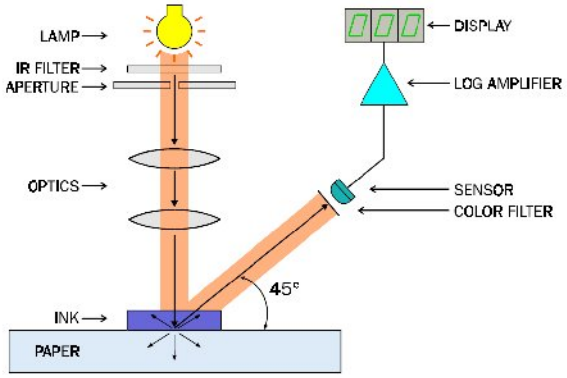
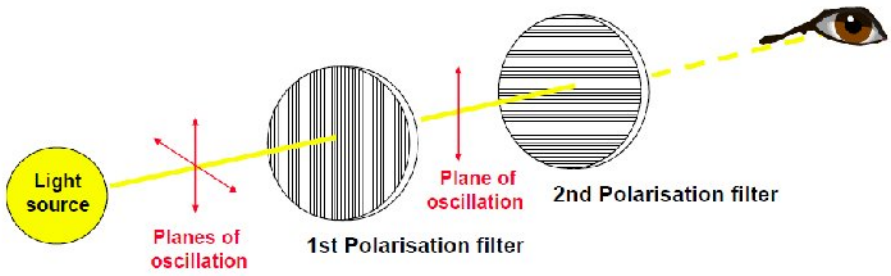


Figure 3: Components of a Reflection

The non-absorbed content of the light is largely scattered by the printing stock. Part of this reflected light again passes through the ink and is absorbed again. The remaining nonabsorbed light reaches ***a detector***, which converts the light into electricity. The result of the measurement with a reflection densitometer is given in density units.

In the measurement, ***lens systems*** are used to focus the light. ***Polarisation filters*** serve to prevent differences in the measured values obtained from a shining wet surface and from the surface of a dry ink.



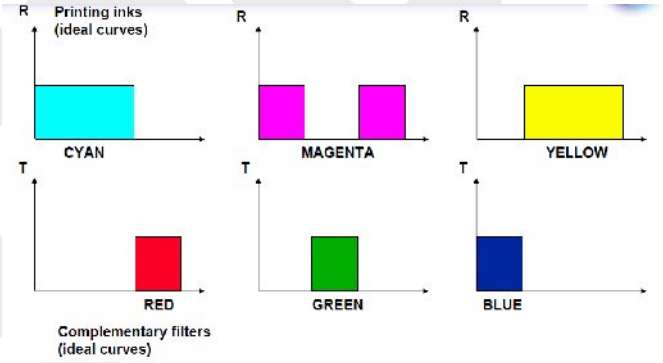
During the drying process, the ink adapts to the irregular structure of the paper surface, and the reflection effect decreases. If a given ink is measured first in wet and then in dry condition, different readings will result.

In order to eliminate this effect, two crossed linear polarisation filters are inserted in the path of the rays. ***Polarisation filters*** allow the light of only one particular vibration direction to pass, while blocking all light waves which are vibrating in other directions.

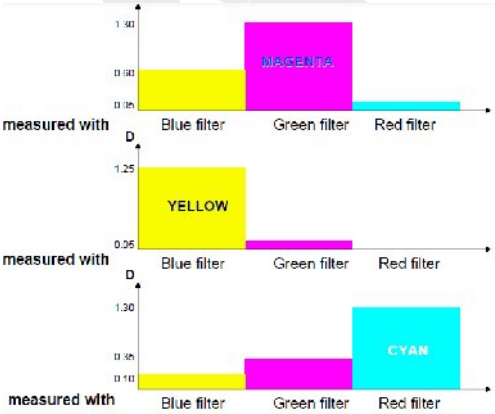
Colour filters are inserted for measurements of colours. The colour filters in a densitometer are tuned to the absorption performance of cyan, magenta and yellow.

Printing inks	Filter colour
cyan	red
magenta	green
yellow	blue

The illustration explains this principle, taking a coloured ink as an example. Ideally, the incident white light consists of equal portions of red, green and blue. The printed colour contains pigments which absorb the red portion and reflect the green and blue portions, which is why we call it “cyan”.

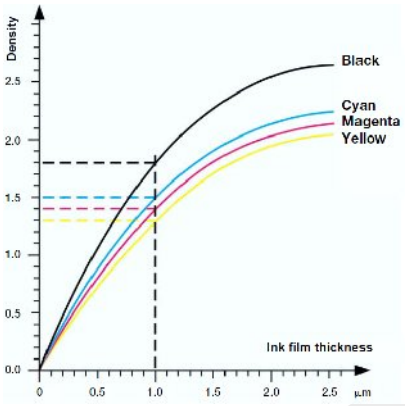


Densitometers are intended for measurement within the absorption range of each colour, where density and ink film thickness closely correlate. In our example a red filter is used which allows only red light to pass, whereas blue and green are blocked.



The density of a given ink mainly depends on the pigmentation, its concentration and its ink film thickness. For a given ink the density is a measure of the ink film thickness, yet it does not tell us anything about the hue.

The diagram illustrates the correlation between ink film thickness and ink density for the four process colours in offset printing.



4.2 SPECTROPHOTOMETERS

A spectrophotometer is a device for measuring light intensity by measuring the wavelength of light. The most common application of spectrophotometers in the printing industry is the measurement of light absorption.

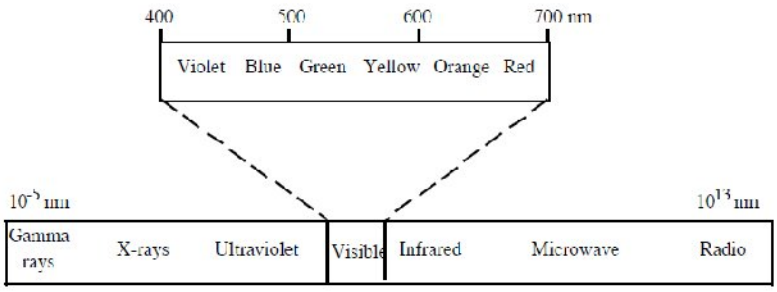
A spectrophotometer will illuminate the sample for measurement with white light. The sample will absorb some of that light and reflect a portion back. The reflected light passes through a detector which splits the light into separate wavelength intervals, and outputs those values to the device itself or an attached computer. The reflectance of a sample is expressed as a fraction or as a percentage.

Ink & paper manufacturers, printing companies, and others, need the data provided by a spectrophotometer. Spectrophotometers commonly take readings every 10 nanometers along the visible wavelengths(400-700nm), and produce a spectral reflectance curve. These curves can be used to make sure a color conforms to a given specification.

How a Spectrophotometer Works

To properly understand how a spectrophotometer works, we first need to understand how color works. Color is made up of wavelengths of light and can be broken into six categories:

1. X-rays
2. Ultraviolet
3. Visible light
4. Infrared
5. Microwaves
6. Radiowaves

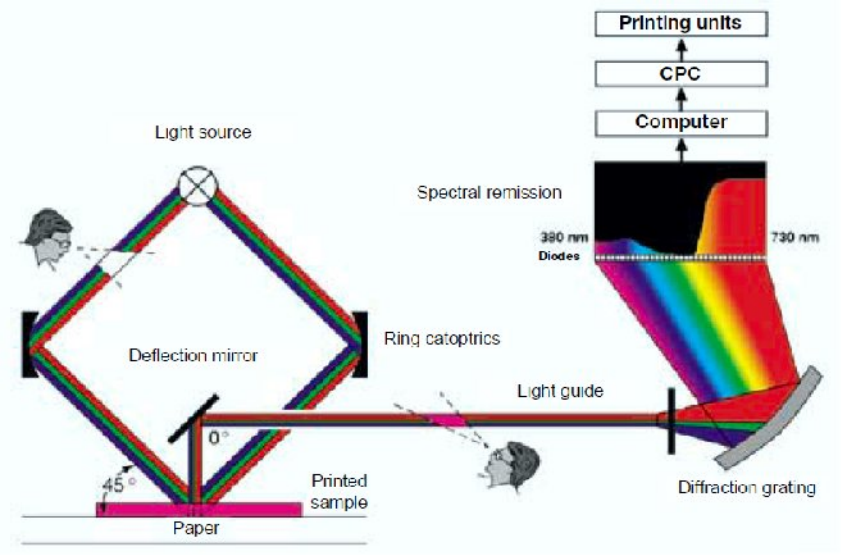


As you can see, visible light is somewhere in the middle, and this is what the spectrophotometer analyzes to match paint. The visible light spectrum is composed of good ol' ROY G. BIV, which is an acronym for red, orange, yellow, green, blue, indigo and violet. These seven colors make up all the different colors we can see with the naked eye. Black is the absence of color, and white is made up of all of these colors. This will come into play in a minute.

Measuring principle of a reflection Spectrophotometers

Colours are measured with tristimulus colorimeters or spectrophotometers. In principle, the construction of colour measuring devices follows the visual and sensoric model of the human eye.

During the measuring process, a measuring head scans the print control strip or the image, making a spectral measurement of all control elements. Alternatively, the standard ***illuminants A, C, D50 or D65*** and the standard observers 2° and 10° can be used. The measuring principle of a spectrophotometer is illustrated in the diagram below.



First, the illuminant is directed to the printed probe via ring catoptrics at an incidence angle of 45°. The reflected light at an angle of 0° is directed via a deflection mirror and a fiberoptical light guide from the measuring head to the spectrophotometer. There it is split into its spectral colours by means of a diffraction grating which has an effect similar to that of a prism.

Photodiodes measure the radiation distribution in the entire visible spectrum

(between 380 and 730 nm) and send the results to a computer. There the measured colour values are evaluated colorimetrically; the result is given in the tristimulus values X, Y and Z and the chromaticity coordinates x, y and Y.

Apparatus:

1. light source
2. filter (the device that selects the desired wavelength)
3. cuvette chamber (the transmitted light passes through compartment wherein the solution containing the colored solution are kept in cuvette, made of glass or disposable plastic)
4. detector (this is a photosensitive element that converts light into electrical signals)
5. Galvanometer (measures electrical signal quantitatively)

Light source

Two kinds of lamps, a ***Deuterium*** for measurement in the ultraviolet range and a ***tungsten lamp*** for measurement in the visible and near-infrared ranges, are used as the light sources of a spectrophotometer.

Spectroscope

A spectroscope plays a role in selecting a monochromatic light from a light source (white light). Spectroscopes include Filter type, Prism type, and Grating (diffraction grating) type.

Optics

A container that contains a sample is usually called "cell"; two types are available, ***glass and quartz cells***. Since light in the ultraviolet range with a wavelength of 340 nm or less hardly passes through a glass cell, it is used for measurement in the visible range of 340 nm or more.

On the other hand, although a quartz cell allows passage of light in the entire wavelength in the ultraviolet and visible ranges, it is mainly used for the measurement in the ultraviolet range due to its high price.

Detector

A detector plays a role in changing the light transmitted from a sample into an electric signal. Optical semiconductor, Types of photomultiplier, etc. are available.

Viewing Geometry

When light from a single direction illuminates objects such as a mirror or metal objects, almost all the light is reflected specularly (as if from a mirror), but for most objects such as solids, when the surface is illuminated from a single direction, the light is reflected as shown in Figure 2, with the surface (gloss surface) reflecting some light specularly like a mirror and reflecting the rest of the light diffusely in all directions.

Measurement from spectrophotometer

The ink (sample) is illuminated by a light source (radiation). Part of the light is absorbed by the sample, the rest is reflected. The reflected light is captured by the human eye. There the red, green and blue sensitive cones (visual receptors) are stimulated. Via optic nerve, this stimulation will trigger off the perception of colour in our brain.

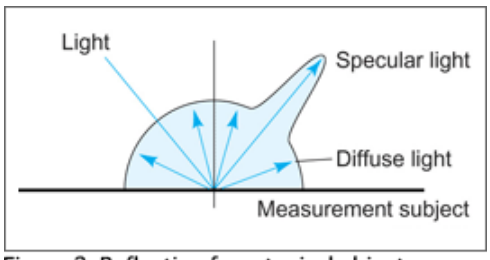


Figure 2: Reflection from typical object

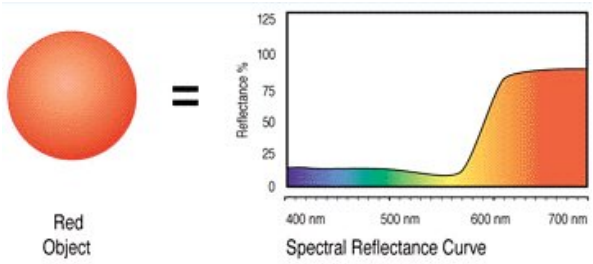
the

Wavelength (nm)	Color Absorbed	Color Observed
400	violet	yellow – green
435	blue	yellow
495	green	purple
560	yellow	blue
650	orange	greenish blue
800	red	bluish green

This natural process is imitated in the measuring device. In the measuring process, the light is sent onto the printed sample. The reflected light passes through a lens system and to a sensor, which measures the intensity of the incident light for each colour and transmits the measured readings to a computer. There they are weighted with functions that imitate the weighting functions of the three types of sensitive cones in the human eye, and which have been defined by the CIE for the standard observer. The result is the tristimulus values X, Y and Z. These are finally converted into chromaticity coordinates or coordinates of other colour spaces (such as CIELAB or CIELUV).

REFLECTANCE CURVES

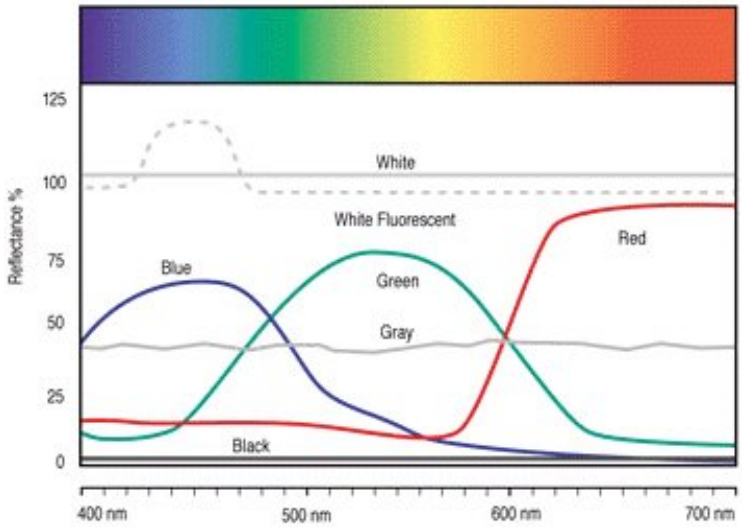
A spectrophotometer produces a reflectance curve that can indicate the color being measured. White light contains all the colors of the rainbow in the visible spectrum.



When white light falls upon an opaque object, the object interacts with that light. If the object appears red it is because the object absorbed most of the white light selectively, reflecting only the red portion, which is observed by the eye.

Likewise, if an opaque object is green, it absorbs all of the white light except the green portion. White objects produce a reflectance curve which is essentially flat at nearly 100 percent (reflecting all wavelengths), and black objects produce a curve which is essentially flat at nearly 0 percent (absorbing all wavelengths). For transparent objects the process is similar, except the white light is selectively absorbed, transmitting (rather than

reflecting) only the color observed. This interaction accounts for all the colors visible.



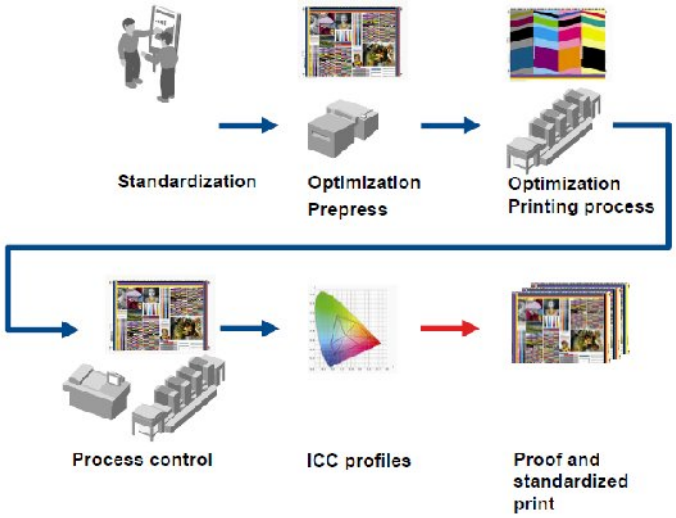
Spectral Reflectance Curves

4.3 INPUT DEVICE CALIBRATION AND PROFILE SETTING OF SCANNER AND DIGITAL CAMERA

Color management system:

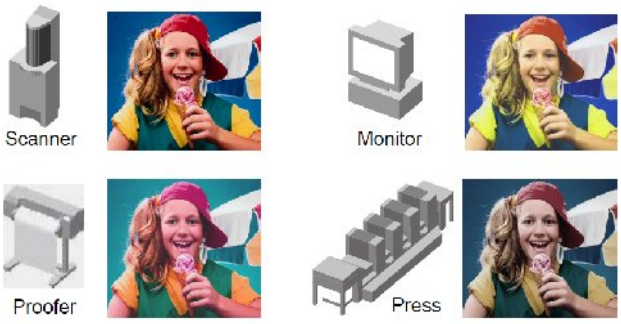
In a color management system, a device-independent definition of colors. Each of the devices in a particular system—from the scanner to the monitor to the printer—may not reproduce a particular color in exactly the same manner. Thus, a ***color management system defines the colors which can be reproduced by each device and determines and corrects colors that deviate from device to device.***

Process:



What's a color profile?

A color profile is a file that describes the color characteristics of a specific device while it's in a particular state. A profile can also contain additional information



defining viewing conditions or gamut-mapping methods. Working with your computer's color management system, color profiles help ensure that color content is acceptably rendered, regardless of the device or viewing condition.

In a color management system, color profiles are used to create color transforms, which programs use to convert color from one device's color space to another. ***(A color space is a three-dimensional model in which the hue, lightness, and chroma of colors are graphed to represent the rendering capabilities of a device.)*** When a new device is added to your computer, a color profile for that device might be installed automatically.

Calibration

To ensure the correct reproduction of images, all devices such as the monitor, color printer, proofer and imaging unit should be coordinated such that the fixed numerical values for CMYK can be represented correctly. In the broadest sense, this also applies to offset printing. Here, imagesetters have to be linearized and inking characteristics of the presses have to be matched to the real ink consumption.

Color profiles

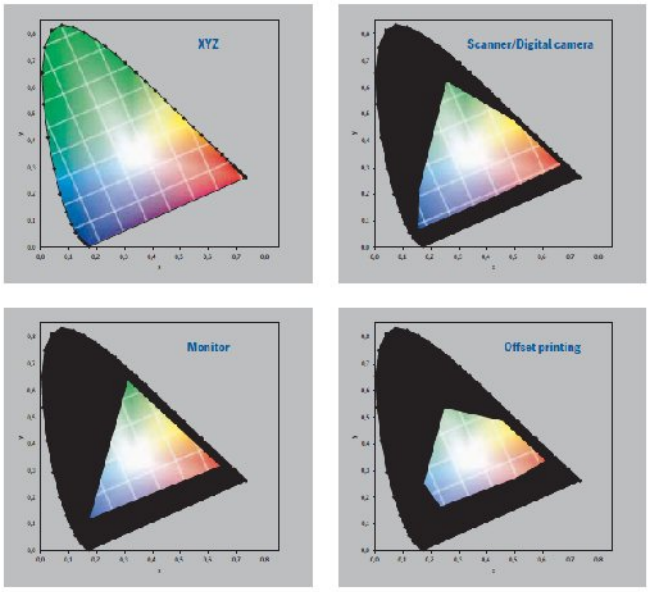
The profile is both a fingerprint of a color space that was previously measured and a set of instructions for the gamut mapping that is to be carried out. There are different types of profiles which can be divided into two main groups. ***Device-dependent profiles such as printer, scanner and monitor profiles.***

They each describe the color space that can represent the device. In the case of print profiles, the combination of ink and paper used is more important than the device. This is particularly apparent when one considers how many of these combinations can be printed with a press.

The second group is the ***device-independent profiles.*** These are profiles which describe a freely defined color space. For example, this can be the whole Lab color space or a color space defined for different applications.

Examples include the sRGB color space or the color spaces ECI-RGB, Adobe-RGB or NTSC (American/Japanese television standard).

Definition - ICC profile *(International Color Consortium profile)*



An ISO-approved color management standard for specifying the attributes of imaging devices such as scanners, digital cameras, monitors and printers so that the color of an image remains true from source to destination. A profile can be embedded within the image itself.

ICC profiles are the building block on which all ICC colour management is based, however by themselves they are nothing more than very simple 'look-up tables' that record the differences between a device's intended colour and its actual created colour. In other words they allow the transformation of colour values to/from the device and the Profile Connection Space (PCS).

R	G	B		L	a	b
255	255	255		100	0	0
255	255	255		99	-2	7
---	---	---		--	---	---
0	0	20		1	2	-9
0	0	0		.58	0	0

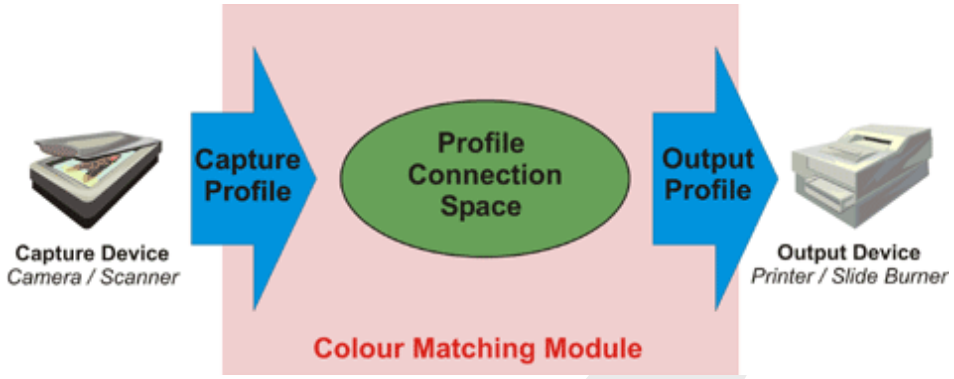
ICC Profiles can be thought of as paired lookup tables with columns of numbers for each colour in the colour space.

Any colours not explicitly listed in the table above are obtained from interpolation by the Colour Management Module.

There are a number of profiles that may be required, each made for the transformation of colour to or from the PCS.

Type	Use
Input Profile	Scanner, Camera etc
Output Profile	Printer, Film Recorder
Display Profile	Monitor (CRT, LCD), Projectors
Device to Device Profile	Custom Transform from Device to Device

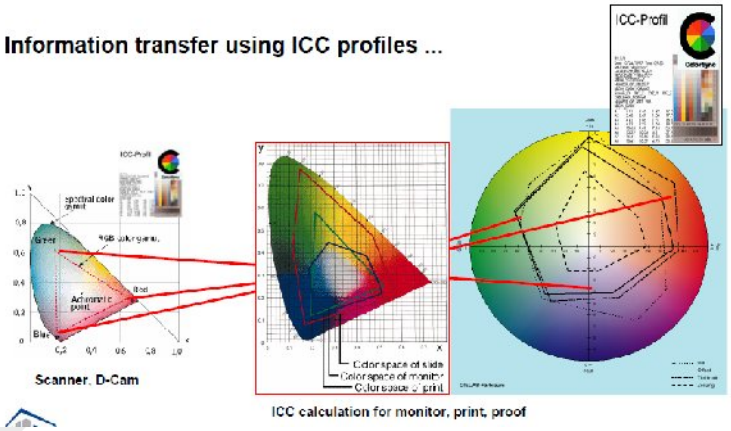
Colour Space Profile	Transform to or from a Working Colour Space



What's the difference between input and output profiles?

The ICC profile specification, now in version 4, is a cross-platform device profile format used for transforming the colour data created on one device into the colour values of a target output device.

Input profiles are used to characterise image capture tools such as digital cameras, scanners and monitors. Input profiles are often, but not always, defined in an RGB space. Output profiles are those of digital printing engines and presses.

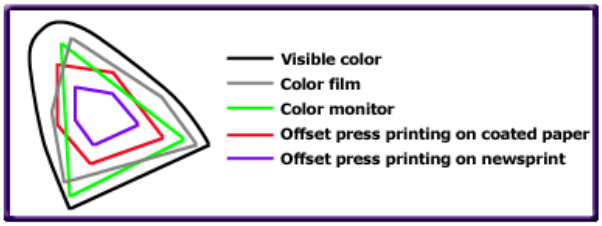


A colour management system can convert say, an RGB digital photo's device dependent colour data into device independent CIELa*b* data, and then into device dependent data, for instance CMYK for printing engine output, according to the constraints of the output profile.

So an input profile is the profile created to describe the characteristics of a data input device, such as a monitor, digital camera or scanner. An output device profile is one that characterises a desktop printer, digital press or offset press. Of course a monitor could also have input profile as when creating an image on screen and an output profile, as when it's used for softproofing.

Color Gamut

The color gamut refers to the range of colors that can be viewed, displayed, or printed. Digital printing equipment is able to reproduce a greater range of color than traditional offset technology which gives it a distinct advantage over offset.



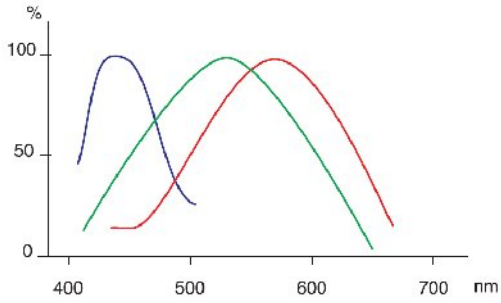


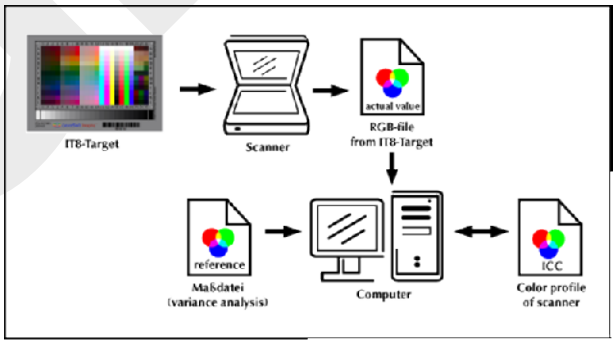
Fig. 4: The spectrum of perception of our cones can be easily illustrated by plotting wavelength against intensity.

The items in the list below are arranged from the greatest to the least in terms of the range of colors that each is able to reproduce:

1. Human Eye
2. Photographic Film
3. Television or Computer Monitor
4. Digital Printing Equipment
5. Offset Printing

Input profiles

An input or 'capture' profile is made for all devices that are making an original digital image from some other analogue source, such as a digital camera or scanner.



The device is characterised by capturing a 'test target' with a range of established and standardised colour values. Each one of the colour patches on the target has a known value that is contained in an associated data file that accompanies the test target. First the test target is captured and then each one of the colour patches within the image of the target is compared against the corresponding value for that colour within the data file.

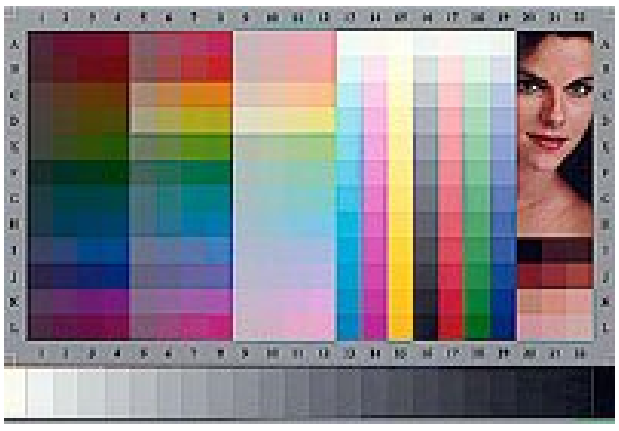
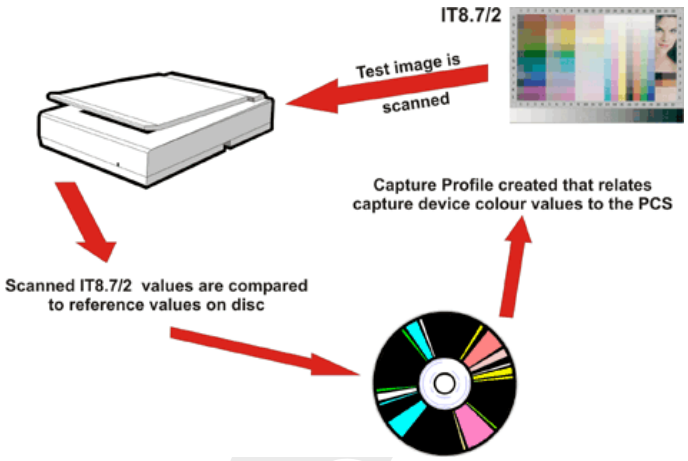


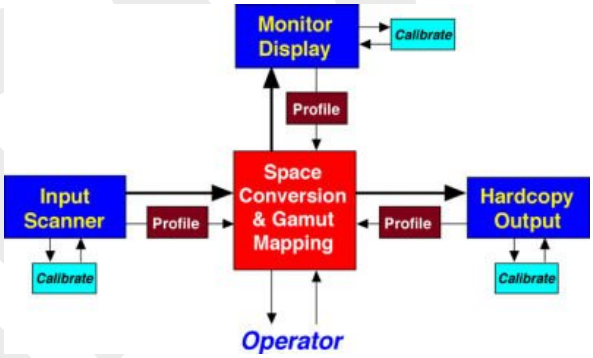
Fig : The IT8.7/2 colour test target

From this a long list of differences is created which can be

used to create a custom adjustment for each of the colours within the target. The more colours the target has the more accurate this system will be. Colours that fall between those on the target will have to use an averaged reading based on the closest colours. The standard test target for creating capture profiles is the IT8.7/2. In its standard form this has 240 test colour patches although some manufacturers make versions that have a few extra patches.



Of course this whole process relies heavily on the data files being an accurate representation of the colours on the target. The data files can be made in a number of different ways that will control both the accuracy of the data and also the cost of manufacture:

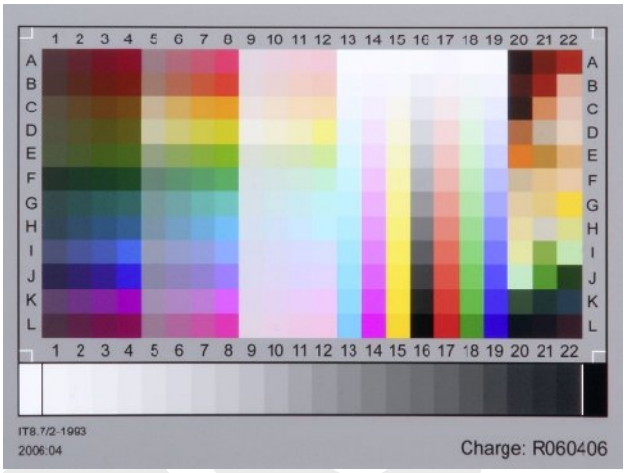


- **Generic 'Target-Data' set:** In this case the target is printed to an established value and the accuracy of the match will depend entirely on the accuracy of the calibration of the printer as it endeavours to print to the established values within the data-files. How accurate this is will depend entirely on the quality of the printing. In general these are not very expensive but they also tend to not be very accurate either and are typical of the 'manufacturer-supplied' target-data set.
- **Batch 'Target-Data' set:** To provide a more accurate set of data-values for the colour patches it is possible to take one of the printed targets from each production batch and individually measure the colour values on the target. As there is only a slight variation of colour within each batch, this should provide a more accurate set of data-values for that target and therefore a more accurate profile. These are the most common target-data sets supplied for the creation of quality profiles.
- **Custom 'Target-Data' set:** The most accurate profile will be made by individually measuring the colours of each and every colour patch and creating a custom set of data values specifically for that colour target. These target-data sets will provide the highest quality but at the highest cost.

It should be realised that the more accurate your target-data set is, the quicker it will become inaccurate if the target is allowed to fade or become marked. It is therefore

imperative with all targets that they are looked after and kept away from light or unnecessary handling. However careful you are with your targets, they will in time fade and it is then best practice to either replace them or to at least re-measure them and create another data-set that matches the 'faded' target.

Profiling a Scanner



Many scanners both flatbed and film come with a calibration target and software that will let you calibrate (bring to a known value) your scanner. Often times the industry refers to this as linearizing the device, which really is the same as calibrating it.

The targets used to calibrate and profile scanners are often times similar or the same. Some devices and or profiling software applications come with custom targets while others use popular targets made by Kodak, Agfa, Fuji and others.

The **Kodak "IT8" target** is a well known and often used target. The manufacturers of these targets also provide reference files (usually simple text files) that include the LAB values for each color patch. These values serve as a reference point for the color values attained when the target is scanned. A point of comparison if you will, that is used to create a calibrated state or generate a custom profile.

Profiling a Digital camera

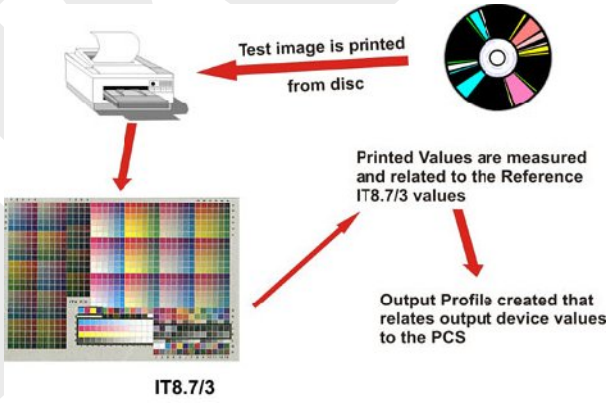
In the early days of digital cameras, it was possible to produce a profile for cameras shooting in JPEG/TIFF mode mainly due to the fact that some cameras produced gross errors that could benefit from correction, even if the result wasn't completely "accurate". Now, most cameras comply reasonably well with the sRGB color space and many more advanced cameras even offer an option of sRGB or Adobe RGB as the color space used by the camera. When we have a relatively recent camera model and/or a color space selection, it is rarely beneficial to try to develop ICC profiles for the camera shooting in JPEG/TIFF mode because it is difficult to impossible to produce corrections that result in any ***consistent*** improvement. If we shoot in raw mode, however, most raw conversion tools offer an option to turn off color management so that custom ICC profiles can be created/used. With color management turned off, the raw data offers a much

more consistent starting point, and profiling becomes not only possible, but often quite beneficial.

The process, at least conceptually, is very simple. Take a shot of a color target in raw mode, develop the raw image with color management turned off in the developing software, and use a profiling tool to create a profile from the image of the target. The profile can then be activated in the raw developing tool. That said, the actual process itself can get a bit complex if we want to ensure a quality profile. You need to get a good shot of the target under good lighting, and you need to use a profiling tool like Profile Prism that was designed with camera profiling in mind as camera profiling requires specialized options like the ability to normalize tone curves and let the device dictate white balance. There are other high-end (read expensive) tools that allow you to develop camera profiles.

4.4 OUTPUT DEVICE CALIBRATION AND PROFILE SETTING OF MONITOR, PROOFER AND COMPUTER TO PRINT.

Output profiles



Output or 'printer' profiles are made in a similar way to input profiles but in this case the test image is in the form of image-data of a colour target in which every colour patch is of a known and standardised colour. This test image is then printed using the device, ink and media that you wish to profile. The print of the target image is then 'read' by a colour photo-spectrometer that measures the colour value of each of the printed target patches. When this data has been recorded into a file, the 'measured' values can be compared with the 'correct' values and again a look up table is created which provides a correction for each colour in the test image.

With printer profiles it is important to realise that 'any' change to how the print is made will make the profile less or even totally ineffective. The profile will be as dependent upon the type of paper and of course the ink as it is on the printer itself. It is therefore important to standardise on the ink and paper used by your printer and if you need to use more than one type of paper, then of course it will also be necessary to make and use a different profile for each paper.

As printer profiles have to be made for each printer-paper-ink combination, it is very hard to make any generic profiles for printers and this is why manufacturers' profiles tend to not be very accurate. Also as each profile has to be custom made, they can tend to be relatively expensive. However, expense is comparative and for any printer that is relied on to

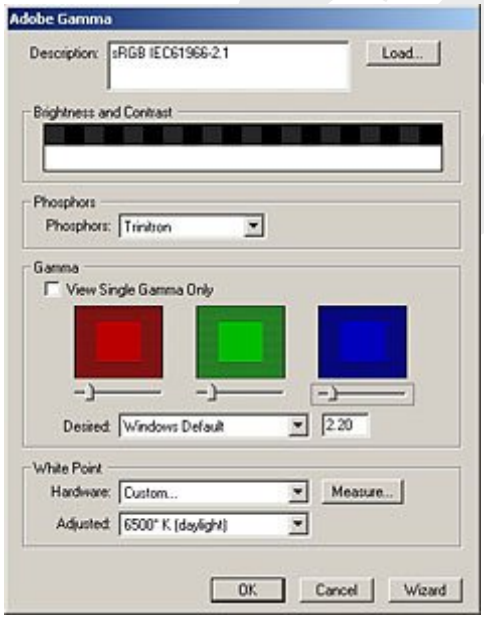
produce high quality colour or to provide a relatively high throughput, the costs might well be considered very low.

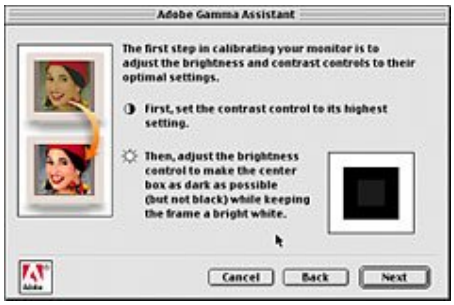
Monitor profiles

It is easy to understand that an input profile is comparing the colours created by that device with the Profile Connection Space (PCS) and that an output profile is again comparing the colour created by that device with the PCS, but what exactly does a monitor profile do?

A monitor profile is made to compare or 'characterise' the colours created and shown by the monitor against those in the PCS. Calibrating the monitor is a relatively easy task and yet it is perhaps the key part of any colour management system. Unless you are quite sure that you are looking at an honest and high quality representation of your digital images, it is quite impossible to make any colour quality judgement or undertake any editing.

Until recently most users calibrated their monitors using 'subjectively' based software programs such as the Adobe Gamma program that came with Photoshop or slightly more advanced programs of the same nature such as Sonnetech Colorific (now ColorWizzard). These programs created a monitor profile by asking the user to make a series of subjective choices where they would alter the gamma and colour settings to match a known standard output on the screen:





This system might well be considered better than nothing but it is hardly an accurate or objective method of characterising a monitor. A quick test will easily show that different users will calibrate the monitor to different values, highlighting the vagaries of this kind of subjective and user based system.

It is therefore not surprising that the importance of this part of the colour workflow has lead to much re-consideration on what is the best way of undertaking this critical characterisation.

To fulfil this demand we are now seeing a range of more objective and automated systems becoming available.

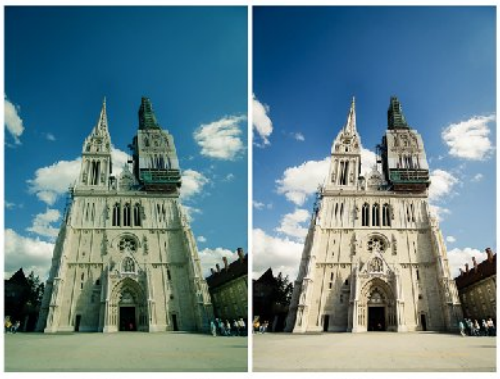
These consist of a colorimeter or colour photo-spectrometer that is attached to the monitor, which then takes readings of a range of colours that are provided by the associated software. There is a large range of these monitor-calibration systems at an equally large range of costs.

Like many other areas of technology, you get what you pay for and, even though the cheapest are likely to provide better results than the Adobe Gamma system, it will be worth paying for the best if you are trying to provide the highest quality and most reliable colour.

It is important to remember that the phosphors of a monitor will change over time and therefore it is important to regularly calibrate your monitor, certainly at least once a month is recommended.

Profiling a Monitor

The term “monitor calibration” actually refers to a two-step process, monitor calibration and profiling. The first component, calibration, changes the physical behavior of the monitor to match a known, desired state. On LCD monitors, this is essentially limited to adjusting the brightness of the backlight. Other corrections listed in the monitor’s on-screen display, such as RGB and white point adjustments, perform software corrections to the display without changing the physical behavior of the device. This differentiation is important because hardware adjustments, like altering brightness, do not negatively impact the quality of the image displayed, while software adjustments can cause problems, particularly with gray balance and the smoothness of transitions and gradients.

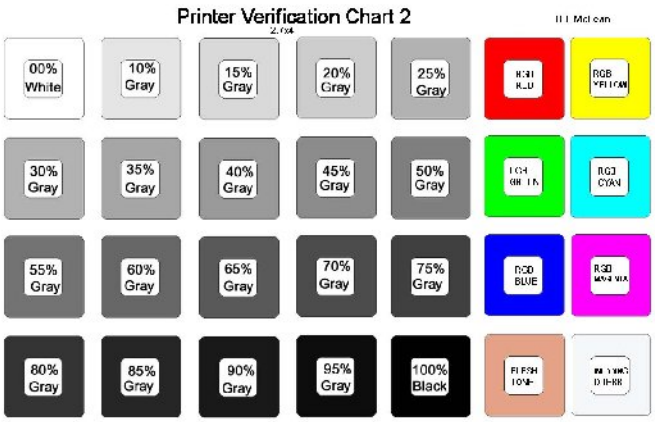


non-calibrated display calibrated display

In profiling, the second portion of the monitor calibration process, a series of colored patches displayed on screen. The monitor calibration software then compares the measured colors against the actual color values stored in the software and builds a look-up table to compensate for the differences.

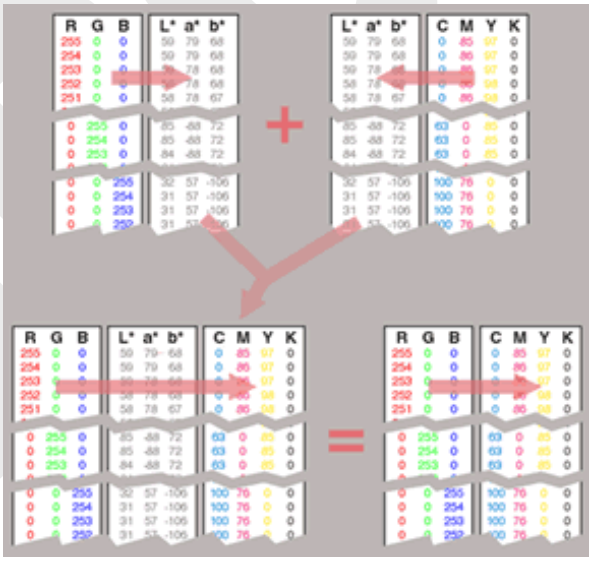
Together, the two-part process improves the accuracy of photos displayed on your monitor. The calibration process brings the monitor’s hardware controls to a known state,

then the profiling portion uses software to correct any lingering inaccuracies. The resulting ICC profile is set as the default monitor profile in your operating system. Any color management-aware applications, like Lightroom, Photoshop or Aperture use this monitor profile to automatically adjust the RGB values of displayed colors. Once you create the profile, there is nothing more you need to do.



Profiling a Printer

While your computer screen shows color by projecting combinations of red, green, and blue (RGB), your printer creates color by printing color inks onto paper. Typically the inks used are cyan, magenta, yellow, and black (CMYK), but can include light versions of cyan, magenta, and black inks or sometimes red and blue or orange and green. To achieve a color match from your monitor to your printer the monitor and printer must both be calibrated and profiled.



When you calibrate your printer you are essentially setting it up for optimum ink distribution on paper. Calibration ensures linear progression of the ink tints from 100% to 1% without a tonal distortion. Calibration also ensures you are getting the best color saturation for vivid color prints. Because each paper absorbs ink differently you must create a seperate calibration for each paper you use.

To achieve the best results a Raster Image Processor (RIP) is recommended. A RIP allows you to communicate to the printer in CMYK rather than RGB as is the case with manufacturer print drivers. Profiling your printer allows a color management system to correctly translate colors to your paper.

Profiling for Computer to Print

Color Management systems provide a profile of the color characteristics for each device used in the print workflow, such as a scanner or a digital press. Color characteristics profiles are incorporated into the print workflow in order to provide consistent color

reproduction throughout the process. Popular color management systems include Apple ColorSync and Microsoft ICM.

Cielab is an acronym for "Commission Internationale de l'Eclairage Lab," with "L" representing lightness, "a" representing the re/green axis, and "b" representing the blue/yellow axis. Cielab is the worldwide standard for color measurement and allows for easy communication concerning colors because it is based on numerical values, which takes the guess work out of color correction.

Cielab models are used for verifying whether the colors of an image fall within the color range of the print process and the piece of equipment that will be used to output the image. Cielab is also used to check the color-carrying capabilities of various papers, which is beneficial for clients in determining the types of papers that are best suited for their application. As most printers are aware, coated stock is capable of displaying a wider color gamut than uncoated paper, so using Cielab to illustrate the color gamut of various papers can justify the use of a more costly stock to achieve better results.

Unit - IV

1 Mark Question

1. Name any two instruments used to find density of the ink.

   Densitometer, Spectrophotometer

2. Name any two types of densitometer.

   Reflection and transmission densitometer

3. What are the uses of densitometers?

   Densitometers are used for process control of density, dot gain (TVI), dot area, and ink trap. Densitometer readings will different for different types of substrates.

4. Why polarisation filter used in densitometer?

   Polarisation filters serve to prevent differences in the measured values obtained from a shining wet surface and from the surface of a dry ink.

5. Mention the filter color used for cyan ink in densitometer?

   Red

6. Define spectrophotometer.

   A spectrophotometer is a device for measuring light intensity by measuring the wavelength of light.

7. Mention the wavelength for visible light?

   400 to 700 nm

8. Mention two kinds of lamp used in spectrophotometer?

   Deuterium lamp & tungsten lamp

9. What is CMS?

   Color management system defines the colors which can be reproduced by each device and determines and corrects colors that deviate from device to device.

10. Expand ICC profile.

    International Color Consortium profile

11. What is color profile?

    A color profile is a file that describes the color characteristics of a specific device while it's in a particular state.

12. What is input profile?

    An input or 'capture' profile is made for all devices that are making an original digital image from some other analogue source, such as a digital camera or scanner.

13. Where are the output profile used?

    Monitor, proofer, printer & Computer to print system.

14. What is color gamut?

    The color gamut refers to the range of colors that can be viewed, displayed, or printed.

15. Define calibration.

To ensure the correct reproduction of images, all devices such as the monitor, color printer, proofer and imaging unit should be coordinated such that the fixed numerical values for CMYK can be represented correctly.

6 Mark Question

1. What are the basic components of densitometer?
2. State the advantages of spectrophotometer.
3. Name the types of Densitometer.
4. What are the difference between reflection and transmission densitometry
5. Explain purpose of color filter.
6. Explain the categories of light
7. Explain reflectance curve.
8. Explain color managements system.
9. Explain input profile.
10. Explain output profile.

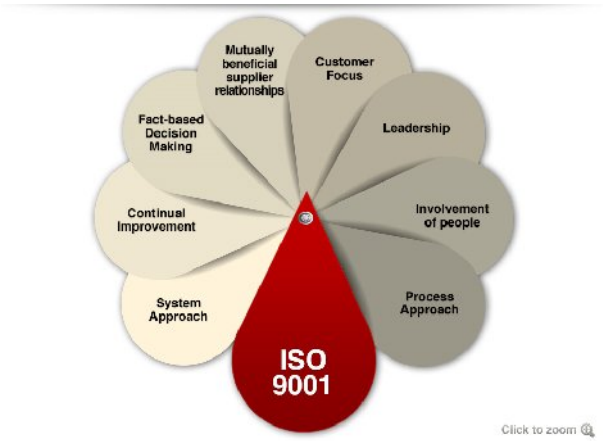
12 Mark Question

1. Explain in detail about densitometer with neat diagram.
2. Explain the working principles of spectrophotometer with neat sketch.
3. Explain the color calibration for any one input device with neat sketch.
4. Explain about input profile setting for scanner with diagram.
5. Explain the color calibration for any one output device with neat sketch.
6. Explain about output profile setting for Monitor with diagram.

UNIT - V – IMPLEMENTATION OF ISO FOR PRINT QUALITY

5.1 INTRODUCTION - ISO 9001

ISO 9000 is a series of standards, developed and published by the International Organization for Standardization (ISO), that define, establish, and maintain an effective quality assurance system for manufacturing and service industries.



ISO 9001:2008 Quality Management System certification enables you to demonstrate your commitment to quality and customer satisfaction, as well as continuously improving your company's operations. The internationally recognized quality management system standard is the preferred solution for organizations worldwide.

An international organization operating with a view towards improving quality, expanding trade, increasing productivity, lowering costs, and transferring technology around the globe. One of the primary duties of the ISO is to set international standards on products, services, and testing in nearly all industries.

Background

In November 2008 the International Organization for Standardization (ISO) introduced a revised Quality Management standard based on the same process model as the 2000 revision, with an emphasis on measuring customer satisfaction. The current version continues to emphasize compatibility with ISO 14001 - Environmental Management Systems.

The goal is for all organizations to seek continuous performance improvement. All requirements for quality management of the product or service are covered in ISO 9001:2008 which includes a quality planning requirement along with policies, objectives and quantifiable targets.

ISO 9001 groups them into these into 4 categories:

- Management - planning, goals & objectives, reviewing progress)
- Resources - people, tools, equipment etc
- Services or Products 'realisation' - whatever is involved in creating or delivering them, and lastly the
- Monitor, Measurement & Checking - the all-important feedback loop.

Key Benefits of ISO 9001:2008

What it does:

- Establishes and streamlines processes through complete documentation

- Improves and establishes training processes
- Defines roles and responsibilities
- Greatly increases operational efficiency
- Increases ability to troubleshoot
- Develops and builds relationships that help to retain existing customers
- Provides advantages over competitors that aren't certified ISO 9001:2008
- Builds opportunities for global commerce with international recognition
- Improves customer relations
- Improves relationships with suppliers due to clear, concise production standards· Provides basis for consistent and fact-based decision making
- Carefully planned improvements, based on documentation and analysis
- Provides for regular audits/reviews of performance

Other Benefits:

- Increases productivity· Maximizes quality
- Increases revenue· Improves employee morale and satisfaction
- Saves time and money
- Enhances ability to attract new customers that have adopted requirements for certification
- Improves accountability of management
- Increases employees' understanding of their roles in success of their work and the company
- Creates greater motivation and dedication

Steps involved in ISO9001 certification

The steps involved in any ISO9001 certification project are the following:

1. **Gap Analysis:** Assessment of existing quality management practices vis-a-vis ISO9001 requirements.
2. **Orientation Training:** Top/Senior Management orientation on ISO9001 requirements and action plans.
3. **System Documentation:** Preparation of quality manuals and design of quality record formats.
4. **System Implementation:** Implementation of quality system as per the quality manuals.
5. **Company-wide Training:** Training on ISO9001 clauses, Statistical Quality Control Techniques, Housekeeping (Japanese 5-S), and Quality Audit.
6. **Internal Quality Audits:** Periodic assessment of quality system implementation and corrective actions.

7. **Pre assessment:** Initial audit by Certifying agency, and, implementation of corrective actions.
8. **Final Assessment:** Certification audit by the Certifying agency and recommendation for certification.

ISO philosophy

ISO Philosophy
• Say what you do • Do what you say • Document what you do • Check the results • Correct the difference

ISO 9001 standard is a very simple approach to developing a quality system. It is based on the principle of the ***standardized operating procedure*** and auditing to that procedure. In essence, in order to become ISO 9001 certified, a company must do the following three things:

1. **Document what you do,** especially if there is an effect on product quality-this means that you must write down exactly how you take an order, make a plate, or run a press as it relates to the quality aspect of the process.
2. **Do what you document-**you must do your work the way you have said you will do it in the documentation.
3. **Give the customer** what you promised you must have procedures for testing, inspecting, and controlling your printing processes.

ISO 9001 series of standards

ISO 9000 series is comprised of the following international standards:

1. ISO 8402 - Quality management and quality assurance vocabulary
2. ISO 9000 - Guidelines for selection and use
3. ISO 9001 - Model for quality assurance: design, development, production, installation and servicing
4. ISO 9002 - Model for quality assurance: production, installation and servicing
5. ISO 9003 - Model for quality assurance: final inspection and test
6. ISO 9004 - Quality management and quality system elements
7. ISO 10011 - Guidelines for auditing quality systems
8. ISO 10012 - Requirements for measuring equipment
9. ISO 10013 - Guidelines for quality manuals.

ISO standards for Printing Industry (ISO 12647 series)

The 12647 International Organization for Standardization (ISO) standard provides standard process control aim points and tolerances for various printing methods and processes.

ISO 12647 consists of the following parts, under the general title Graphic technology – Process control for the production of half-tone colour separations, proof and production prints:

ISO 12647 is broken down as follows

1. ISO 12647-1 Parameters & Measurement methods
2. ISO 12647-2 Offset Lithographic processes
3. ISO 12647-3 Coldset Offset Lithography on Newsprint
4. ISO 12647-4 Publication Gravure
5. ISO 12647-5 Screen Printing
6. ISO 12647-6 Flexo Printing
7. ISO 12647-7 Proofing process from digital data
8. ISO 12647-8 Digital Printing

Current standards for the printing and media industry

- ISO 2846-1 which describes ink color and transparency.
- ISO 3664 defines lighting conditions for viewing color copies and their reproduction with either incident or transmitted light.
- ISO 15930-X (PDF/X) for data exchange in print production.
- ISO 15076 for the ICC color profile format.
- ISO 12640 for the data format from which ICC profiles are calculated.

5.2 TYPES AND PURPOSES OF AUDITS

ISO 9001 mandates that the company audit its own processes internally as well as being audited regularly by an outside firm. There are generally three different types of audits as it pertains to who is doing the audit and two different types of audits as it pertains to what is being audited. These are:

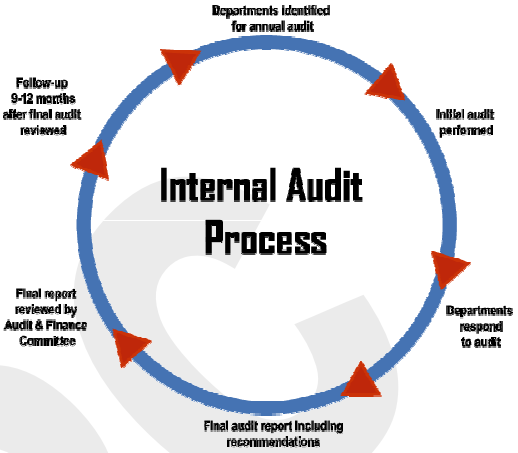
Description	Audit Category	Conducted by
First party	Internal	By the organisation on itself
Second party	Supplier	By the organisation on a supplier or sub-contractor
Third party	External	By the IC, its sub-contractors, or an independent consultant on the organisation

- What will be audited:
  1. **Adequacy assessment-**the system meets the criteria of the standard
  2. **Verification assessment**-the system is being implemented as it is spelled out.

What is Audit?

An audit is an evidence gathering process. Audit evidence is used to evaluate how well audit criteria are being met. Audits must be objective, impartial, and independent, and the audit process must be both systematic and documented.

There are three types of audits: **first-party, second-party, and third-party.** First-party audits are internal audits. Second and third party audits are external audits.



Organizations use first party audits to audit themselves. First party audits are used to confirm or improve the effectiveness of management systems. They're also used to declare that an organization complies with an ISO standard (this is called a self-declaration).

Second party audits are external audits. They're usually done by customers or by others on their behalf. However, they can also be done by regulators or any other external party that has a formal interest in an organization.

Third party audits are external audits as well. However, they're performed by independent organizations such as registrars (certification bodies) or regulators.

Purpose of Audit

Typically, there are two types of International Organization for Standardization (ISO) audits: ***internal and external.*** Some professionals add another audit, the **supplier audit,** to the list.

The basic purpose of audits and ISO certification is to improve the business through standardization and controlled processes. A business may conduct each type of audit in a different manner, but the resulting purpose is to improve the business. There are several types of ISO certifications, and administrators often customize the audits to help a business obtain a specific certification.

The main purpose of the internal ISO audit is to **prepare for the external audit**. On-site ISO auditors generally conduct the internal ISO audits, whereas an independent company conducts the external audit. Either vendors or customers of the company perform

the supplier audits. Many companies prefer to do business with companies that are ISO certified, and by auditing their vendors or customers, they are assured that the other company is upholding the proper standards.

Suggested ISO Certification Audit Process
• First-party audit • Third-party paper pre-audit • Third-party on-site pre-audit • Certification audit • Ongoing first-party internal audit • Ongoing third-party internal audit

First-party audit preparation. After choosing a cross functional team and doing the appropriate team building exercises as outlined in Chapter 9 ("The Team Approach"), it will be necessary to develop questions for each clause. Remember that auditors cannot audit their own departments. As an example, if the team was reviewing the criteria for Internal Quality Audits (4.17 of ISO 9002), some appropriate areas for investigation would include, whether:

1. Documented procedures cover how to carry out, document, and follow up on planned, comprehensive, internal audits of both the quality system procedures and quality results.
2. An adequate number of trained, independent people are available to implement the auditing procedures.
3. Audits are conducted at defined intervals.
4. Records indicate that the audits have been useful in driving improvement.
5. Records indicate that improvements recommended are made in a timely manner.
6. Records indicate that improvements are effective.
7. Records indicate that senior management reviews the results of internal audits on a regular basis.

The internal auditing team should grade the investigation as follows:

0 - Does not apply at all

1 - There has been discussion about the need for this clause

2 - Rough drafts or outdated versions exist

3 - Documentation exists, but it is superficial, seen as insufficient, or seen as not useful

4 - Documentation exists and is generally useful, but it is not always kept up to date

5 - Relevant documentation is available, complete, useful, and up to date.

Benefits of audits

1. A Customer Focus

As stated before, the customer is the primary focus of a business. By understanding and responding to the needs of customers, an organization can correctly targeting key demographics and therefore increase revenue by delivering the products and services that the customer is looking for.

2. Good Leadership

A team of good leaders will establish unity and direction quickly in a business environment. Their goal is to motivate everyone working on the project, and successful leaders will minimize miscommunication within and between departments.

3. Involvement of people

The inclusion of everyone on a business team is critical to its success. Involvement of substance will lead to a personal investment in a project and in turn create motivated, committed workers. These people will tend towards innovation and creativity, and utilize their full abilities to complete a project.

4. Process approach to quality management

The best results are achieved when activities and resources are managed together. This process approach to quality management can lower costs through the effective use of resources, personnel, and time.

5. Management system approach

Combining management groups may seem like a dangerous clash of titans, but if done correctly can result in an efficient and effective management system. If leaders are dedicated to the goals of an organization, they will aid each other to achieve improved productivity.

6. Continual Improvement

The importance of this principle is paramount, and should a permanent objective of every organization. Through increased performance, a company can increase profits and gain an advantage over competitors.

7. Factual approach to decision making

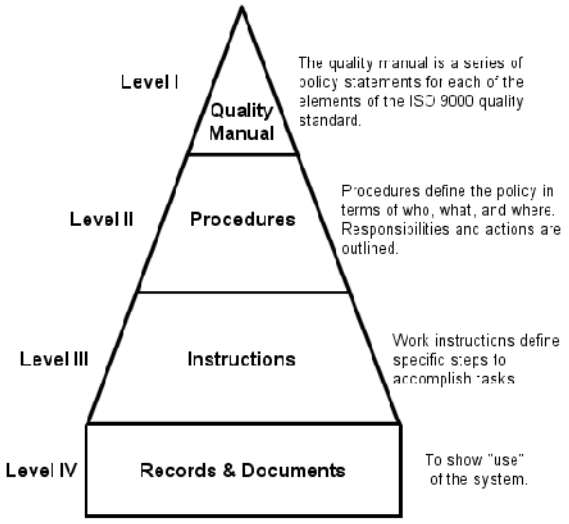
Effective decisions are based on the analysis and interpretation of information and data. By making informed decisions, an organization will be more likely to make the right decision.

8. Supplier relationships

It is important to establish a mutually beneficial supplier relationship; such a relationship creates value for both parties. A supplier that recognizes a mutually beneficial relationship will be quick to react when a business needs to respond to customer needs or market changes.

ISO 9001 Implementation

Implementing ISO 9001 is primarily a process of organizing, training, and documentation. Depending on the present level of your company's procedures and level of documentation and system's complexity, the process can take from several months to several years, with a typical registration cycle taking from twelve to eighteen months. Some printing organizations, such as in-plants for pharmaceutical companies, have been documenting their procedures and policies for years. For them, it should be very easy to get ISO 9001 certification. Others, including many commercial printers, have done a very poor job of writing down what they do. For them, it will take longer to become certified. A basic plan of attack for getting certified would consist of four phases.

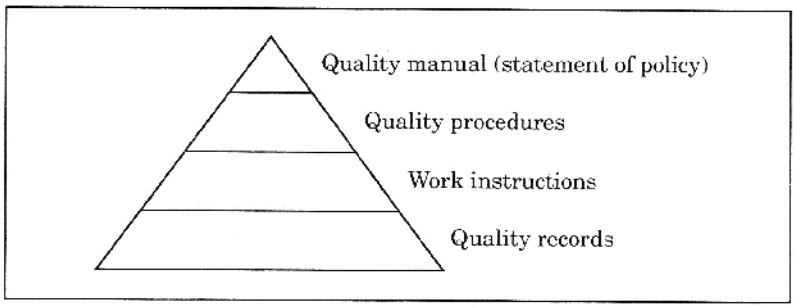


Four Phases of ISO Registration
• Management commitment • Training and organization • Documentation • Third-party audit

Phase I. In phase I, the company's top management becomes committed to pursuing ISO 9001. This involves training top managers as to what ISO 9001 is, how much it will cost, why it should be pursued, and what will be their role in the process. Top management's primary role is to allocate resources, set goals, review progress, and develop an awareness throughout the organization.

Phase II. Phase II of the implementation is to develop a structure and a system that will support the certification process. It will be necessary to involve employees at all levels and from all functions of the organization in the process. Various leaders, such as department heads, must be trained in the methods of documentation and standard operating procedure (SOP) development.

Phase III. In phase III of the implementation, the actual SOP development begins. The outcome of this process is typically a four-tiered system of documentation consisting of a quality manual, which is a set of company policies concerning quality. The **second tier** is process specifications that document what should be done and who will do it. The **third** is the development of work instructions. The **fourth tier** consists of quality records indicating that a procedure has been carried out and includes a calibration log and completed purchase orders as examples of this process. The following diagram illustrates the four-tiered quality system documentation typically associated with ISO 9001:



Phase IV. The final stage is phase IV, in which an outside auditor (registrar) is brought in for an ISO 9001 quality audit. It is beneficial to have a pre-audit done by the third-party auditor. The auditor will evaluate your ISO system pointing out its weaknesses and strengths. They will not assist you with suggestions on how to fix deficient areas. During the official audit, the auditor will look at your documentation developed in the previous phases and then go out into the plant and observe what the people are actually doing. If the procedure says that each plate will have a UGRA scale burned on it and be checked for proper exposure, the auditor will simply check if the platemaker is doing this and if the records are there to support that it is being done on the prescribed basis. If all procedures are found to be followed, the printer will be issued a certificate that the company is in conformance with ISO 9001. This assumes that the system itself meets all of the required elements of the standard.

5.3 COST OF IMPLEMENTATION OF ISO STANDARDS IN PRINTING ORGANIZATION

Although the costs of implementation can be offset with increased sales, reduced defects and improved productivity throughout the organization, the investment of implementing and maintaining an ISO quality system needs to be considered.

Many factors should be considered when calculating your company's ISO implementation costs. The time, effort and money your organization puts into ISO registration depends on the number of employees, locations, the ISO standard selected for registration and the current state of your quality system and processes. Typical costs include:

- Management and employee time and effort
- Upgrading and creating documentation
- Training employees
- Registration fees
- Maintenance

As with implementation of any new tool, the key to minimizing costs is to arm yourself with knowledge about the process, and then to design a sensible plan that has realistic objectives, adequate resources and a practical time schedule. Having a leader or consultant to guide you through the process and manage deadlines can also help you to control costs and achieve your goals more quickly. In addition, if you have multiple locations or departments, costs can be minimized by leveraging the information you learn and the resources you use as you move through the implementation and maintenance process.

The cost of ISO 9001 will vary depending on the size and complexity of your organization and on whether you already have some elements of a quality management system in place.

First, there are typically three options for an organization seeking registration:

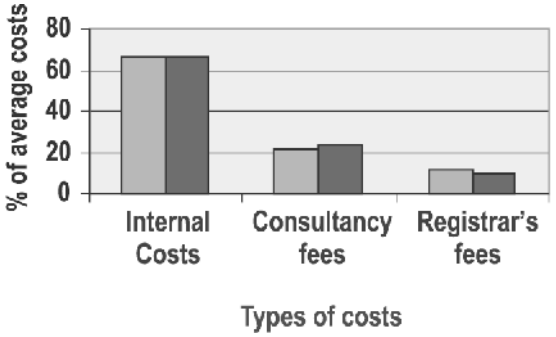
- Create everything (Documentation, training, etc.) on your own by reading and interpreting the standard.
- Use documentation templates and training programs (like ours) to train your organization.
- Hire an ISO consultant to complete the entire process with you.

ISO 9001 Certification Cost in 3 parts:

1. **Hiring a Registrar** - The registration audit is performed by a Registrar and the cost will depend on how large and how intricate your organization is. They will charge you depending on how much time they spend auditing your organization by days.
2. **Internal Cost** - the time your employees will need to spend building and implementing the system.
3. **Outside help** - This is either consultant fees or the purchasing of tools to help you with the project.

An average size printing company should allocate 1% of its sales dollar in preparation for an 18-month to 24-month plan to become ISO-certified. However, approximately only 27% of this 1% allocation will be directly out-of-pocket expenses; 73% will be the cost of employee involvement in time.

The costs of implementing ISO 9001 have been estimated to run as low as $10,000 to $15,000 actual out-of-pocket expenses, although a more accurate figure that takes into account man-hours to document and training time would be in the $200,000 range. ISO 9001 can be a costly process when you start adding up the internal work that must be done to build and maintain the system (SOP development, administration, record keeping, training, internal auditing). However, if you look at the costs and the benefits, it is likely that you will conclude that ISO 9001 is a good chance to start your quality improvement process and is well worth the money.



ISO Cost Estimates	
Category	Percent of Cost
Registrar	9
Outside consultant	18

Internal	73

The total cost of ISO 9001 certification come from 3 basic elements:

- Indirect cost of maintaining a quality focused organization. (This can be done with or without ISO)
- Indirect cost of doing additional operations only for purpose of maintaining an ISO certification
- Direct cost of registration

Indirect costs with a quality focus

Many elements of the ISO 9001 standard are a no-brainer for a quality-focused company. Processes like engineering change order system, revision control of documents, receiving inspection, and some form of management review should be in place at any company with a history of more than 3 years. Therefore, these are not additional cost of ISO, they are the minimum requirements for growing a long-term successful business and should not be including in the analysis of whether to implement ISO or not.

Indirect costs with an ISO 9001 focus

There is a significant ISO 9001 requirements that is simply record keeping for the main purpose of maintaining the certification. This cost is dependent on the size of the business but for the sake of discussion, it is at least one half-man year per year. The ISO 9001 requirement is typically for some high level tasks that require an understanding of quality systems and the ISO 9001 standard and some low-level tasks that are basic filing, data entry, and maintenance function. Based on this my ballpark for justification purposes is $40K per year (minimum). This could be split between a clerk and a consultant or you could get luck and hire a clerk that want to learn ISO 9001 without being paid extra for responsibility. You can easily double that number if the company has poorly designed system that put a drag on all the employees.

Direct Costs of Registration.

An ISO 9001 certification audit can run from $10-25K for small and mid-size companies. This is based an a 3 to 5 man-day audit with an average cost of $3000 per man-day plus travel expenses. ISO 9001 maintenance audit is usually much shorter, averaging about $5-$10K for a 2 man-day audit.

Benefits of ISO Implementation

ISO standards are a guide that can help transform your company's quality system into an effective system that meets and exceeds customer expectations. Your company will start to realize these benefits as you implement and adhere to the quality standards, and you will see the internal and external benefits accrue over time.

Internally, processes will be aligned with customer expectations and company goals, therefore forming a more organized operating environment for your management and employees. Product and service quality will improve which decreases defects and waste. Process improvements will help to motivate employees and increase staff involvement.

Products and services will be continually improved. All of these internal benefits will continually drive better financial results, hence creating more value for your business.

As for the external benefits, ISO certification shows your customers and suppliers worldwide that your company desires their confidence, satisfaction and continued business. Your company also has the opportunity to increase its competitive advantage, retain and build its customer list, and more easily respond to market opportunities around the world.

Some of the benefits to your organisation:

- Provides senior management with an efficient management process
- Sets out areas of responsibility across the organization
- Mandatory if you want to tender for some public sector work
- Communicates a positive message to staff and customers
- Identifies and encourages more efficient and time saving processes
- Highlights deficiencies
- Reduces your costs
- Provides continuous assessment and improvement
- Marketing opportunities

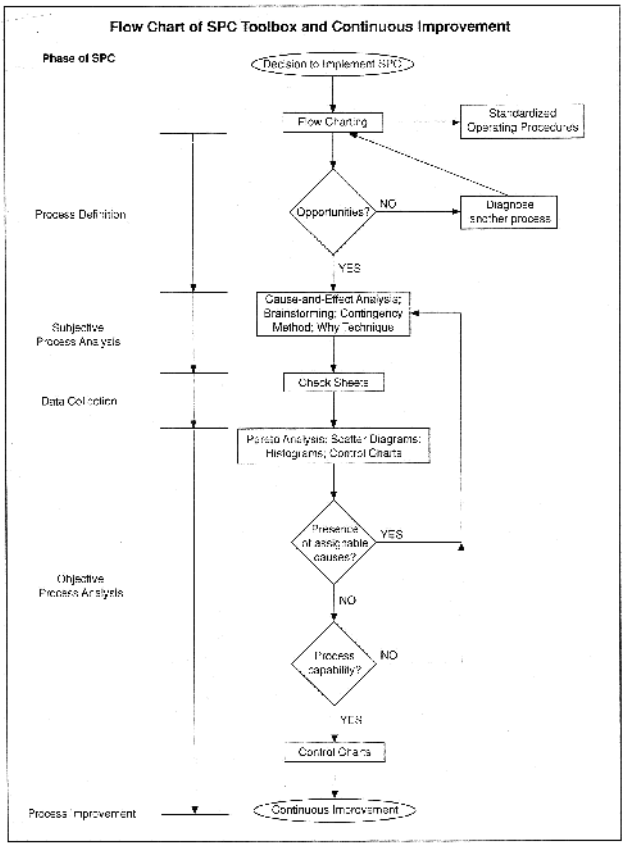
Some of the benefits to your customers:

- Improved quality and service
- Delivery on time
- Right first time attitude
- Fewer returned products and complaints
- Independent audit demonstrates commitment to quality

5.4 Customer Satisfaction

Customer satisfaction is a measurement of how pleased customers are with a particular product or service. Satisfied customers are likely to make repeat purchases and often refer others.

Case Studies of ISO Certified Print Industry



Casey Press is a hypothetical, but typical, commercial printer founded in the 1950s and built from scratch to its present state. The company has annual sales of $7 million, primarily in the highly competitive four-color commercial market. The customers are mostly other small and medium-size businesses who use its services for their own advertising, promotional, and internal purposes.

Recently several complaints from customers have surfaced. These have included complaints about color consistency, poor folding on some brochures, and a couple of late deliveries. In the old days, the owner and president, Ms. Casey, would have thought of these as isolated incidents, but recently she has been doing some reading about quality management and wondered if the problem might be more systemic in nature. These readings have included the following information:

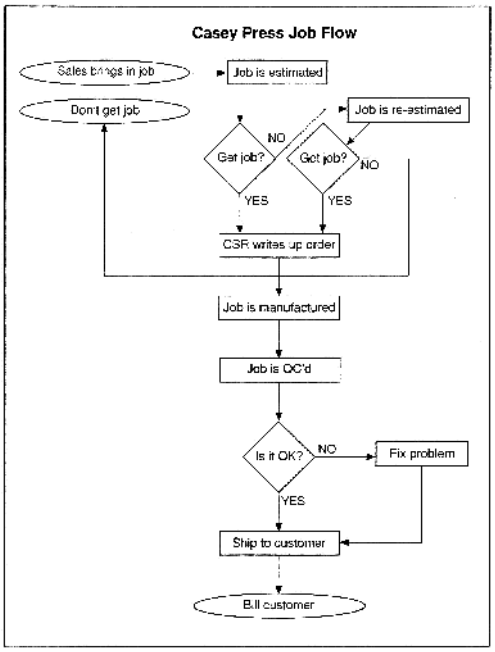
- Most customers don't complain; they just leave and you never find out why.
- It's not enough to satisfy customers; if you want them to be loyal, then they must be delighted.
- 85% of quality is the responsibility of management.
- If you want to improve quality, it's best to take a planned, scientific approach.

The best people to improve a process are usually the ones who actually do the work in that process.

Having read this, Casey decided to do a little investigating. The first thing she did was to conduct a customer survey of all of the customers who had come to the company in the past but not in the previous year. Asking why they hadn't returned in the past year, Casey found out the following from those who returned the survey:

1. 10% had gone out of business.
2. 25% had found somebody to do their printing cheaper.
3. 15% had found somebody to do their printing more quickly.
4. 30% had experienced quality problems with Casey Press and had therefore gone elsewhere.
5. 20% had gone to other printers, but couldn't explain why.

Casey's first reaction to this information was typical: disbelief, having believed that Casey Press was price, schedule, and quality competitive. Apparently she had been mistaken, but how could she improve costs, on-time delivery, and quality at the same time. This seemed an impossible task until she came across something called the Deming Chain Reaction, which said that by improving and focusing on quality you would be able to reduce waste and in turn reduce costs, improve pricing flexibility, improve turnaround time, and - therefore improve customer satisfaction.



Casey became convinced that this was the answer to her dilemma, so she sat down with the employees at the plant and began working on improving quality. Our tools will give you a picture of some of the things that were found, and done, to improve quality.

Flow charting at Casey Press. At Casey Press, a crossfunctional team of employees came up with a flow chart for the rough overall flow of the process as a job flows through from start to finish. This exercise proved beneficial, because for the first time all of the employees had to agree on the actual way in which they did things (not how they would have liked to do things). They also discovered many things that could be improved. Interestingly enough, the group noticed that not everyone did the same things the same way, even though they all had the same goal in mind. A rough version of the flow chart they came up with follows on page 95.

Brainstorming at Casey Press. You will recall that the employees at Casey Press were going to brainstorm about the many possible causes of job problems. This is exactly what they did. First, they stated the problem clearly and wrote the problem in a statement on the flip chart for all to read and see:

- Lack of attention to detail
- Equipment in poor condition
- Lack of understanding of what the customer wants
- Press operators not trained
- Equipment not capable
- No measuring equipment for QC
- Use of poor materials (ink and paper)
- Hickeys
- Excessive makeready times on press
- Static electricity in prepress department

These were then organized into a fishbone diagram according to the six M's:

Man	• Lack of attention to detail • Lack of understanding of what the customer wants
Machine	• Equipment in poor condition • Equipment not capable
Material	• Use of poor materials (ink and Paper)
Milieu	• Hickeys • Static electricity in prepress department
Measurement	• No measuring equipment for QC
Methods	• Press operator not trained • Excessive makeready times on press

Remember that these are only a few of the ideas the group came up with. In reality, a group might come up with fifty or more items in a brainstorming session like this. If the group comes up with a huge list, the group can use the multivoting technique to narrow the list down to a more manageable number. These were:

- Print the wrong PMS color
- Charge the wrong amount for the job
- Deliver the job later than promised
- Deliver the job to the billing (not shipping) address, if different
- Print the job out of register
- Plugging in the shadows on critical halftones
- Color variation not controlled

Now that the team had developed a list of likely causes of quality problems and customer dissatisfaction, it was ready to go into the mode of collecting data so that the issue could then be analyzed with less subjectivity. To do this, the team developed a checklist.

Unit - V

1 Mark Question

1. What is ISO 9001?

   International Organization for Standardization (ISO) defined establish, and maintain an effective quality assurance system for manufacturing and service industries.

2. Write any two benefits of ISO?

   Increases productivity, Maximizes quality, Increases revenue, Improves employee morale and satisfaction

3. State two management responsibility in implementation of ISO for print quality.

   Top management's primary role is to allocate resources, set goals, review progress, and develop an awareness throughout the organization.

4. What are the different types of audits?

   First party audit, second party audit & third party audit

5. Expand SOP.

   Standard operating procedure

6. Mention ISO standard for printing industry.

   ISO 12647

7. What is audit?

   An audit is an evidence gathering process. Audit evidence is used to evaluate how well audit criteria are being met.

8. What is the purpose of audit?

   The basic purpose of audits and ISO certification is to improve the business through standardization and controlled processes.

9. Define customer satisfaction

   Customer satisfaction is a measurement of how pleased customers are with a particular product or service. Satisfied customers are likely to make repeat purchases and often refer others.

10. What is documentation?

    Preparation of quality manuals and design of quality record formats.

11. Write ISO code for offset printing industry.

    ISO 12647-2

12. What will be audited in ISO?

    The organization quality system meets the criteria of the standard.

13. What is second party audit?

    By the organization on a supplier or sub-contractor

14. Mention two benefits of audit.

    A Customer Focus, Good Leadership, Involvement of people & Continual Improvement.

15. Define Quality manual.

    The quality manual is a series of policy statements for each of the elements of the ISO 9001 quality standard.

6 Mark Question

1. What is ISO standard for Printing printing?
2. What are the benefits of a good documentation?
3. What is the purpose of auditing?
4. Explain the advantages of external auditing.
5. What are the benefits of ISO implementation in print industry?
6. State few customer satisfaction of implementation of ISO for print quality.
7. Discuss the cost of ISO implementation.

12 Mark Question

1. Explain in detail about ISO 9001 standards for printing industry
2. Explain in detail about the implementing of ISO for print quality.
3. Explain in detail the benefits of audit in improving printing quality.
4. Explain in detail the various types of audits and their purposes.
5. Explain the cost of implementation of ISO for print quality and state the benefits out of implementation.
6. Discuss in detail the customer satisfaction in implementing ISO for print Quality.
7. Discuss any one of the case studies of ISO implemented print media industry.
