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Image analysis techniques for assessing print quality

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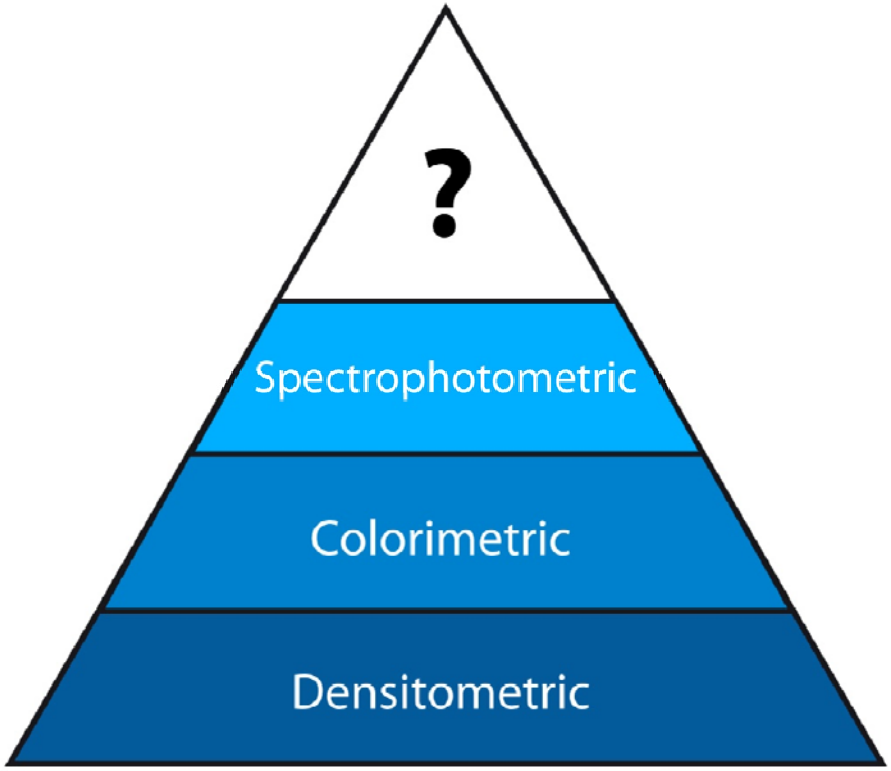
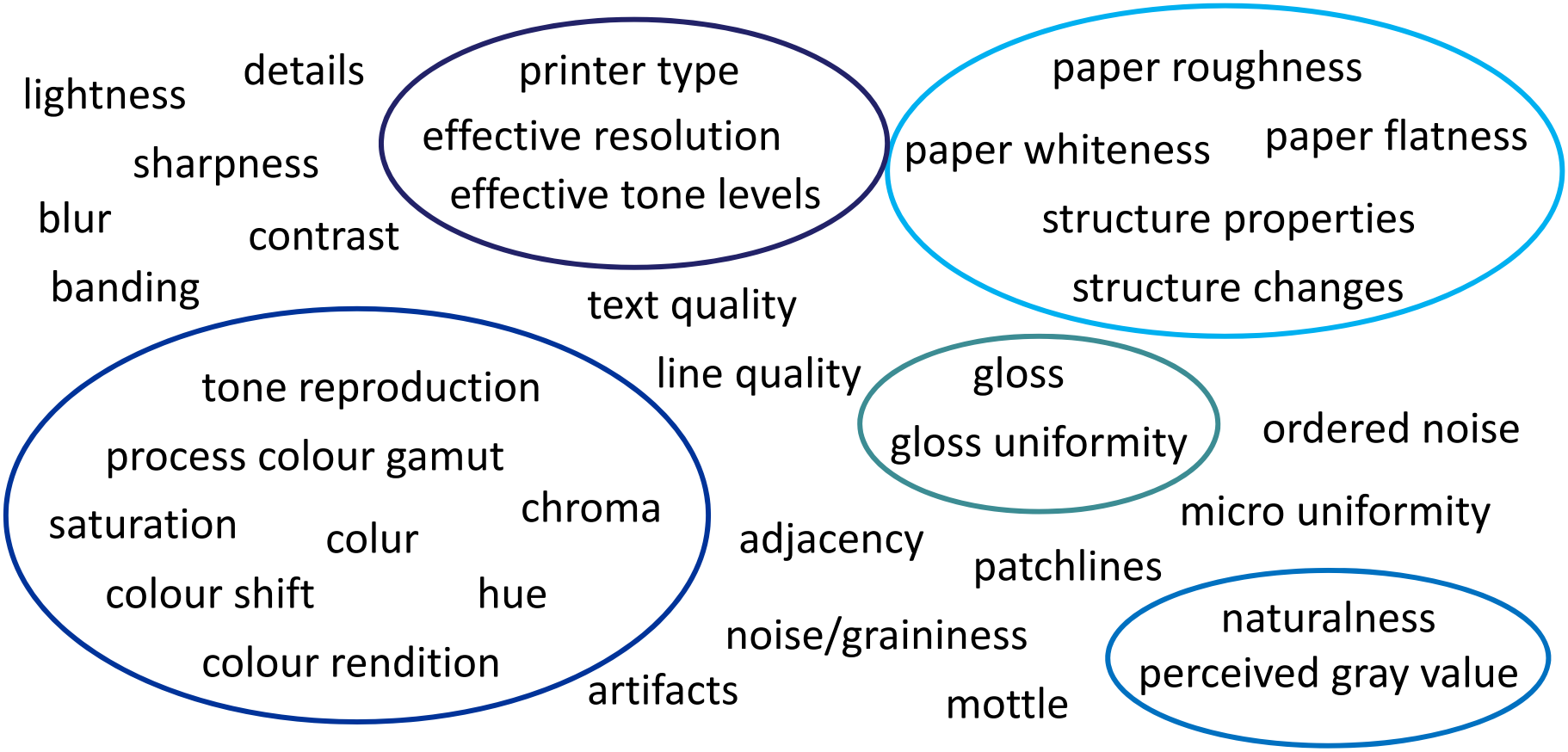
Print quality control



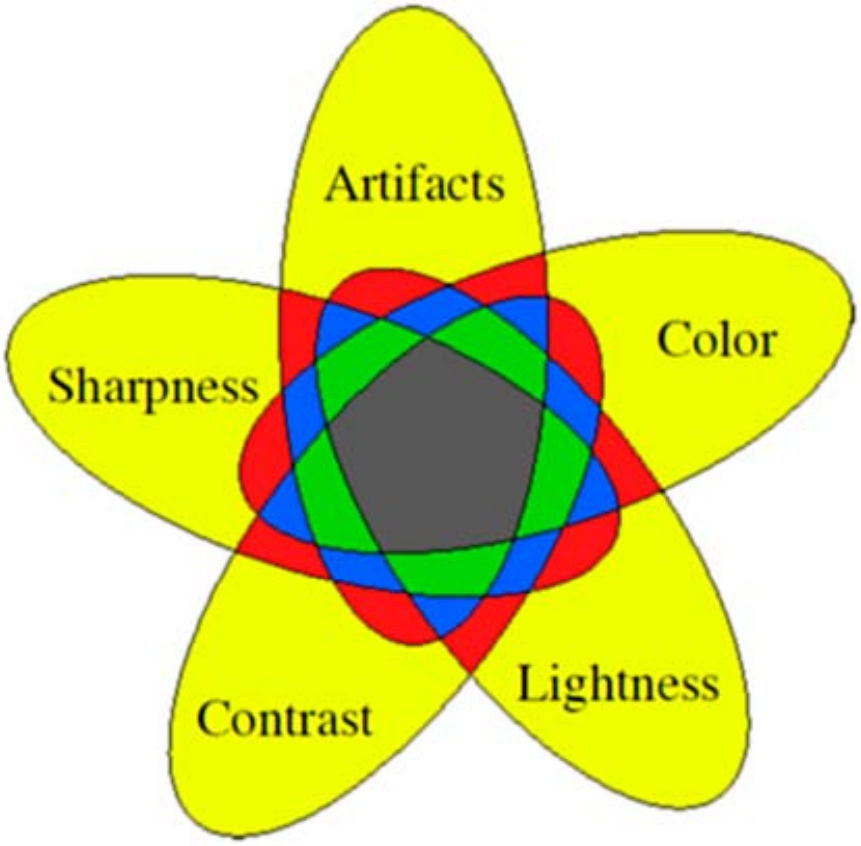
Defining quality

- Print quality had been defined through many attributes:



Quality attributes

- Grouping quality attributes enables efficient quality assesment



+ physical quality attributes

Basic print quality attributes by ISO

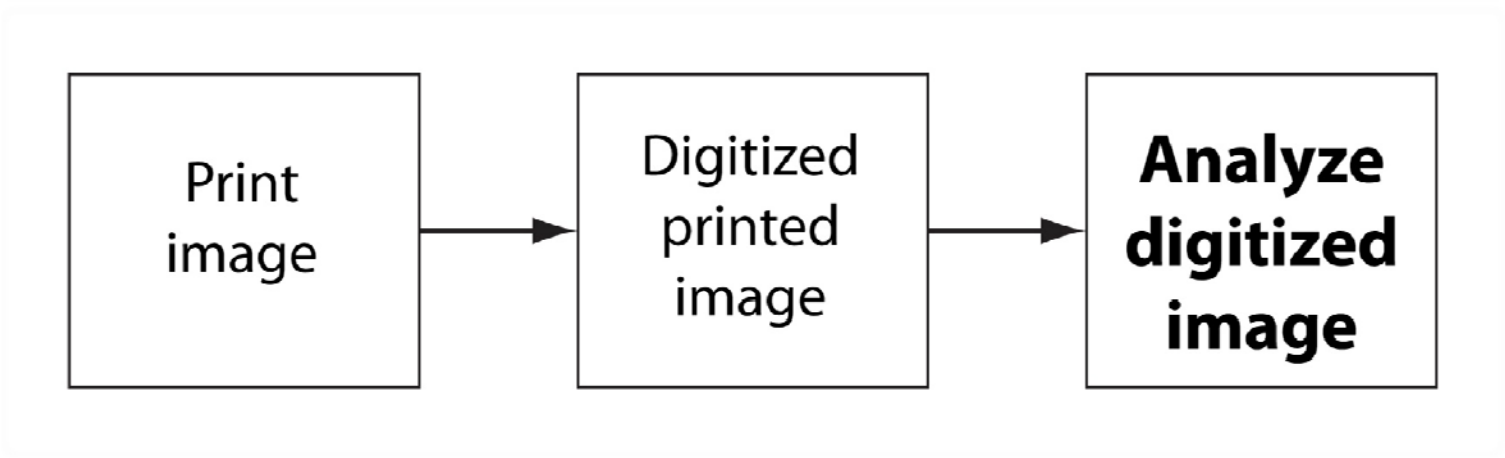
- ISO 13660 (for digital printing) defines procedures and algorithms for quantifying basic print quality attributes

Character and Line
❶ Blurriness
❷ Raggedness
❸ Line width
❹ Darkness, character
❺ Contrast
❻ Fill
❼ Extraneous marks, character field
❽ Background haze, character field

Large Area
❶ Darkness, large area
❷ Background Haze
❸ Graininess
❹ Mottle
❺ Extraneous marks, background
❻ Voids

Evaluating print quality attributes

- Quality attributes evaluation involves using some of the image analysis technique



What are the elements of importance?

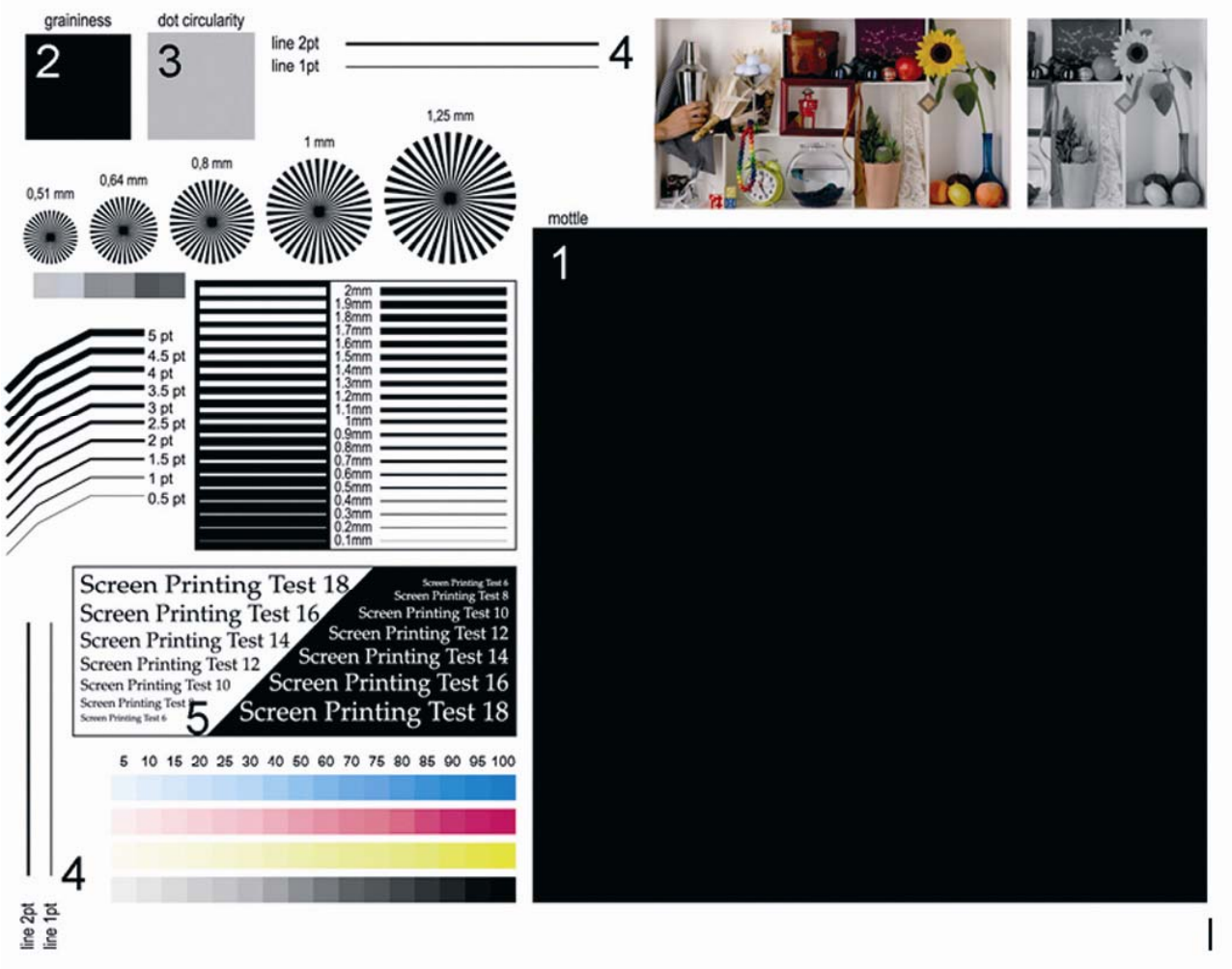
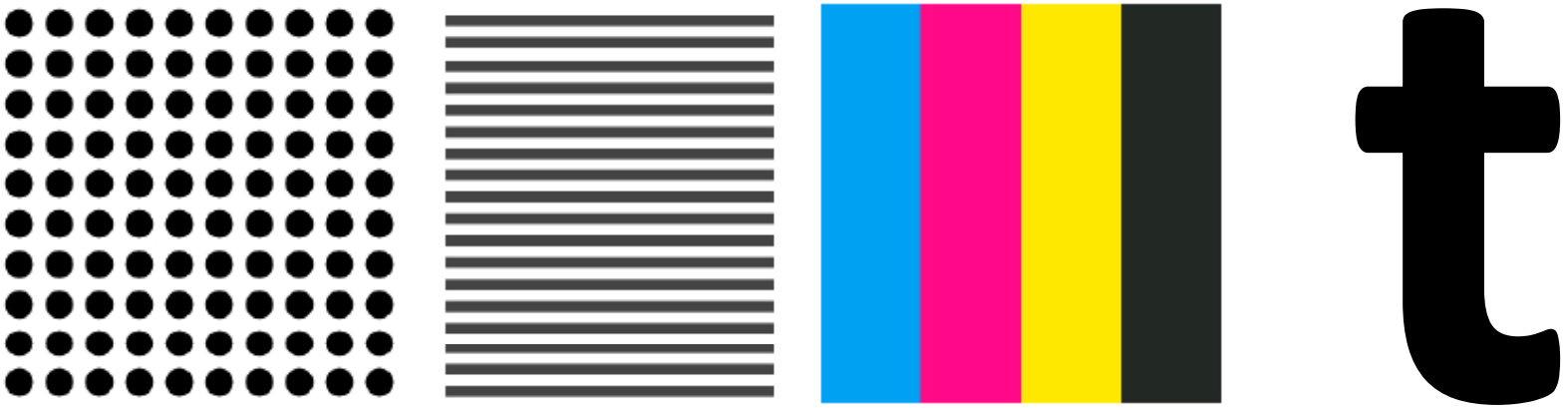


Image elements assessment

- Image elements to be assessed consists of:



dots lines solid areas + text

Dot quality assessment

- Printed dot fidelity is determined by evaluating dot area and roundness
- Area gives an information about tonal value increase (dot gain)
- Roundness indicates reproduction of a fine details and can be measured as:

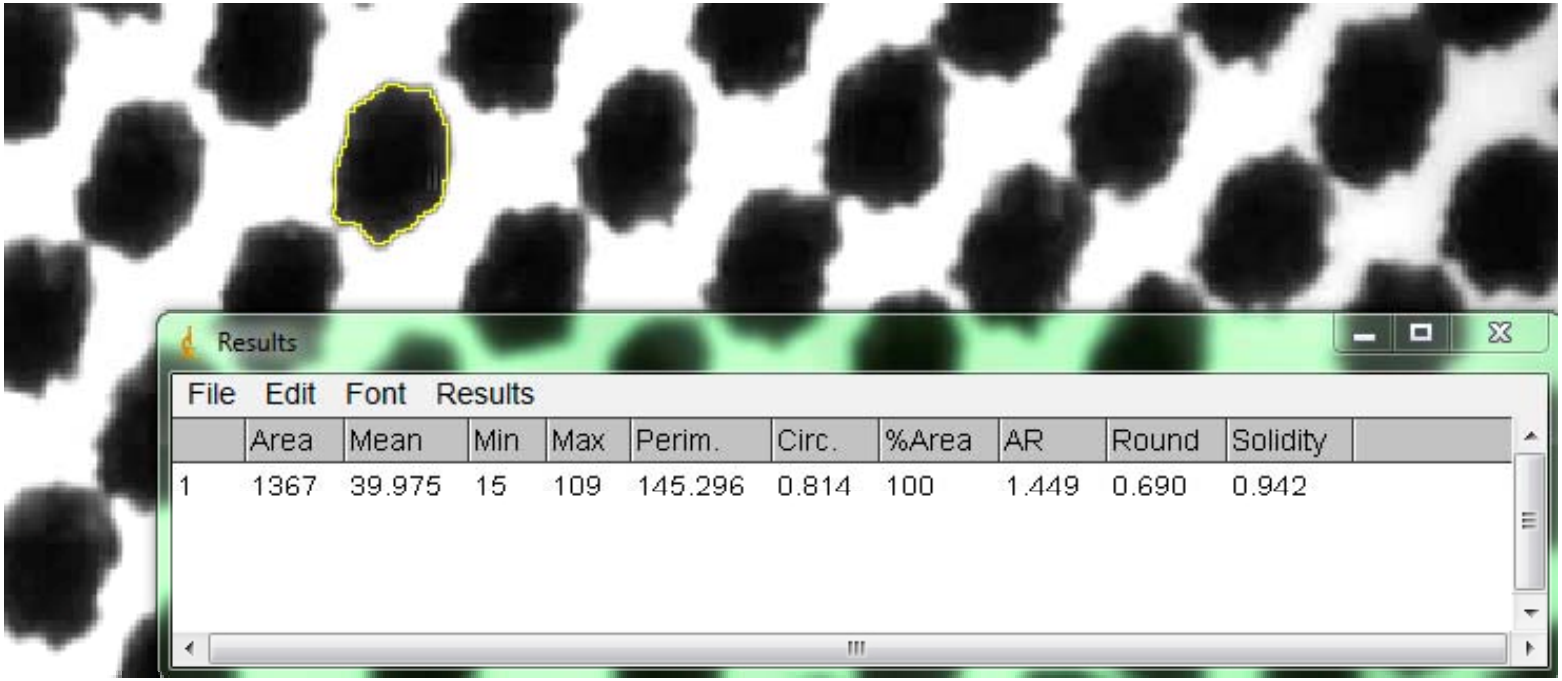
$$\text{Roundness} = 4\pi\,(A/p^2)$$

A-area

p - perimeter

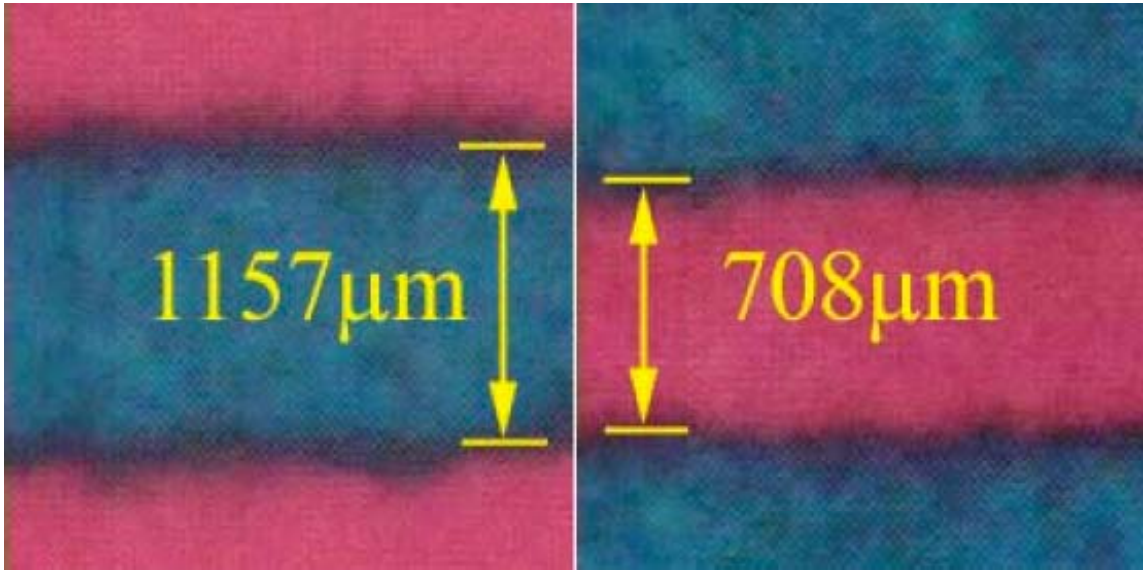
Dot roundness

- The closer to 1 the roundness, the better the quality of the dot



Line quality assessment

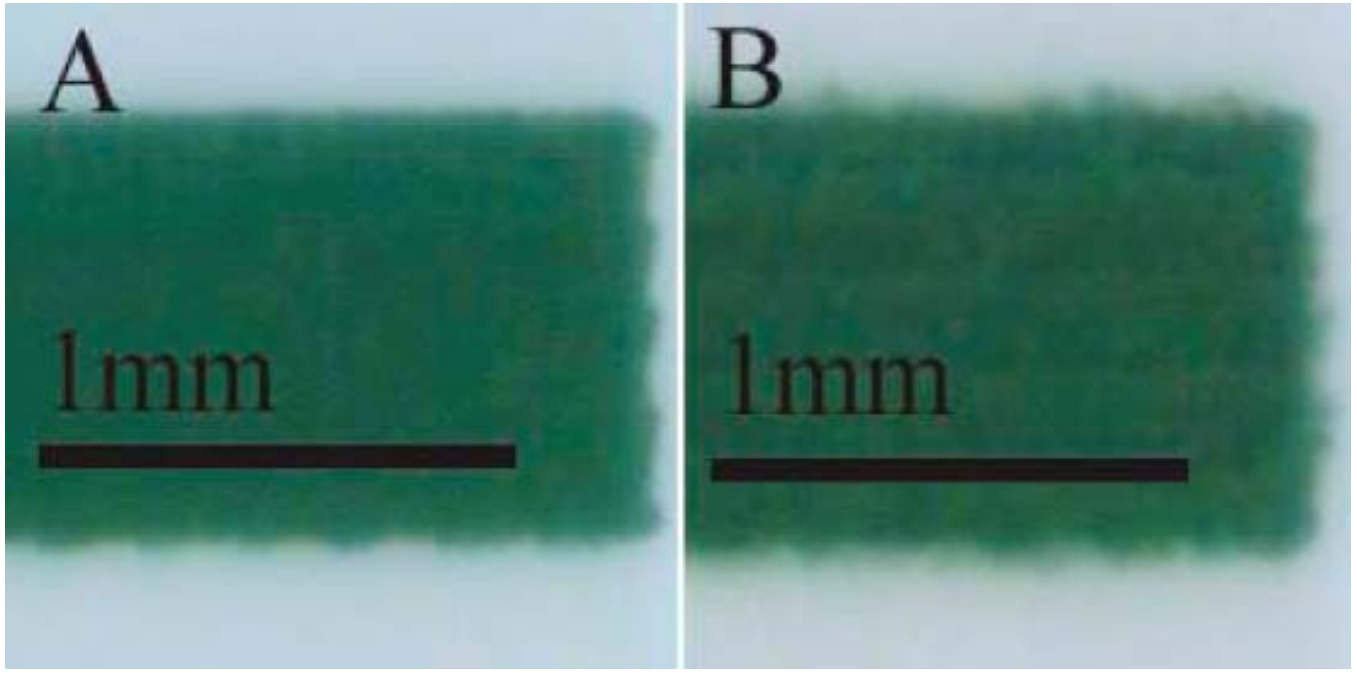
- Line evaluation could include: area, perimeter, width, raggedness etc.
- Evaluation of area and perimeter gives the information about ink bleeding



Intercolour bleed = (1154-708)/4

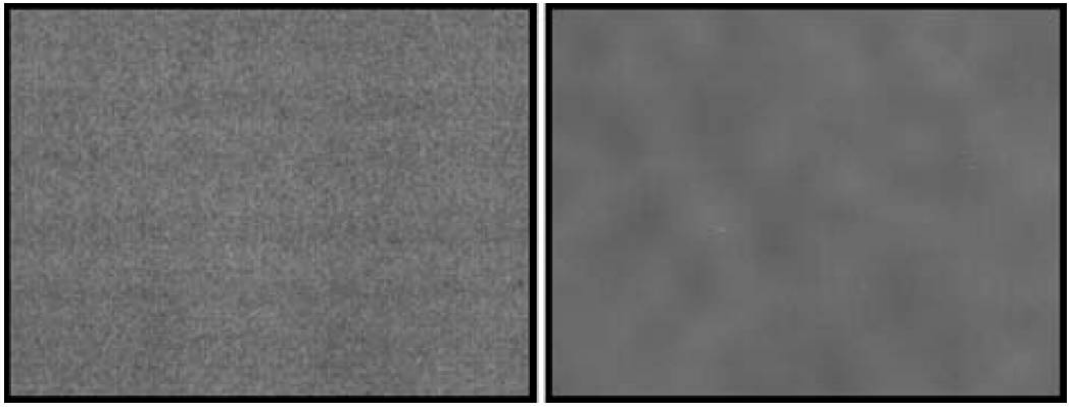
Line raggedness

- Line width and raggedness indicates amount of wicking



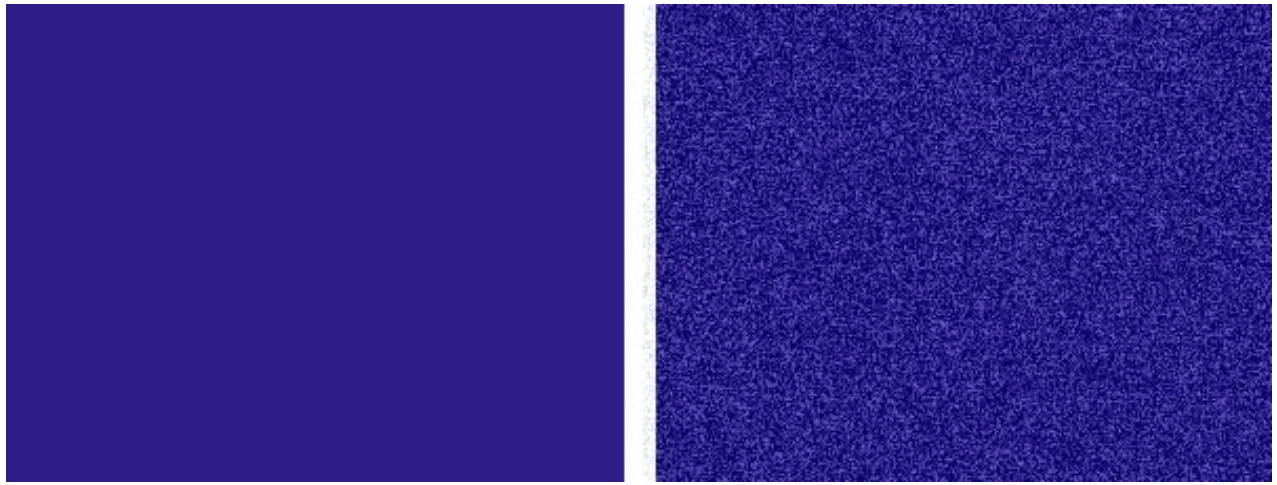
Solid area evaluation

- Solid area evaluation could include: micro, macro and gloss uniformity
- Micro uniformity implies measuring of high frequency noise and defines graininess
- Macro uniformity can be assessed by measuring low frequency noise indicating the degree of mottle



Measuring micro uniformity

- Metric of graininess defined by ISO 13660 is the standard deviation of density of a number of small areas that are 42 µm square

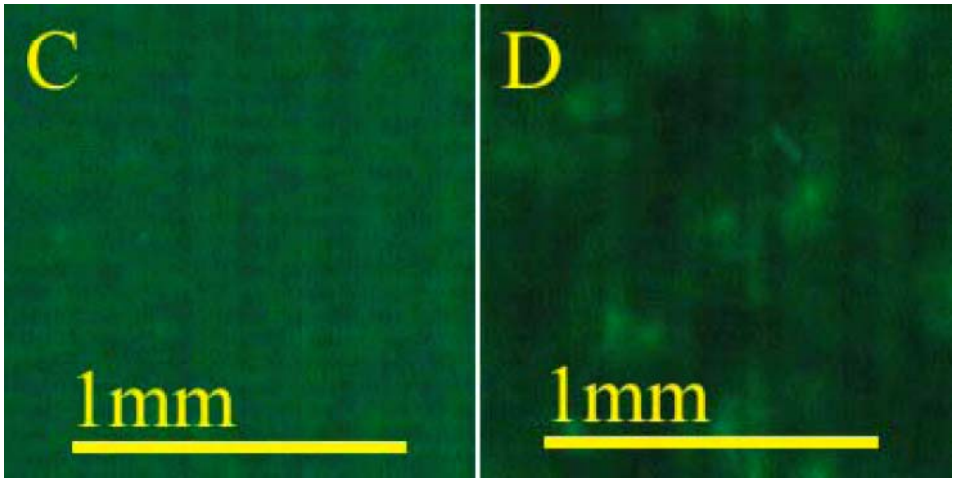


Measuring macro uniformity

- Mottle measurement method described in ISO 13660
- Dividing the area into a number of small square cells and computing the variations in the reflectance or density in those cells
- Area to be measured

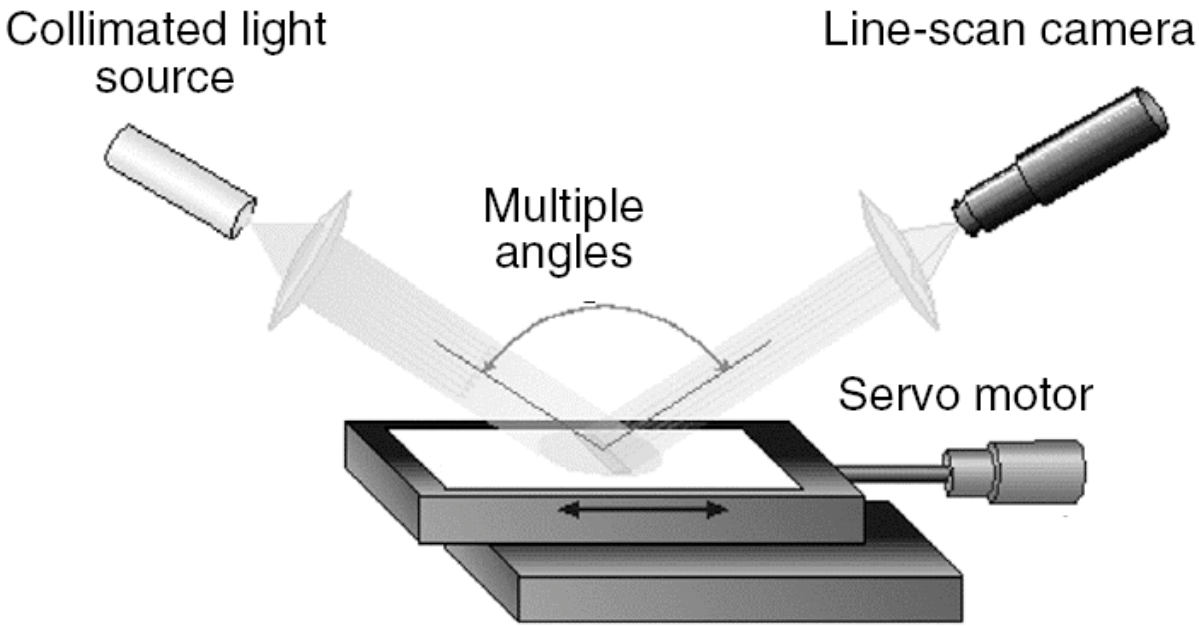
should be no less then

16 x 16 cm



Measuring gloss uniformity

- Gloss uniformity is very important parameter since it indicates uneven distribution of coating on print



Distinctness of image (DOI)

- Defines the deviation of the spread of light reflected at the specular angle
- DOI is a good indicator of:

  - incorrect particle size/distribution in printing and enhancing

  - incorrect coating flow

  - inappropriate cure time or temperature

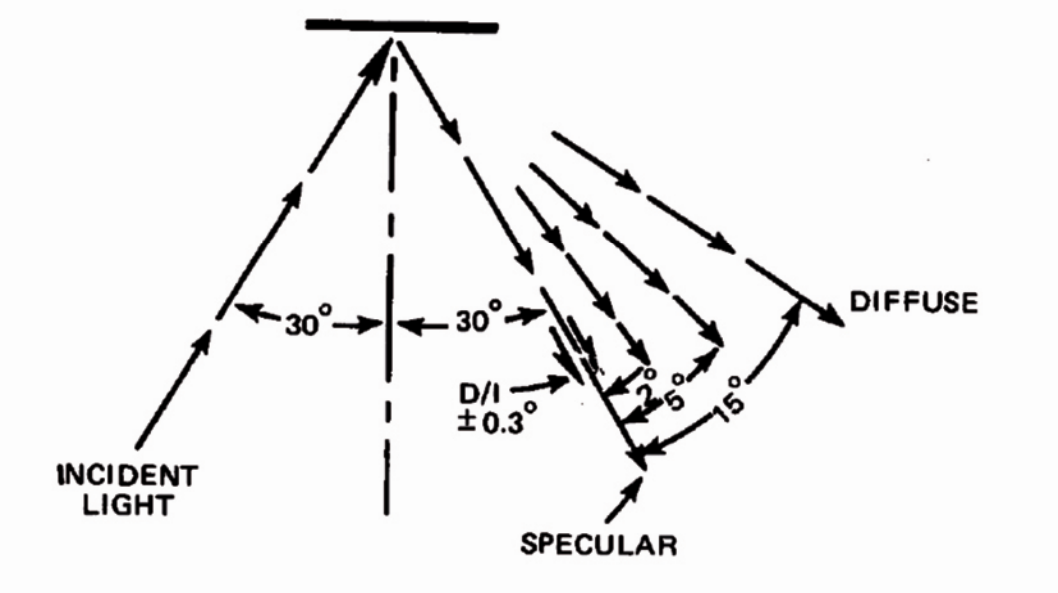
  - application problems etc.

DOI applicability in printing

- Symptoms of poor DOI can be visually perceived as brush marks, “orange peel”, waviness or other structures visible on the surface

Measuring DOI according to ASTM D5767 - 95(2004)

- **Method 1:** Measuring light reflected at a specular angle and at the angle slightly of the specular



$DOI=100\ (Rs-R_{0.3})\ /\ Rs$

DOI range: 0-100

Measuring DOI

- **Method 2:** Projecting the light through a small slit on the specimen surface and measuring its reflected image intensity through a sliding combed shutter

- **Method 3:** Projecting the light through the pattern on the specimen surface and measuring reflected image intensity in order to provide a value of image clarity

Slanted edge method

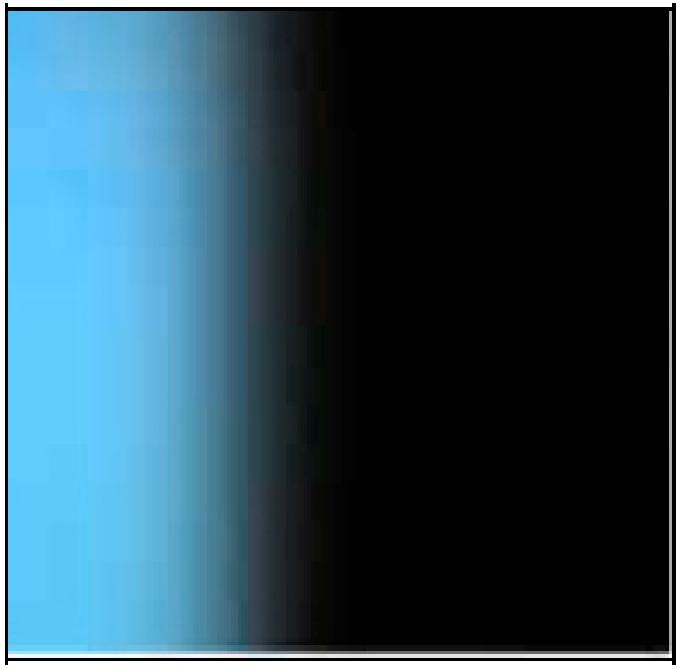
- Evaluates image sharpness according to ISO 12233

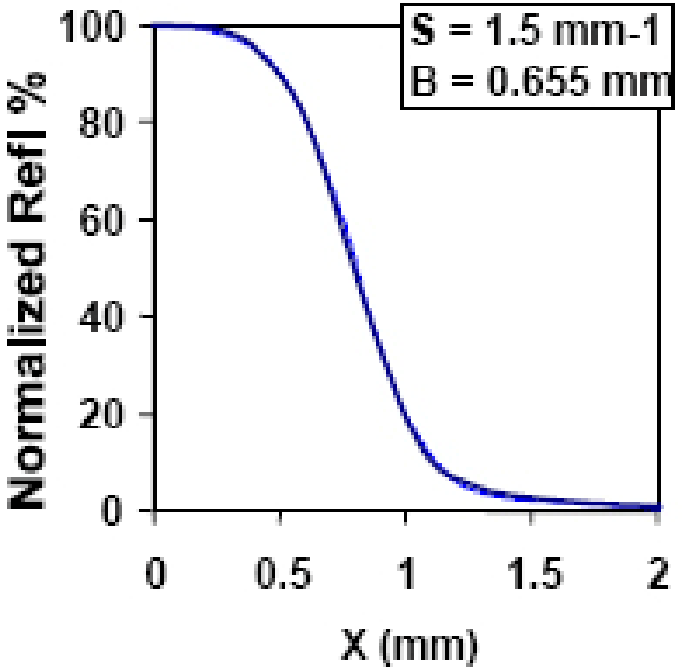
Slanted edge

Straight edge

Sharpness analysis for calculating DOI

- **Step 1:** Obtaining the reflectance profile (Edge spread function - ESF) from the digitalized image





Sharpness analysis for calculating DOI

- **Step 2:** Calculating line spread function (LSF) as a first derivative of ESF
- **Step 3:** Aplying a Fourier transform to LSF in order to obtain Modulation transfer function (MTF)
- **Step 4:** Incorporating human sensitivity into calculation in order to filter out the noise - obtaining subjective quality factor (SQF)

Text quality assessment

- Determine readability by measuring letters area and perimeter

Is the image analysis flawless?

Possible issues

- Providing enough information with currently available sampling devices
- Errors in calculations due to the inaccurate selection of certain element
- Some methods are not precisely defined and need refinement

Should the image analysis be used for print quality evaluation?

Conclusion

- Quality control methods based on image analysis provide enough information about quality of important attributes in printing
- They can easily be implemented
- Can be combined and used for developing image quality metrics

Thank you for your interest and attention.

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