

**USB Print Microscope used for measuring in
the print process.
Using this handheld microscope with the
latest in print evaluation software**

IMDA Convention 2007 May 23-25



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Good morning Ladies and Gentlemen.

Thank you IMDA for the invitation to present at this conference.

My name is: Wilbert Streefland, I'm the owner/director of Technology Coaching BvbA. I have been involved in the printing industry for the last 20 years starting with textile screen printing, flexo printing and later printing on packaging specifically corrugated board.

I would like to present to you today about "Minimum printed dot size as a print capability measurement" The content of the presentation will go a bit further then that!

**The essence of ingenuity is
simplicity!**



**A USB Print Inspection
Microscope**



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The presentation will be about a USB digital print microscope. The idea for this instrument came early 2005 when I started Technology Coaching.

USB Microscope used for measuring in the print process

- Demonstration of the USB print microscope;
- How important is it to know the minimum dot size you can print;
- Can you measure dot area coverage using a densitometer;
- Demonstration of 3 software tools for the USB print microscope.



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The 4 main topics of this presentation are:

- Demonstration of the USB Print Microscope;
- The minimum printed dot size as a function of the print process;
- The main problem when measuring dot area using a densitometer;
- A demo of 3 software tools that measure dot size and dot area.

How often have you been looking at print through a magnifier and handed it over to someone else to look at the same object asking yourself what he would be looking at?



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USB Print Microscope:

During my time in the industry I found it always difficult to show people something noticed in printing using a Magnifier. I always questioned what the other person would see when I handed over the magnifier. Using the USB print microscope we can all look at the same time at the same image. You can even use it via internet so you don't need to be at the same place!

**With this device you can both
look at the image at the same
time on the screen of your PC
and record images!**



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So let us have a look how good the image quality is. We will do this live. Not that the quality of the image might be influenced by the beamer.

Minimum Dot Size

**Is the minimum
Negative or Positive dot
size printed
independent of the
screen count used in an
Image?**

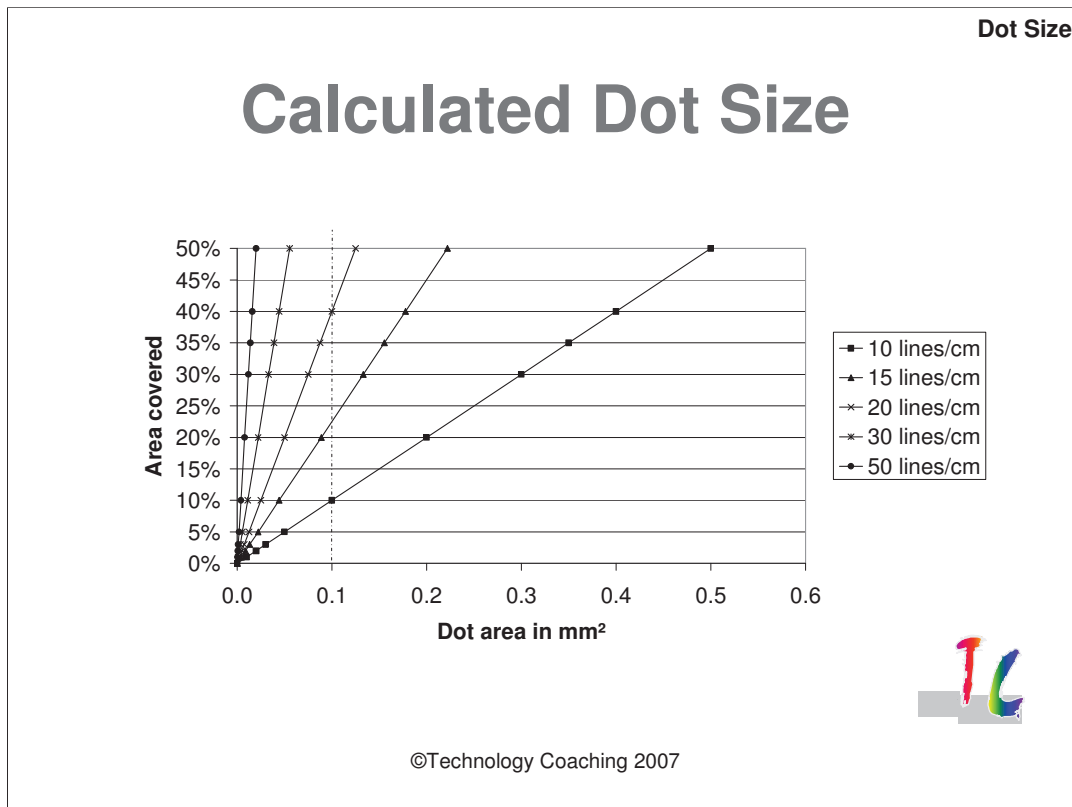


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Minimum dot size:

The next few slides will provide the answer to the question:

Is the minimum negative or positive dot size printed independent of the screen count used in an image?



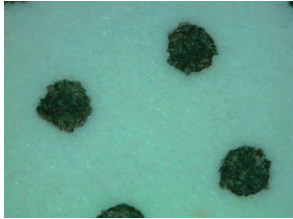
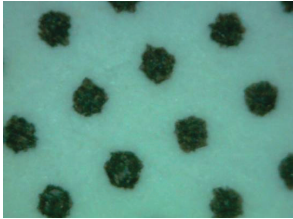
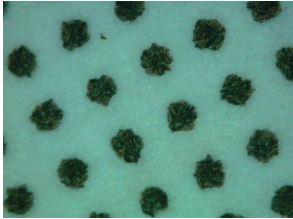
This graph shows the relation between the coverage of a halftone area and the dot size. We can see that for a 10 lines/cm screen and a dot size of 0.1 mm² the coverage is 10%. The same dot size will result in 40% coverage for a 20 lines/cm screen.

Thus we can find similar dot sizes for all screens.

Note that the maximum dot size is limited depending on the screen count used. For a 10 lines/cm screen the maximum dot size is 0.5 mm², for a 50 lines/cm screen this is: 0.02 mm².

To print a halftone range using a low screen count results in a large difference in dot size that can be used. It will thus be easier to print contrast.

Comparing Printed Dot Size

Flexo printed Dot: 200x Magnification, 2% coverage, 12 L/cm, calculated dot area 0,014mm ² Measured cov.: 10.68 % Measured diam.: 0.31 mm Actual area: 0.075 mm ²	Flexo printed Dot: 200x Magnification, 5% coverage, 20 L/cm, calculated dot area 0,013mm ² Measured cov.: 16.79 % Measured diam.: 0.20 mm Actual area: 0.032 mm ²	Flexo printed Dot: 200x Magnif., 10% coverage, 30 L/cm, calculated dot area 0,011mm ² Measured cov.: 20.86 % Measured diam.: 0.18 Actual area: 0.025 mm ²
		

Note that there is not that big a difference in the 3 dot sizes!



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These are 3 photographs made using a digital microscope. Visually the dots show a “comparable” size. The screen counts used in the images was 12, 20 and 30 lines/cm. The calculated area is identical within 0.003 mm². The visual differences are related to the variation in the print process and raw materials.

Comments to Dot Size

- Do we know what the dot size variation is in a printed halftone area?
- Is using a higher screen count in print really evidence for achieving a higher print quality?
- The smallest dot a print process can print is independent of the screen count used in the image;
- The print contrast range is limited for high screen counts depending on the dot size variation.



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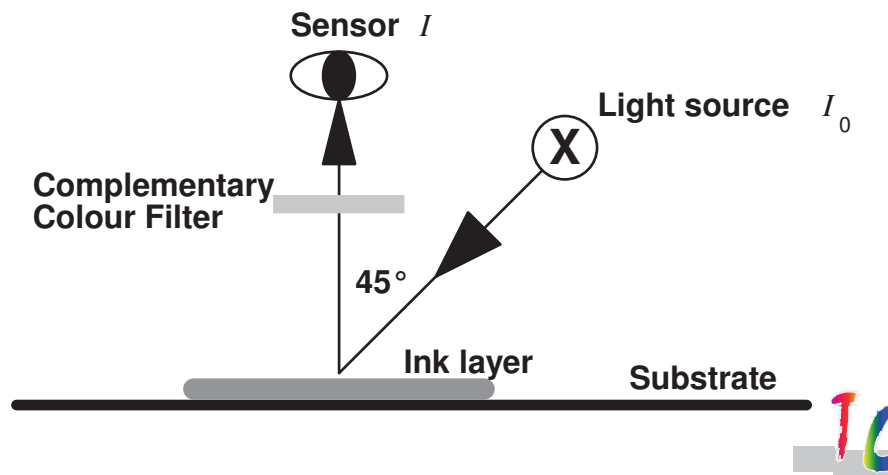
Has the industry already measured the dot size variation in a halftone area for the different print processes? It would provide a deeper inside in the capabilities of these processes.

It probably also will show that using a higher or lower screen count in the printed image has nothing to do with the quality of print.

Thus the smallest dot a print process can print is independent of the screen count used in the image.

The print contrast will be limited the higher the screen count used for printing that image. How sever this is depends on the dot size variation.

The Densitometer measuring principle



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Now I would like to take a look at using a densitometer for measuring dot area. The working principle of the densitometer is shown in the image. A light source emits light that is partly reflected and partly absorbed by a printed ink layer. The reflected light is passed through a filter determining for which colour we will measure the density. The filtered light intensity is measured by the sensor.

The equation and filtering used to calculate density

$$D = \log \frac{I_0}{I}$$

D = Colour density

I_0 = Light send (100%)

I = Light returned (between 0 - 100%)

Measured process colour:	Filtered colours:	Complementary colour of the filter used for measuring density:
Yellow	Red + Green	Blue
Magenta	Red + Blue	Green
Cyan	Green + Blue	Red
Black	Non	Transparent



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The received light on the sensor is measured first by measuring a white surface for calibration then measuring the colour for which the density needs to be determined. Note that the Density value is a logarithmic value! The table shows how the filtering works and what colour light is emitted to the sensor to determine the density of the printed colour.

The equations used to calculate dot area from density readings

Murray-Davis equation:

$$C_a = \frac{1 - 10^{-D_h}}{1 - 10^{-D_f}} * 100$$

C_a = Percentage covered area

D_f = Density full tone area

D_h = Density halftone area



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Using the density values for a full tone and halftone area allows to calculate the dot area coverage for the halftone area using the Murray-Davis equation. An other equation commonly used is the Yule-Nielsen Equation. Both equation assume that the lower density for the halftone area is a measure for the dot area of that halftone area. Is this assumption correct?

The linear dot gain equation

$$C_{a_cor} = C_a + (100 - C_a) * \frac{a}{100}$$

C_{a_cor} = Corrected percentage covered area

C_a = Percentage covered area film

a = Covered area constant (0 - 100)



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The dot gain equation is as presented in this slide. In this case we do a calculation between the target dot area coverage and the actual dot area coverage. This equation can always be applied regardless how the dot area coverage is determined.

Error calculation

Density calculation of halftone coverage based on a given full-tone density and the error resulting from a 0.02 density reading error

Is using colour density readings, for determining dot area coverage, really reliable?

Dot %	Calculated density	Dot% Error half tone
100	1.200	0.30
90	0.805	0.75
80	0.601	1.20
70	0.463	1.65
60	0.359	2.10
50	0.274	2.55
40	0.204	3.00
30	0.143	3.45
20	0.090	3.90
10	0.043	4.35
5	0.021	4.58
3	0.012	4.67
2	0.008	4.71



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This table shows the influence of an density error reading on the dot area calculated using density values.

If we assume that the reading accuracy of a densitometer is 0.02 then how can we detect reliable a value for halftone areas below 30%? We have calculated the impact of a 0.02 density reading error on the halftone values. The result is that a 20% coverage area has a tolerance of 3.9%. Thus can be wrong by 20%! And it gets worse for a 2% area.

Personally I would not promote to use density readings for any corrective action on the designed image.

But what can we do more?

- [Measuring Distance in an image;](#)
- [Measuring screen count;](#)
- [Measuring Dot Gain;](#)

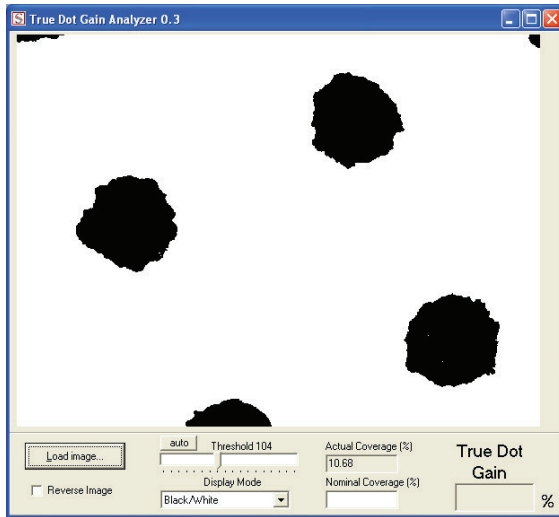


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Now it is time to demonstrate how you can use the USB Print Microscope in combination with software tools for measuring:

- Distances in an image;
- Screen Count;
- Dot Area coverage.

Measuring Dot Coverage



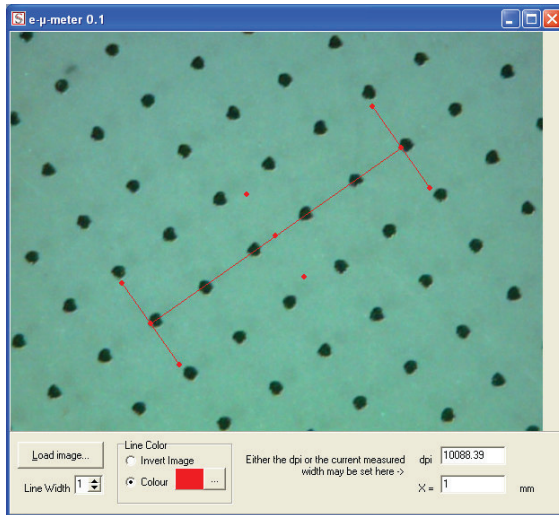
- 2 % dot at 12 L/cm flexo post printed;
- Actual Coverage: 10.68 %



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Measuring dot coverage can be done using a digital microscope. It will give you an average value for coverage of all the dots in the image. This is an image of a 12 lines/cm screen 2% dot.

Measuring Dot Size Calibration



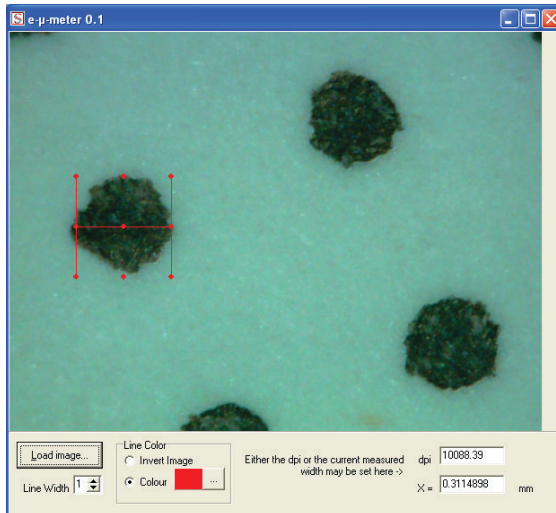
- Calibration was done on a 50 L/cm film;
- 5 lines is 1 mm



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For measuring dot diameter, area and screen count we first need to calibrate the microscope. This is done using a film with a 5% dot and 50 lines/cm screen.

Measuring Dot Size



- 2 % dot at 12 L/cm flexo post printed;
- Actual Dot Diameter: 0.31 mm
- Actual Dot Area: 0.075 mm²



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This is the evaluation of the same image as in slide 13 having 12 lines/cm, screen 2% dot. Aligning the rulers with the dot gives us a value for the dot diameter. Calculating the area of the dot might be done using the equation for calculating the area of a circle.

Summery

- There is a minimum dot size you can print independent of the screen count used in the image;
- Care must be taken when using a densitometer for evaluating dot area/dot gain;
- The USB print microscope can give you a value for dot area based on image analysis;
- Using the USB print microscope it is possible to accurately measure the size of a dot;
- Print quality needs to be expressed quantitatively.



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To summarise my presentation:

- One has to be careful to use screen count as a quality measure for a printed image. The minimum printed dot size and its consistency is more likely a value for print quality;
- Using a densitometer to determine the dot area coverage inherits a large error depending on the resolution of the densitometer;
- Using the USB print Microscope can help you to evaluate the actual dot area coverage;
- The USB print microscope can also be used to measure the dot size.

Important is that we use quantitative values when expressing print quality.

A measure of print quality may be obtained by expressing “ideal” values for a number of measurable factors and comparing the actual measured values with the ideal values.

Time for your Questions.
Thank you for your attention.

Wilbert Streefland
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Thank you for your attention. I hope you enjoyed listening. You can find more information about the topics discussed in the articles I have published in various magazines. You can find them on my website: www.tcbvba.be

Time for your Questions?