Minimum printed dot size as a print capability measurement !

Pira Conference

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Good morning Ladies and Gentlemen.

Thank you Pira 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!

Minimum printed dot size as a print capability measurement

- Print quality related to paper and inks;
- Exploring the minimum printed dot size as a function of the print process (ink and paper interaction);
- What print process, materials and design specifications to use for an image.

Wilbert Streefland

Technology Coaching BVBA

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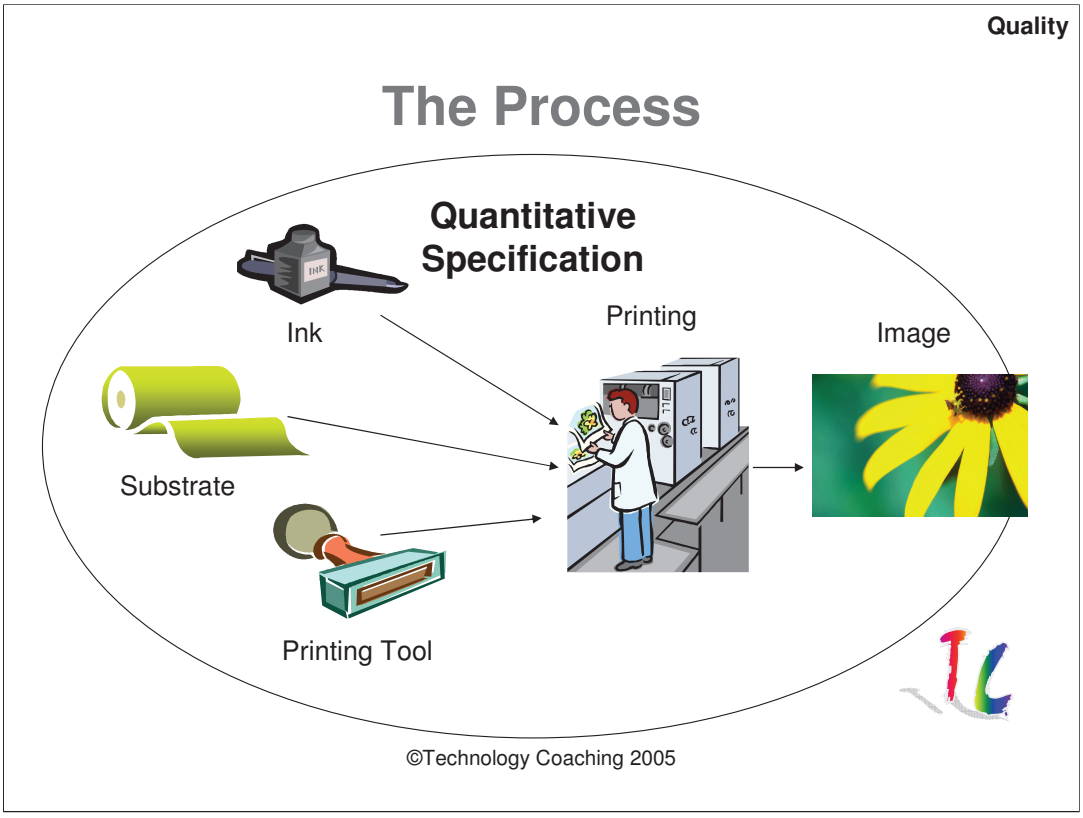
The 3 main topics of my presentation are:

1) Print quality related to paper and inks;
2) Exploring the minimum printed dot size as a function of the print process. We will look at how to evaluate the result of ink and paper interaction;
3) What print process, materials and design specifications to use for an image.



This is the simplest representation of the process. It involves 5 main parties:

1) The ink;
2) The substrate;
3) Printing Tool;
4) The print supplier;
5) The print customer.

It all requires quantitative specification.

Print quality

What is print quality and what is expected from Ink and Substrate in relation to print quality:

	Ink	Substrate
Colour consistency:	☑	☑
Edge sharpness between printed and un-printed area:	☑	☑
Mottling (Uniformity):	☑	☑
Defects (Dust):		☑
Register consistency:		☑

Taking a closer look at colour consistency over time for:

- Printed Colour;
- Substrate Colour;
- Substrate Brightness.

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When talking about quality we need to be sure that we can measure it in a quantitative way.

Print Quality can be expressed in 5 elements:

- Colour Consistency;

- Edge sharpness between printed and un-printed area;

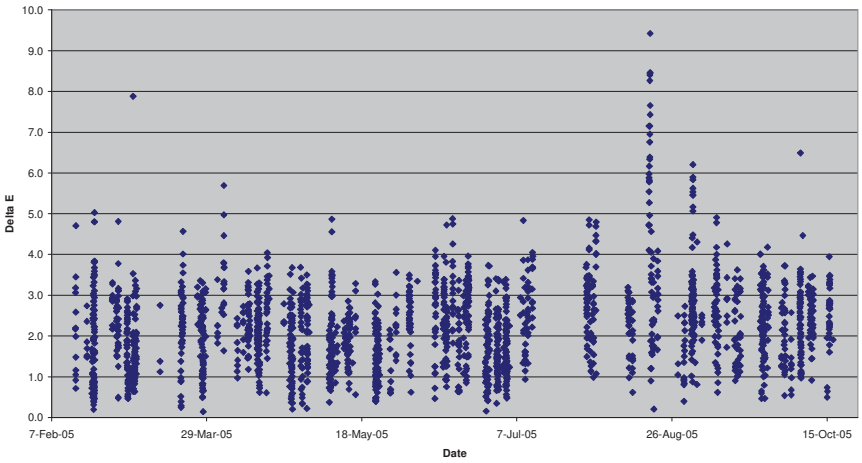
- Mottling (non-uniformity in a full tone area)

- Defects (dust). (Probably not affected by ink);

- Register. Colour to colour and print to structure. (Probably not effected by ink.)

Let us first take a closer look toward printed colour consistency over time and substrate colour consistency and then next to substrate brightness.

Printed Colour Variation



2,384 measurements in 10 Months

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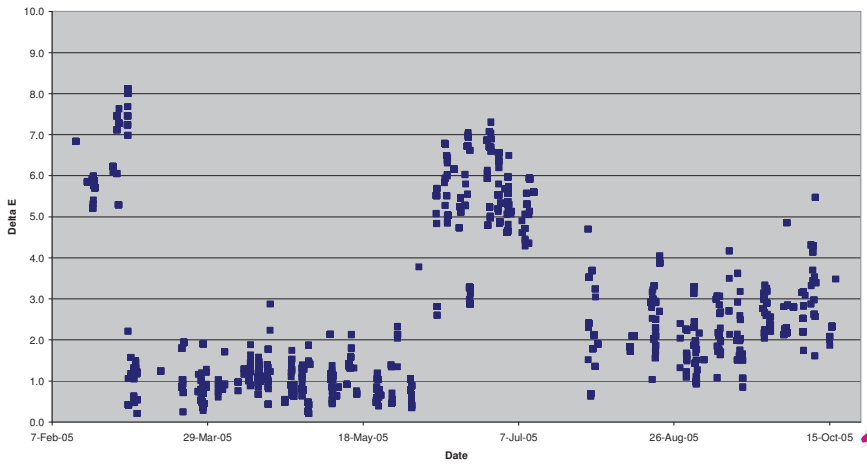
This graph shows the colour difference over time between a digital colour standard (The spectral data of the perceptual agreed colour swatch, this data will not change over time the colour swatch will!) and the printed colour measured with a spectrophotometer. It is a Brand colour. The time period is about 10 months.

The spread of the colour printed around the 26 Aug 2005 was large.

Substrate Colour Variation



926 measurements in 10 Months

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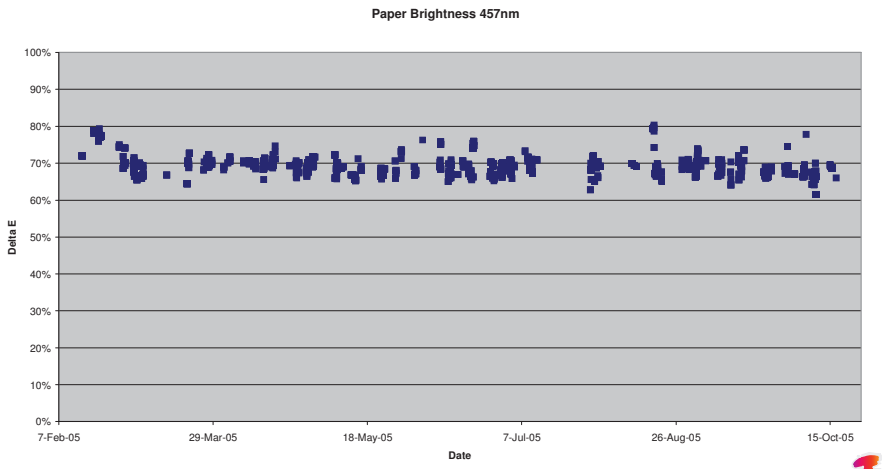
This graph shows the colour difference over time between a digital colour standard and the substrate colour measured with a spectrophotometer. The colour of the previous slide was printed over the same time period of about 10 months.

We see clearly that some periods the colour difference is larger between the measured paper colour and the standard then other periods.

Substrate Brightness Variation at 457nm



926 measurements in 10 Months

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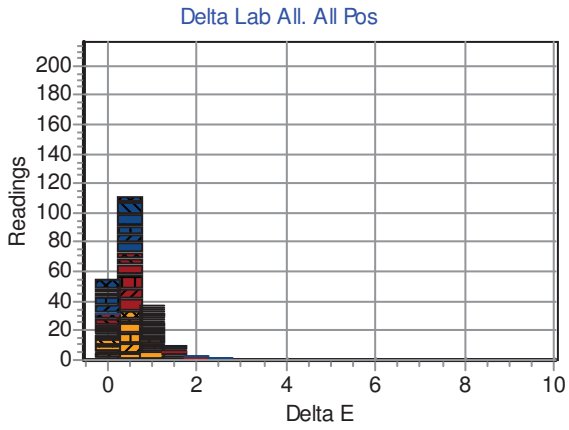
This graph shows the brightness values for the same measurements as the previous slide. The brightness values are derived from filtering the full spectral curve and only using the reflectance value measured at the wavelength: 457 nm.

Notice that the variation in colour seen in the previous slide is not visible in the brightness values.

Printing Equipment Colour Consistency

- Measuring 3 colours on 12 consecutive printed sheets in 6 positions:



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We have looked at long term colour data. But what if we would look at a printing machine only printing 12 consecutive prints in 3 colours and measure colour variation in 6 positions for each of the 3 colours on the 12 prints. The colour variation is shown in this graph. It shows that the maximum deviation between the measured colours and the average colour calculated of all measurements is CieLab DE 2. This is what we call a snapshot.

Comments on Colour Consistency

- Does the brightness value for paper give any indication for the colour variation of the paper?
- Can printers really guarantee the long term colour consistency for brand colours within the today's Brand Owners demand?
- Would it not be better to select brand colours that can be printed with a realistic tolerance in function of the print process and raw material capabilities used?
- It all looks like that perceptual evaluation/judging of colour has driven us to not achievable numerical targets for the current print processes, equipment and raw materials.

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Is paper brightness really telling us anything about the colour of the substrate and does it provide information about the substrate colour consistency and how a printed colour on the surface will appear?

We need to ask ourselves if the printer using the current equipment really can print within the targets set by the brand owners/print buyers.

Like most industrial processes, we need to identify and quantify the sources of variation for each important print property.

For some properties all the variations will add (this is the worst case).

We must accept that there is a limit to how much we can reduce variation. (How well we can control our process).

This limit should correspond to the tolerances we specify in our agreements with customers.

Thus would it not be better to select brand colours using a realistic numerical tolerances based on the capabilities of equipment and materials used?

It all looks as if perceptual evaluation/judging of colour has driven us to not achievable numerical targets for the current print processes, equipment and raw materials.

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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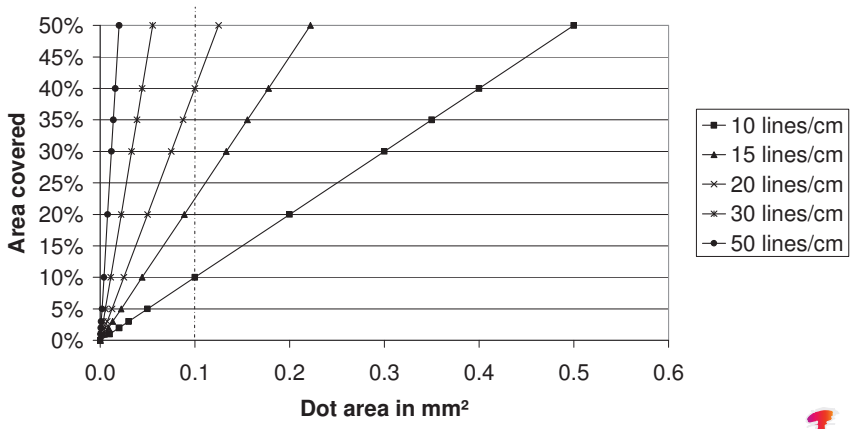
Minimum dot size:

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?

Calculated Dot Size



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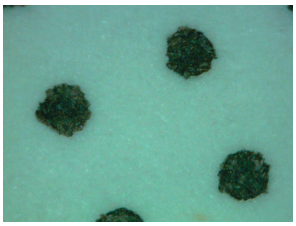
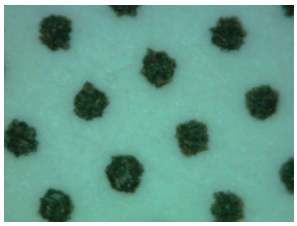
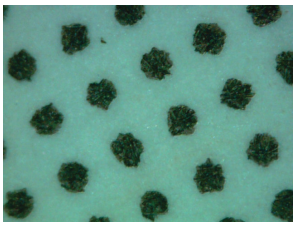
This graph shows the relation between the coverage of a halftone area and the dot size. We can see that for a 10 lines/cm screen and a dot size of 0.1 mm² the coverage is 10%. The same dot size will result in 40% coverage for a 20 lines/cm screen.

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 0,014mm² Measured cov.: 10.68 % Measured diam.: 0.31 mm Actual area: 0.075 mm²	Flexo printed Dot: 200x Magnification, 5% coverage, 20 L/cm, calculated dot area 0,013mm² Measured cov.: 16.79 % Measured diam.: 0.20 mm Actual area: 0.032 mm²	Flexo printed Dot: 200x Magnif., 10% coverage, 30 L/cm, calculated dot area 0,011mm² Measured cov.: 20.86 % Measured diam.: 0.18 Actual area: 0.025 mm²
		

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

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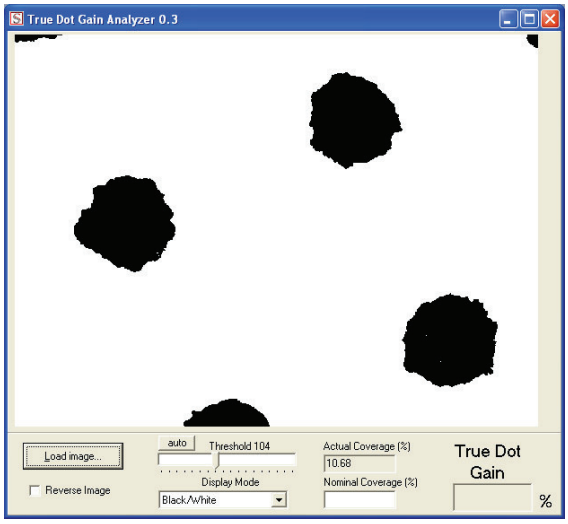
These are 3 photographs made using a digital microscope. Visually the dots show a “comparable” size. The screen counts used in the images was 12, 20 and 30 lines/cm. The calculated area is identical within 0.003 mm². The visual differences are related to the variation in the print process and raw materials.

Measuring Dot Coverage



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

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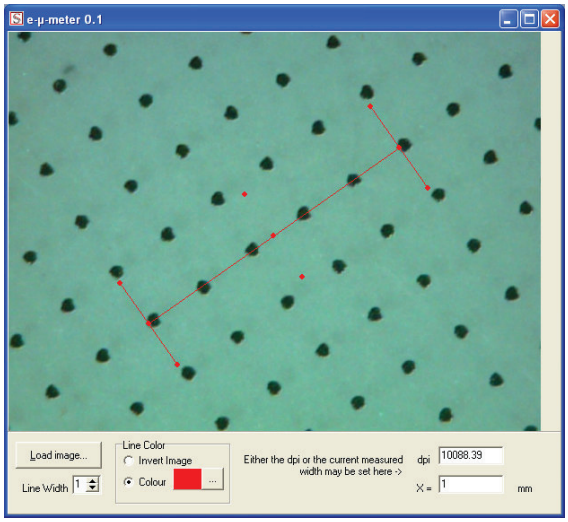
Measuring dot coverage can be done using a digital microscope. It will give you an average value for coverage of all the dots in the image. This is an image of a 12 lines/cm screen 2% dot.

Measuring Dot Size Calibration



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

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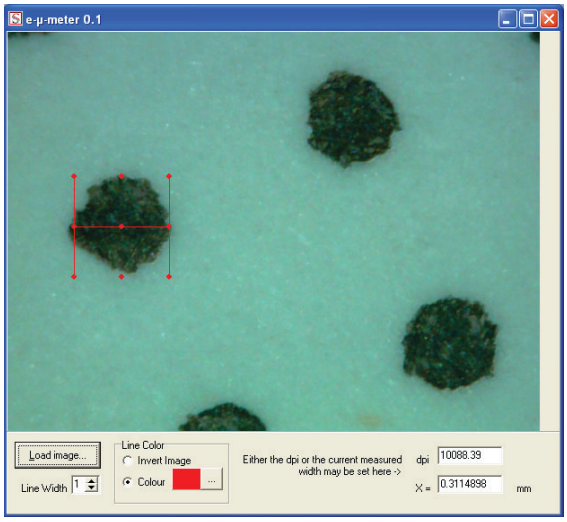
For measuring dot diameter, area and screen count we first need to calibrate the microscope. This is done using a film with a 5% dot and 50 lines/cm screen.

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.

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.

When do we need what (1)

- Brand owners want colour printed consistent without defects ➔ Ink film thickness printed has to cover the defects of the substrate.
- Print contrast is depending on the screen count ➔ Low screen count high contrast, high screen count low contrast.
- Resolution is depending on screen count ➔ Low screen count low resolution, high screen count high resolution.

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What do we need to specify or know when we are designing an image:

1) Brand owners want their colours printed constant and without defects. This can only be achieved if the ink film thickness is sufficient thick to cover the defects of the substrate;
2) The print contrast that can be achieved is depending on the screen count. Thus: Low screen count results in high contrast and high screen count will result in low contrast;
3) The resolution in print (printing of small details) is also depending on the screen count. Low screen count will result in low resolution and high screen count in high resolution.

When do we need what (2)

Image viewing distance determines the screen count to use:

- Short viewing distance ➔ High screen count (Reading);
- Medium viewing distance ➔ Medium Screen count (Recognition and Impact);
- Far viewing distance ➔ Low screen count (Bill boards).

All can be printed at a high quality level!!

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What screen count is best is depending on what the customer wants to do with the image. Important is to know what the viewing distance will be for the image in practice:

-For a short viewing distance we use a high screen count. We want to see details in the image. Contrast is not really important the eye is very sensitive and compensates. Think here of the magazine you read;

-For medium viewing distance use medium screen count. This is for images on display in shelves. Most important is recognition and impact on the observer. But don't forget. Much of "on-shelf" packaging contains small print information to be read like a magazine;

-For a far viewing distance use a low screen count this is for bill boards in the street. Contrast in the image is most important.

If all of the images printed create the customer's desired result then they are all at the right quality level. This independent of the screen count or ink film thickness used to produce these images.

Summary

- The consistency and size of the smallest printable dot is a value for the capability of the print process and the raw materials;
- The ink film thickness needed for printing depends on the substrate surface properties. Important is to print a full tone area without defects (Brand colour);
- The screen count used in an image is depending on the viewing distance;
- Select materials and process depending on what the customer wants to achieve. If it is low cost then it all might be very limited.

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Let me summarize the presentation:

-The consistency and size of the smallest printed dot (negative or positive) might provide a value for the capabilities of the print process and/or raw materials used. It is not the screen count used in an image;

-The film thickness needed for printing depends on the surface printed on. It is thus not the image we would like to print that sets the value for the ink film thickness to be used;

-Before choosing the screen count for an image to be printed we need to understand what the observer distance will be in practice;

-Select the materials and process depending on what the customer wants to achieve. Not all combinations are possible. The result will be very limited if the customer is only interested in low cost.

Time for your Questions.

Thank you for your attention.

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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?