# A NEW MEASURING DEVICE FOR AUTOMATIC DENSITY MEASUREMENTS

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Abstract: A new measuring device, the AutoSmart** densitometer is described and its potential applications are discussed. Compared to existing densitometers, the device allows much faster and more complete analysis of printed results for much better feedback to the printing process. It permits reading anywhere on the sheet, including in the image area for better press control. It can also be used to simplify gathering the large amounts of data needed for some of the new techniques in the printing process, such as optimizing color separation curves for press conditions and may eventually be important in closing the loop for printing press control.

## INTRODUCTION

The purpose of this paper is to describe a new measurement tool, the AutoSmart densitometer and its potential applications in the printing industry. The AutoSmart densitometer, I believe, will change forever the way leading printers look at quality control. Just as the Smart** densitometer allowed densitometry to move beyond simple density readings into measurement of dot gain, trap, and hue error, the AutoSmart densitometer moves from analysis of single readings to real-time analysis of multiple readings anywhere on the sheet including measurements at precise locations in the image area.

The equipment can have a number of configurations, 2 of which are shown in Figures 1 and 2. Figure 1 shows a common configuration for a QC room. Figure 2 is a configuration for a pressroom with very little aisle space. The equipment consists of an X-Y measurement table capable of measuring anywhere on the sheet and a console containing the computer equipment, printer, and color display. A viewing booth for standard viewing conditions can be provided as shown in Figure 2.

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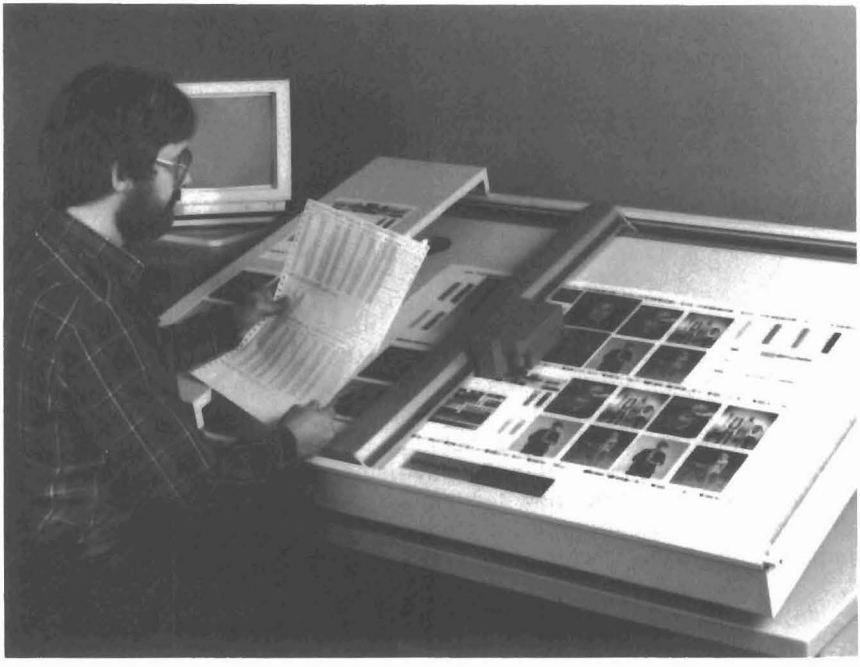

Figure 1. A typical QC room configuration of the AutoSmart densitometer.


Figure 2. A configuration for a pressroom where aisle space is limited.

## MEASURING LOCATIONS

- **Operator Selected**
- **Anywhere on Sheet Including Image Area**
- **Any Number of Locations**
- **Any Number of Patterns Can Be Stored**

Figure 3. Measurement locations.

Figures 4a through 4d show some typical measurement locations. The locations to be measured can be selected by the operator. Any number of points may be selected for a particular sheet and once the pattern is established it can easily be stored by name to be recalled whenever the pattern is to be run again. If several presses are being controlled at the same time, it is easy to switch between a number of patterns as they are simply saved and recalled by name. The number of patterns that can be stored is unlimited.

Selection of patterns is made by moving the target to the desired measurement location, then pushing a button. A number of movement methods can be used. We are currently using a track ball. The Figures illustrating the movement were actually made during the selection of measurement targets. When the measurements are made, the target lamp is off and measuring head is positioned over the target as shown in Figure 5.

### ALIGNMENT

The first step in laying out a measurement pattern is to select 3 reference points. These may be corners of pictures, register marks, or any other feature that is convenient. Then, each time a sheet is measured, the operator is given the opportunity to trim the alignment to correct for misalignment that may occur if the sheet is not positioned against the mechanical stops accurately enough. This alignment procedure will also correct for paper stretch or intentional changes in dimensions or location on the sheet.

Figure 4a

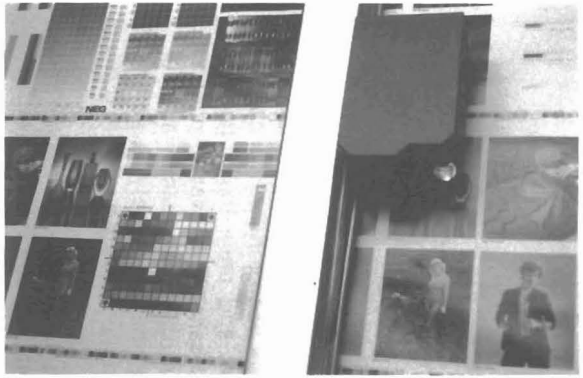

Figure 4b

Figure 4c

Figure 4d

Figure 4 (a through d). Typical measurement locations

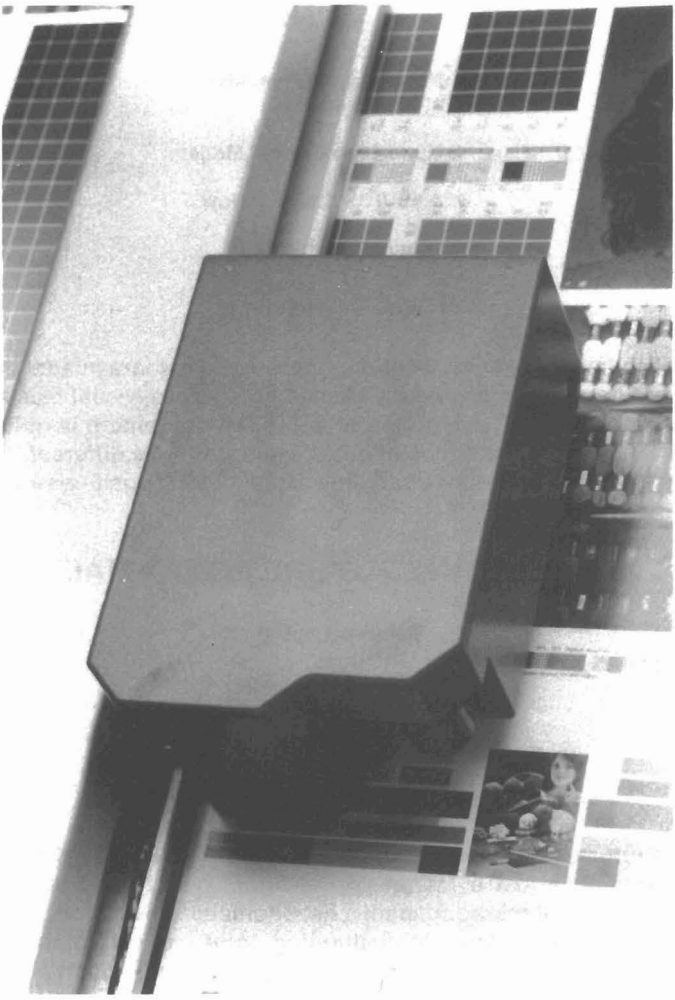

Figure 5. Measuring head in measuring position.

## READINGS

- **Multiple Filter Readings at Each Point**
- **Up to 12 In Current Model**
- **ANSI/IOS Status T Now**
- **Others Possible**

Figure 6. Readings

At each measurement location, measurements are made through a number of filters. Currently we are measuring 4 values, visual plus ANSI and ISO Standard Status T red, green, blue.[1,2] The equipment is quite flexible however. The number and type of filter readings can be different than those now being used if it suits the application. Up to 12 filter positions are provided in the current model.

## IMPORTANT FUTURE POTENTIAL

**Colorimetric Data from Anywhere on Sheet Including Image Area**

Figure 7. Important Future Potential

In the future, we expect to supply colorimetric data with the AutoSmart densitometer. It is just a matter of the filters being used. It is an over-simplification to call this equipment a densitometer. The AutoSmart densitometer is actually an automatic positioning color measuring and analyzing device that is designed to fit the product of the printing industry.

## DATA PROCESSING

- **Standard Data File**
- **IBM PCXT**
- **Lotus 123 Compatible**
- **RS232 Output**
- **Customized Printed Reports & Color Display**

Figure 8. Data Processing

Data obtained with the AutoSmart densitometer can readily be analyzed using programs supplied by Cosar, by the user, or by third parties because

readings are stored in a standard data file. The IBM PCXT*** in the console has a 10 megabyte hard disk and 640 kilobytes of memory so substantial data processing capability is built into the system. An RS232 port is provided for transfer of data to a larger computer if desired. The file is LOTUS 1-2-3*** compatible so that the many non-programmers who use LOTUS 1-2-3 can generate reports or perform mathematical calculations and statistical analysis on the data. Also, the data would fit most data base systems. The standard data file and powerful built-in computer allows Cosar to customize the output for each customer and update those outputs as the customer's needs change.

## APPLICATIONS

- **Better Press Control**
- **Better Quality Control**
- **Better Process Analysis**
- **Close the Loop**

Figure 9. Applications

There are a number of applications where the AutoSmart densitometer is expected to be used immediately. Compared to hand-held densitometers, it will provide better press control, better quality control, and better process analysis. In the future Cosar expects the AutoSmart densitometer to play an important part in closing the loop on the printing press. Each of these four applications will be discussed in more detail.

## APPLICATION

**Better Press Control**

- **For the Printer Who Does Not Sell Color Bars**
- **For the Printer Who Can Not Use Color Bars**
- **For the Printer Who Uses Color Bars — But Wants Better Control**
- **Image Area Readings**

Figure 10. Application—Better press control

One of the most common expressions used by printers when discussing densitometry is "I don't sell color bars." Sometimes they are simply complaining about the cost of color bars, but often what they mean is that color bars are inadequate for the control they need. They can print good color bars and still produce a poor job. For example, as one printer pointed out to me, it is

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difficult to control an important flesh tone that happens to line up with only cyan and black color bar patches. In other cases, just a few extra readings in an important trademark color, product color, or background color and display of differences could improve quality or reduce set-up time and waste. Then there are the situations, such as newspaper printing, where color bars are not permitted, sometimes because there is no trim area. USA TODAY, for example has been using density measurements in the image area since they started.

Miles Southworth of RIT, in his 1984 TAGA paper[3,4] proposed that a densitometer be used to compare image area red, green, and blue densities to those of an OK sheet and referred to several studies[5-7] that demonstrate the shortcomings of measuring only solid ink densities and indicate that readings in the image area may be more useful in controlling printing quality.

## IMAGE AREA READINGS

- **Now — Use of Differences Practical**
- **Real Time Analysis of Multiple Points**
- **Potential — More Sophisticated Real-Time Analysis**

Figure 11. Image area readings

The question normally raised is how to use the readings made in the image area. That is the wrong question. The question should be how to measure in the same location on the image each time so that the readings have meaning. Once that is accomplished, simple differences have practical value. If an image area has a low cyan reading compared to the OK sheet, increasing cyan ink frequently helps. Most pressmen now realize that increasing magenta ink increases both the yellow and magenta reading and they can learn to compensate for the complication. USA TODAY, for example, requires that pressmen run to specified density values in specified image areas and they check samples to be sure it is done. Of course, the computer positioning allows more measurements to be made and displayed than could be done by hand and the computerized analysis allows more sophisticated analyses to be made to simplify and improve the data for the pressman.

## APPLICATION

**Better Quality Control**

- **Statistical QC**
- **Histograms & Variance Analysis from Image Area as well as Color Bars**
- **Automated QC Reports**

Figure 12. Application—Better quality control

With the AutoSmart densitometer it is now practical to sample 10 or 12 sheets from a job, measure in color bars and key image areas and print out

histograms or mean values and standard deviations for the sample. Thus statistical quality control can replace or at least assist subjective judgments of quality. Automated QC reports can be more objective and informative than manual reports and convey an image of accuracy and professionalism.

## APPLICATION

**Better Process Analysis**

- **Automated Test Form Analysis for**
  - **Optimized Color Separations**
  - **GCR — Gray Component Replacement**
  - **Press Performance Evaluation**
  - **Proofing Method Evaluation**

Figure 13. Application—Better process analysis

Sometimes it is desirable to measure press characteristics to check or improve the printing process rather than for immediate control of a job. A recent application in which test forms are used is the optimization of color separations for a press based on the measurement of typical dot gains for the press.[8] In another application, Chuck Reiter of Spectronics, in his 1984 TAGA paper described a system for gray component replacement (GCR) that uses density measurements from a test target with 225 combinations of black and 3-color neutrals. Tests of new presses often involve running and evaluating substantial numbers of test forms and perhaps it would be a good idea to run a routine test once per month and evaluate it to find any needed maintenance to improve quality or productivity of the press. Evaluation of test forms on press compared to proofs can determine the degree to which proofing methods predict press results or show where improvement may be possible by a change in pigmentation or exposure.

## APPLICATION

**Close the Loop**

- **Cosar's Approach**
  1. **Image Area Control Essential**
  2. **AutoSmart Densitometer — World's First Practical Off-Line Image Control Tool**
  3. **Apply Knowledge Gained with AutoSmart Densitometer to On-Line Control.**

Figure 14. Application—Close the loop

For many years the printing industry has been trying to close the loop in lithographic press control so that ink and water could be controlled directly by measuring the output printed product. A few systems have been built, but a generally accepted system still seems impractical with today's technology. At Cosar, we believe that image area control is essential to closing the loop. We first plan to learn more about image area control off-line where there are fewer variables and more time to measure, then apply that knowledge to the on-press measurements to try to close the loop.

## CONCLUSION

The AutoSmart densitometer is a new measurement tool that can read anywhere on the sheet including in the image area. Compared to hand-held densitometers, it will allow better press control, better quality control, better process control and may lead to the long-term goal of closing the loop on the printing press. We believe that the problem of measuring and controlling printing using the image area is more a problem of accurate measurement location than of usefulness of the measured data and the AutoSmart densitometer provides accurate measurement locations. We consider image control practical now, used in conjunction with color bars if you have them and believe that the usefulness will improve rapidly with experience and more sophisticated computer assistance in interpreting the results.

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