Adding Black Generates Green: How Gray Component Replacement Generates Significant Benefits

by Jim Summers, President, GMG Americas

It is no surprise printers face constant pressure to reduce costs and shorten deadlines. While there are no signs this situation will change significantly in the near future, printers can remain competitive and realize substantial cost savings and process improvements through tools that optimize the color-separation process.

Somewhere during the prepress process evolution, printers lost a valuable tool that saved significant costs while contributing to a more consistent print process. The concept of gray component replacement (GCR) on images and pages was inherent in high-quality direct separation scanners. Tertiary colors—colors made up of the three chromatic colors (CMY)—were partially replaced by black. A skilled operator knew how and when to use these specialized functions. When separation scanners disappeared, the prepress processes that replaced them did not replace this function.

Today, images and page designs have heavy color coverage. Most often, when images are separated from RGB to CMYK, black is added only in the shadows, in order to achieve greater saturation. The consequence is a lot of ink is applied to the pages during printing, causing excessive ink consumption, longer drying times, difficult make readies, and instability during the press run.

With properly engineered gray component replacement, printers can expect cost savings, quality improvement, and process improvement—an unusual triad of benefits. A good solution complements, rather than disrupts, the workflow, integrating with most image file formats, including EPS, contone TIFF, JPG, and PDF.

Color Models

There are a number different ways to represent color used in printing processes. Typical approaches to replacing colored inks with black inks refer to chromatic, achromatic, undercolor removal (UCR), and gray component removal (GCR) approaches.

In these techniques chromatic mixtures of cyan, magenta, and yellow forming achromatic black and gray are replaced by the black process ink. Color mixtures using the four process colors have the advantage that several mixture ratios can achieve the same visual color result. Depending upon how much black is used, a greater or lesser chromatic component is required. The lower the chromatic component, the easier it is to keep the gray balance stable during the press run. In pure achromatic separation, all the achromatic elements are replaced by black. This means that all colors consist of a maximum of two chromatic process colors and black.

The problem with pure achromatic separation is that the image loses considerable contrast and is flattened. Many printers are familiar with the result of pushing too much UCR or GCR with unoptimized tools—poor density, posterization and/or mottling, unsaturated colors, etc. Even at less extreme settings, the eye readily detects that something is "wrong" due to the loss of contrast and saturation.

In chromatic separations, black is used to enhance contrast, without replacing the chromatic component (skeletal black). The problem with chromatic composition is that it results in higher ink applications—with the inherent cost and process control problems you would expect.

While the concepts behind these approaches are good, both models have fundamental disadvantages. Between these two extremes are UCR and GCR models that address many, but not all, of the weaknesses. UCR goes beyond skeletal black to use black in neutral image shadows. Overall ink application is reduced. GCR also replaces the chromatic component within CMY, but does not go as far as full achromatic composition, so it retains contrast in the image.

To push the limits of color replacement while retaining identical visual results requires an approach that goes beyond the traditional UCR or GCR processes. Techniques that calculate and measure results of the process on press using visual color results, rather than density or dot area, can support separations and ink optimization of the process without image degradation.

It's All in the Process

There are many tools available to apply most of the above color-separation concepts. For example, within Adobe Photoshop, an operator can, on an individual image-by-image basis, apply UCR and GCR on an image. But, on cost grounds alone, it is clearly not possible to work through all the graphics in a project and adjust them individually. At the next level, several software packages implement UCR or GCR within the prepress workflow. The fundamental flaw in these approaches is image editing is a pre-separation, or front-end, process rather than a back-end process.

To fully optimize any color-removal process, the back-end, reprographic process must be incorporated and the process must be based on measurable, visual results. The process cannot be blind to the ink, paper, and print process interactions, let alone the workflow, prepress operations, and process control. When this is done, a fingerprint of the press on day one will match on day thirty. Ink optimization works best for those who push the process and are able to narrow tolerances.

Good color-removal software optimizes ink usage by taking image information, continuous tone, and linework—treating them separately, if required—and optimizing separations immediately prior to RIPping and screening.

To achieve an optimum result, an individual profile must be created for the printing conditions, taking the ink, paper, press, configuration, and printing conditions into account. Usually, the printer carries out various fingerprinting tests—based on the profiles and optimization setting—and ultimately decides which ink reduction profile is the most sensible for their applications.

Based on sophisticated color-reduction algorithms, ink optimization solutions calculate a CMYK-CMYK color transformation that reduces the ink applied to a page. Properly implemented, the process is independent of the image content or any previously applied color modifications. In contrast, most UCR and GCR algorithms are based on density or dot area. These approaches are difficult to calibrate because they assume certain spectral qualities of the ink, and because density is not an accurate description of the interaction of colors. Further, due to these limitations, pushing color replacement to the highest levels is not possible and the process is highly content-dependent. A colorimetrically based system is more accurate and image independent. A higher threshold of ink reduction can be calculated without image artifacts, such as posterization in saturated colors, muddy shadows, and banding within pastels.

The greatest possible ink reduction is not always the best solution. Depending on the printing stock and the application, it may be appropriate to vary the degree of ink reduction. In individual instances, a high level of color reduction can also mean a slight loss of image definition in the shadows, and also of saturation. This is why it is critical for an optimized process to incorporate a feedback loop that verifies the ink-removal algorithms, visually and colorimetrically.

Similarly, solutions operating with ICC profiles have the classic ICC problem of losing black channel information. It is common that this approach will add CMY to pure 20% black when generating a new separation. In contrast, a colorimetric solution preserves the integrity of the black channel in the process.

A Closer Look

The results of ink optimized color reduction can be startling. (See page 24)

To the naked eye, none of the five images on the page—nor the color wedge—differ after using the ink-optimization solution. This is easily verified by spectrophotometer color measurements.

Examination of Images 1, 2, and 3 (as numbered in the CMYK illustration, before optimization) in the individual color separations shows the effect of the software. Before application, the colors in the CMY separation are highly saturated. The substantial color reduction in the CMY separation afterwards is clearly visible. At the same time, the short black before the transformation becomes a long black after applying the software. This is easily seen in the much darker page composition in the black separation of Images 1 to 3.

Also, as shown above, little or no color reduction takes place in images that contain little CMY, and no color reduction takes place if the image is composed entirely of black. This is shown when comparing the illustrations of the CMY separation and black separation of Images 4 and 5, before and after optimization. Less difference (Image 4) or none at all (Image 5) can be detected.

The quantity of CMY inks used is reduced, and the proportion of black ink simultaneously increased, while maintaining identical color reproduction. No difference can be determined between the two images, either visually or colorimetrically (ΔE close to 0). However, the individual color separations differ distinctly.

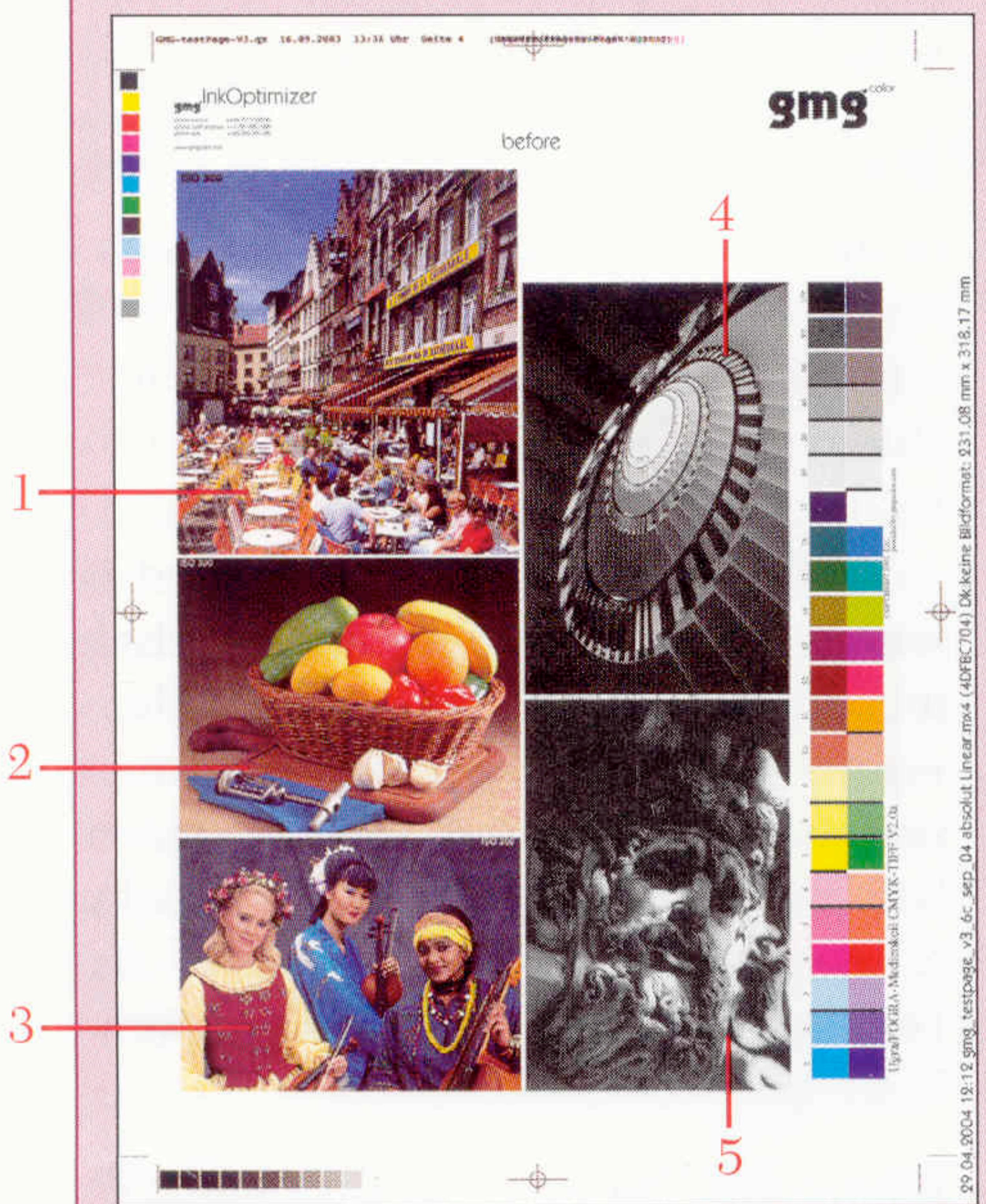
Where Do You See the Difference?

While the visual results are identical, the impact of the optimization is dramatic in numerous areas, all translating to the bottom line. Ink optimization solutions allow printers to automatically optimize the achromatic separation of the print data without altering the visual color result. They offer great potential for saving ink and, therefore, costs in printing, but the additional benefits also translate to retention of customers.

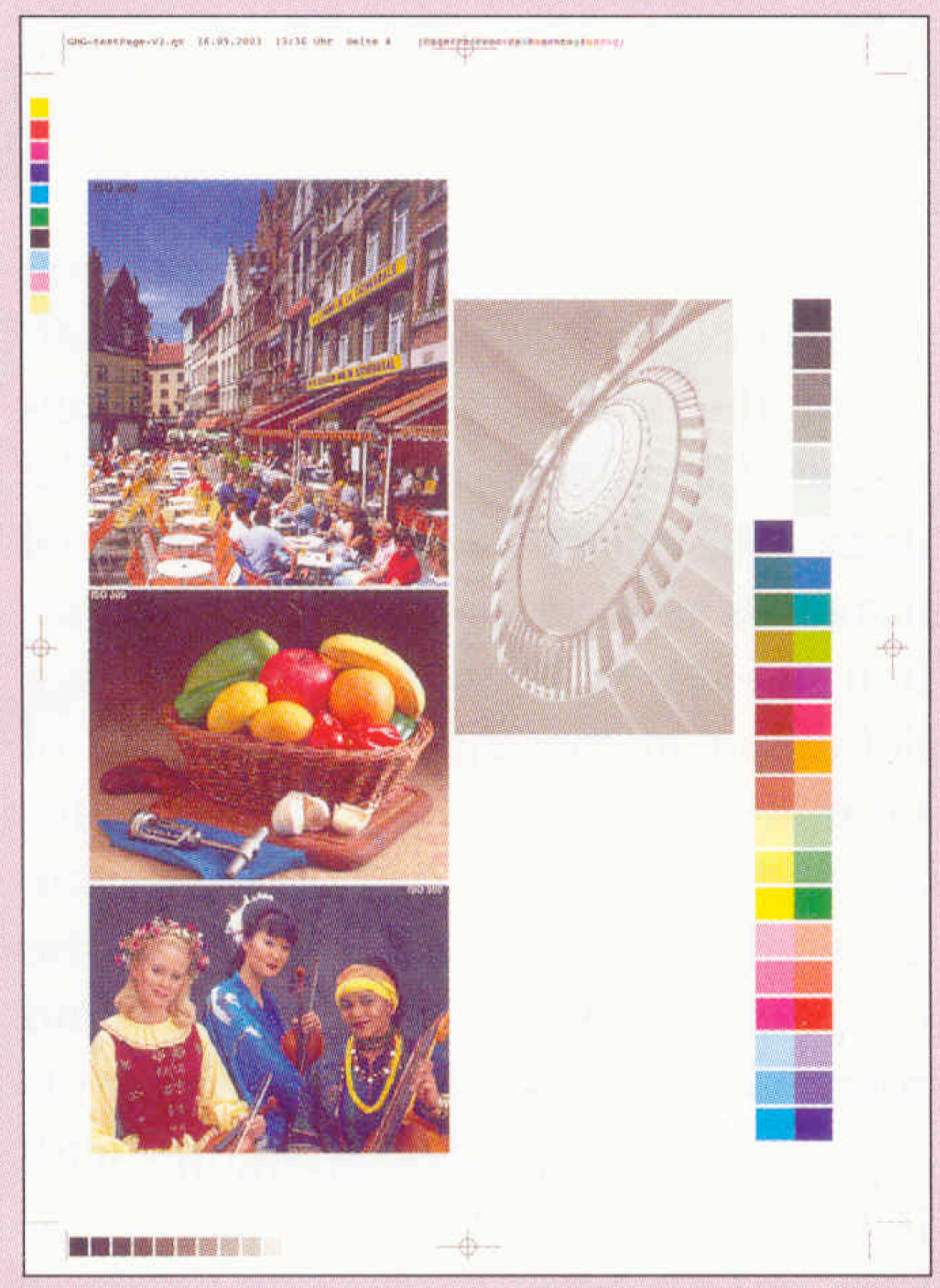
Lower costs. Although there are a number of ways a printer can save production costs by utilizing a color-removal system, the most obvious advantage is the substantial potential for directly cutting costs by using less ink.

We have conducted a number of studies of ink utilization. Depending on the page/images and the ink reduction profile used, ink savings can be up to 25% by volume. While black in volume increases slightly, color ink volumes are dramatically reduced. Since color ink is substantially more expensive, cost savings are dramatic and immediate, particularly in high-volume applications.

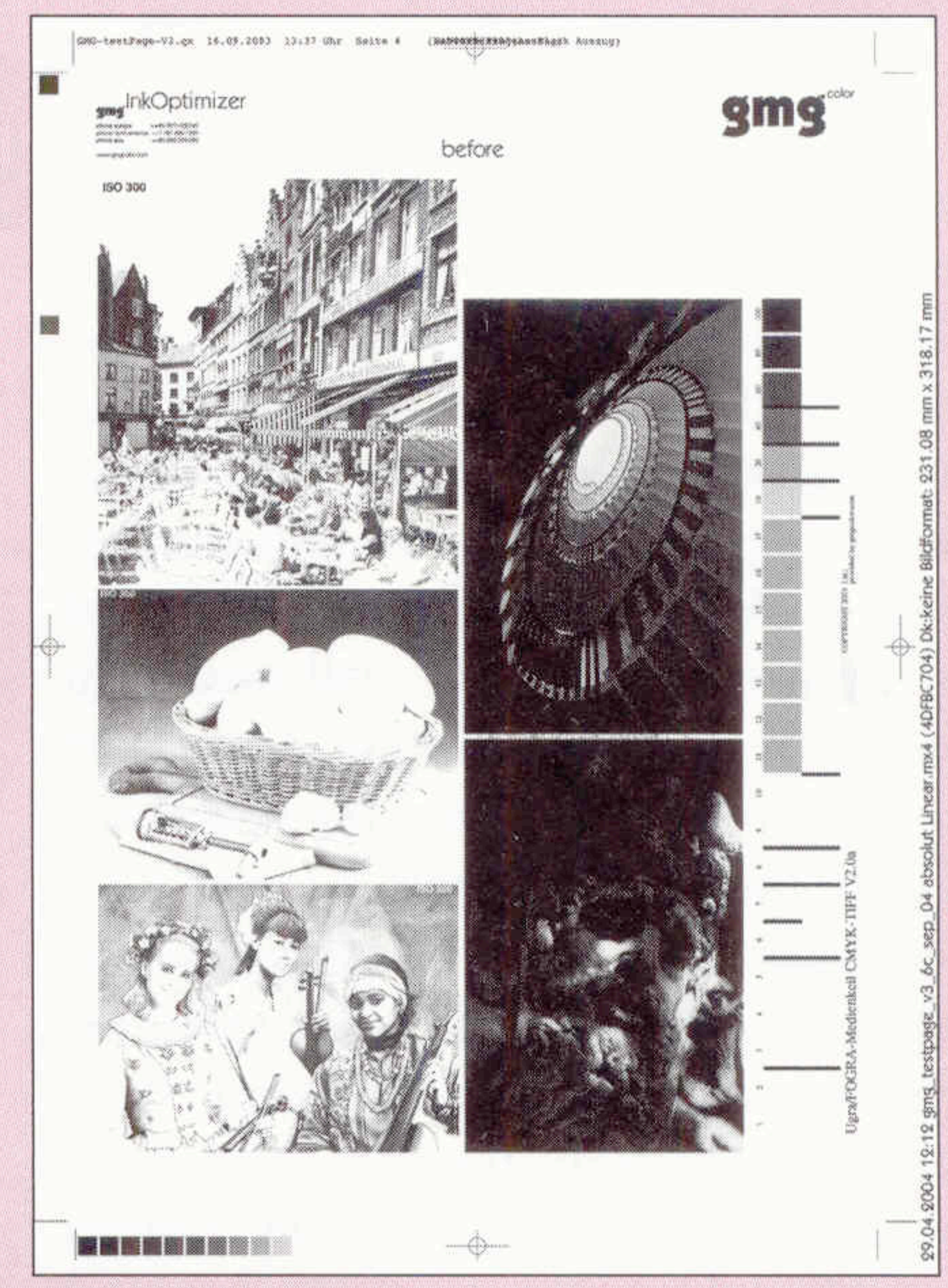
Before Using Ink Optimization



Page before using ink optimization

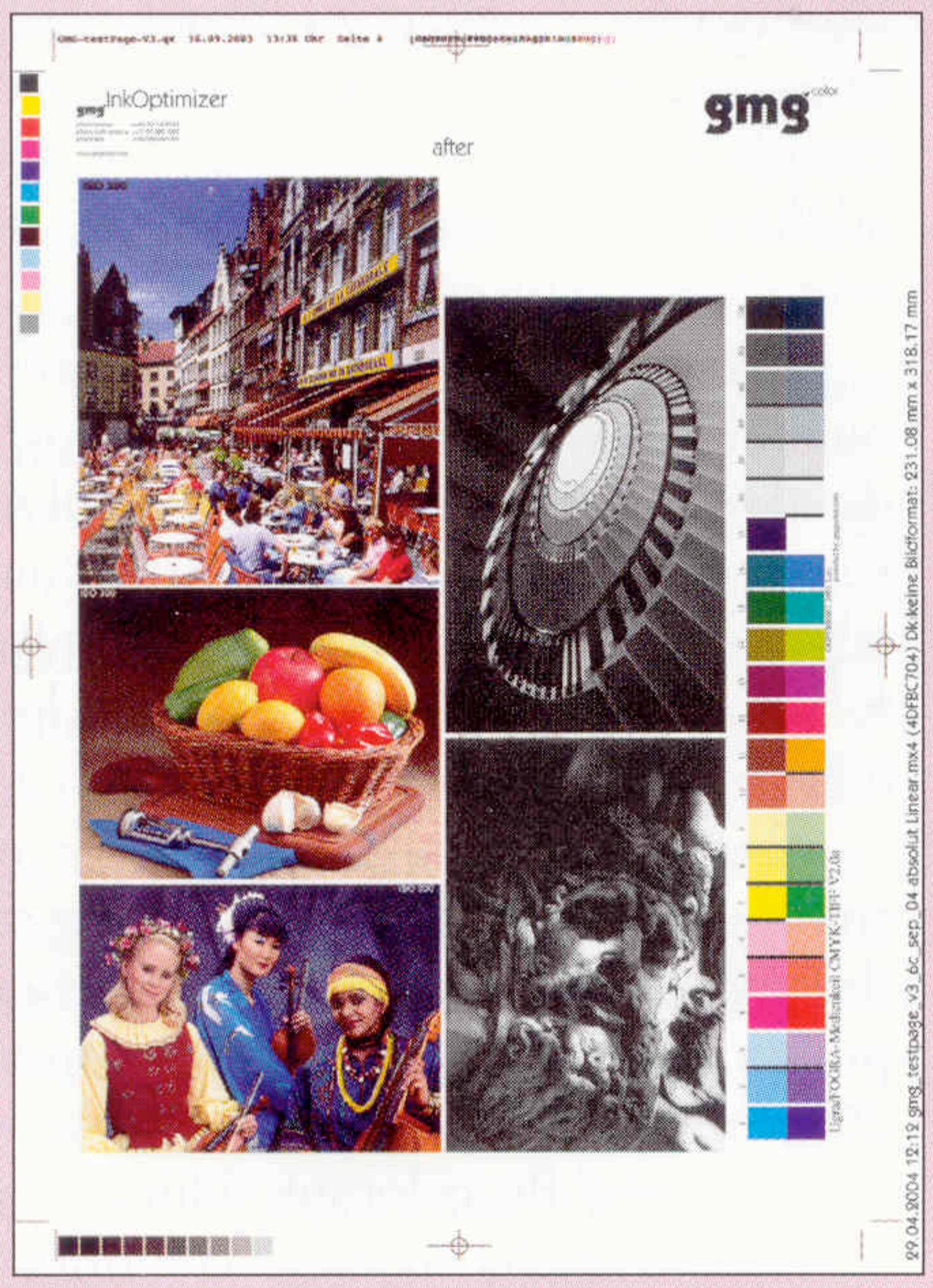


CMY separation before using ink optimization

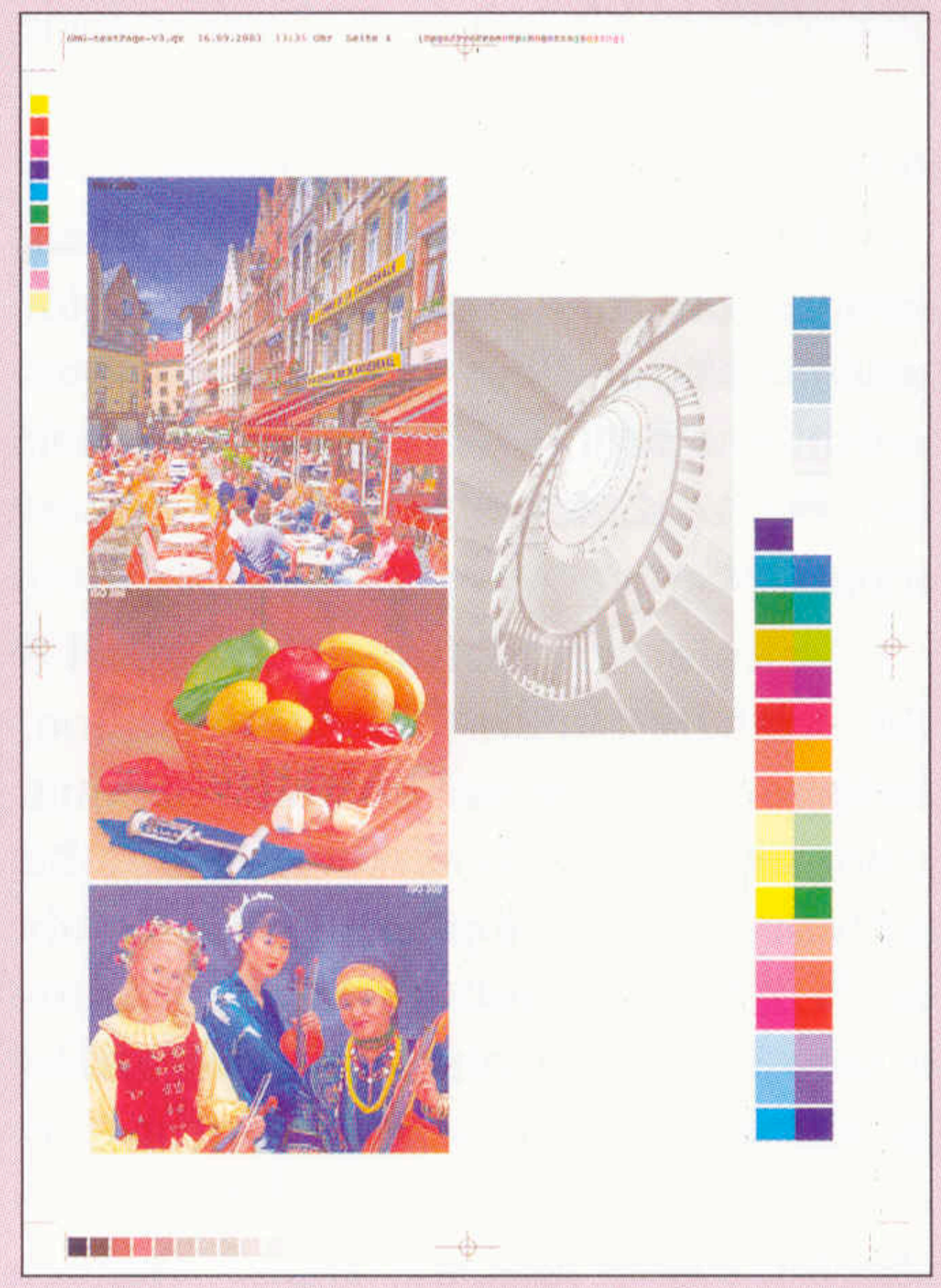


Black separation before using ink optimizaton

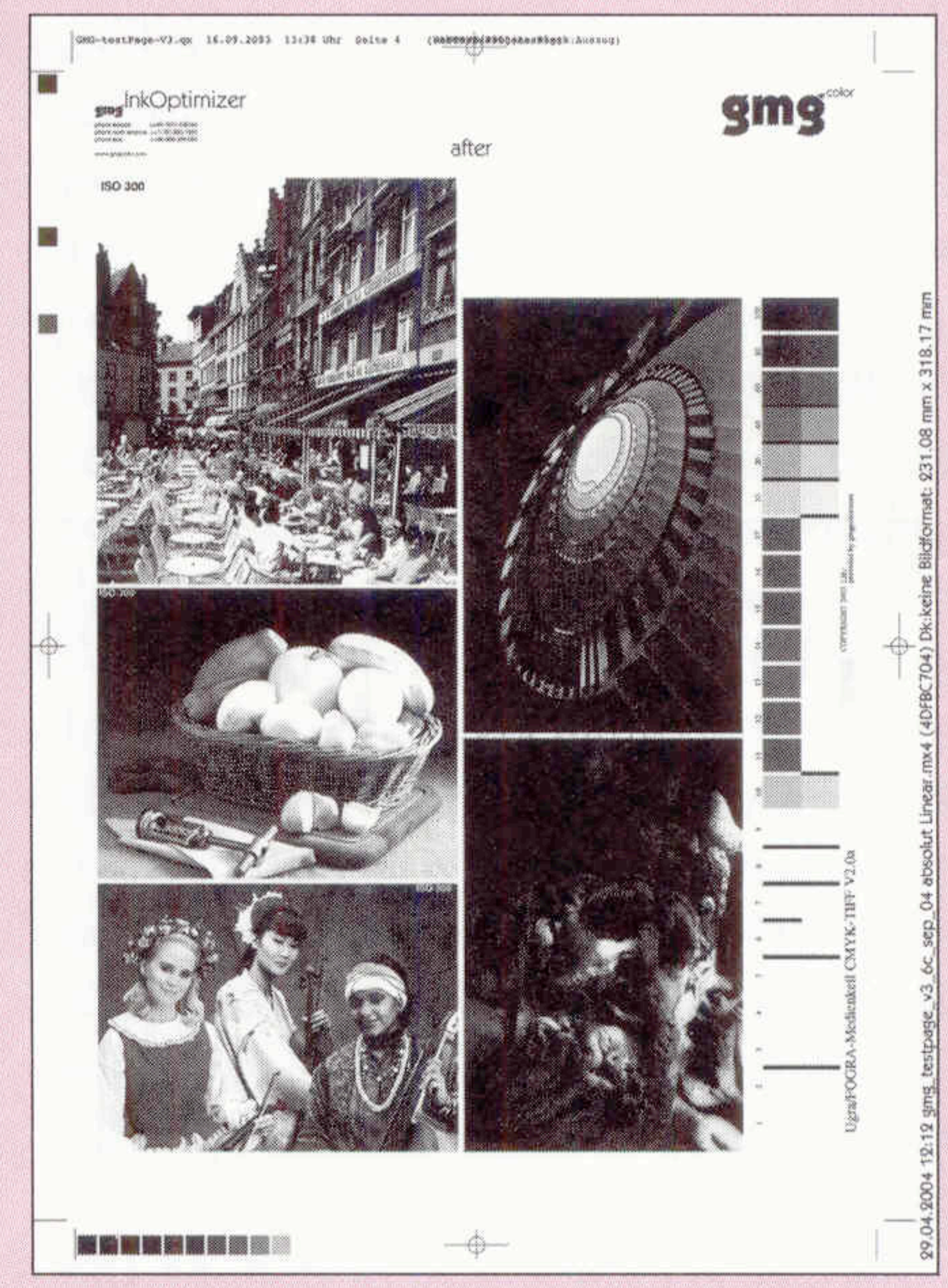
After Using Ink Optimization



Page after using ink optimization



CMY separation after using ink optimization



Black separation after using ink optimization

The reduction of CMY inks also means faster makereadies, as color balance is easier to achieve. This results in more available production time and less waste paper during makeready. Similarly, less color ink on press means it is easier to hold color balance during the print run. As a result, the press run is more stable, quality is raised throughout the entire run due to reduced color fluctuations, and production yields, particularly as tight-tolerance work is increased.

Less total ink and water volumes on the press sheet also create additional benefits. Drying times and/or energy are reduced and running performance is improved. With some presses and paper types, this permits faster press speeds. On web presses, there is less likelihood of breaks during the run—a very real and directly measurable cost benefit. Further, offsetting of ink from one press sheet to the next is reduced because of reduced ink volume and faster drying speeds.

Better printing quality. Reduced color ink volumes also impacts the visual image quality. Because the three colors carry less image information, CMY registration is less critical and/or faster to achieve. It is also less critical throughout the press run, so overall quality is improved. Further, the visual sharpness of the image is improved due to the black carry more image information. So, not only is the color more stable, but the prints are sharper.

Highly critical applications, such as process color packaging with sensitive corporate identity colors or fashion colors with exacting press specifications, can yield more good press sheets. Thus, there is less waste and shorter runs requiring less inspection—and less overs, to get to quantity.

By reducing the color ink, ink optimization solutions normalize the images to a "common denominator," thereby standardizing/harmonizing the color appearance of the entire print job—improving the overall qualitative impact. This is particularly noticeable if the images on a page are composed differently. Images are matched to each other, because they are all corrected to the optimum value. Only the separation is changed, and not the visual color impression. This helps to match possibly different separations of images on one page; for example, in catalog production, when images are used from different sources.

Time savings. Time is money. The reduction of the quantity of ink on the paper roughly doubles the washing intervals for blankets in offset printing. The result? The press does not need to be serviced until later, and can produce non-stop for longer periods of time. Ink deposits on the idler rollers are also reduced, resulting in a positive influence on maintenance times. The improved drying properties means that the print job is ready for finishing sooner—a critical factor when jobs have short deadlines, for example.

What Does it Mean to Me?

Just about any medium- to large-volume printer can benefit from software solutions that reduce ink use.

Web offset printers. Typically, web offset printers handle high printing volumes and will reach the break-even point very quickly. Due to ink reduction, less weight acts on the paper web, resulting in less likelihood of web tearing. The shorter drying times and the possibility of operating at higher press speeds are also significant.

Larger sheetfed offset printers. The more the monthly printing volume, the more the cost-saving potential is inherent in these software solutions. Ink reduction becomes particularly attractive when jobs are frequently printed in long runs. Less ink means less powder and presses that can run faster. In specialty printing applications, such as plastics or metals, the cost savings in substrate alone often produce less than a one-year return on investment.

Gravure. Because of the very high printing volumes involved, the advantages for gravure printers are rapid and quickly cost-justified on ink savings alone. There is also less energy to dry the sheet.

Publishers. Even publishers benefit. I'll bet you know at least one publisher who, while traveling across the country, compares magazine issues from the start of a press run to the end. With ink optimization, achieving this match is greatly simplified, even with different equipment and materials in different locations. In fact, with less ink there is less show-through, opening the opportunity for reduced costs with substantial (lighter) paper and postage savings.

Separating Yourself

As discussed, ink optimization is a new technology evolved from old concepts. Using new software technology and modern process controls, the technology presents a rare opportunity to simultaneously reduce costs while improving quality and consistency. Separations may look different, but they result in more efficient—and consistent—press runs.

Any solution that provides the apparent benefits of ink optimization deserves a new look. There is certainly enough evidence to suggest that adding black produces more green.

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