Color Paper: What Must Be Done to Meet the Challenge of Non-Impact Printing Technologies?

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The challenges that non-impact printing technologies pose to the use of color paper today are accompanied by two major trends: the proliferation of digital imaging and the need to protect our ecology. The color paper technology industry can respond by increasing the productivity of color processing systems, continuing to minimize those systems' demands on waste disposal, as well as by dealing with the interrelationships of these two trends.

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Introduction

The color paper industry today is clearly challenged by non-impact printing technologies, yet challenged in a very positive way: The industry is being called on to seize the opportunities for the use of color paper that non-impact technologies have created. To see where these opportunities lie, consider two important current trends: first, the proliferation of digital imaging through the booming use of personal computers and digital image sources and, second, the ever more critical need to protect our world's ecology.

The proliferation of digital imaging is a trend that is obviously important to the use of color photographic paper and to the photographic industry as a whole. Personal computers and a growing array of digital image sources are changing the ways that images are being handled, and changing them at a blistering pace. Likewise, the expanding need to protect our ecology — and the expanding appreciation of that need — is also an extremely important trend. There is clearly no way that our industry can or should compromise with the critical need to protect our planet. Each of these developments brings opportunity to the design and use of color photographic paper.

The Proliferation of Digital Imaging

Within a few short years, we can expect virtually all images in our larger markets to be stored and transmitted digitally, and the heart of this development lies in the personal computer boom. This worldwide boom has been strong and steady, and, by the year 2000, it is predicted that more than 120 million personal computers will be in use around the globe.[1] The numbers are staggering, and no end to the boom is in sight.

But there is more to consider beyond these numbers: it is not simply personal computer use that is booming, but the image processing power of personal computers and the sophistication and discrimination of the people who use them. And, with personal computers becoming more image oriented, more people are dealing with more images than ever before.

This helps explain why personal computers now outpace televisions as America's most desired household appliance.[2] The personal computer is now becoming the hub of family life as it feeds such needs as education for children, entertainment for adults, and a channel for creativity and communication for all the family. If the Nineteenth Century family circled around the fireplace, and the Twentieth Century family around the TV, the Twenty-first Century family will find itself circled around the computer.

Of course, many peripheral and even separate technologies add their weight to this trend. CD-ROMs, DVD-ROMs, and other even more sophisticated media immediately come to mind. But beyond these, one of the most salient developments has been the digital still camera. Demand for digital still cameras has risen steadily over the past few years, with worldwide demand projected[3] to surpass 2.5 million units by 1999. If this projection holds, this will give quite a boost to the proliferation of digital imaging.

But how do these developments affect opportunities for the use of color paper? A closer look at the phenomenon of digital still cameras gives an indication. While projected demand for digital still cameras is certainly impressive, this demand is tempered significantly by consumer expectations. In a recent poll, American consumers were asked[4] to rate the importance of various factors in the decision to purchase a digital still camera (Fig. 1). Topping the list was hardcopy print quality.

Unfortunately, when the same consumers were asked just how good they anticipated the print quality would actually be, their responses spelled trouble (Fig. 2). Broken down between computer owners and noncomputer owners, even a majority of computer owners (whom one would expect to be more familiar with digital imaging) anticipated that digital still cameras would deliver higher

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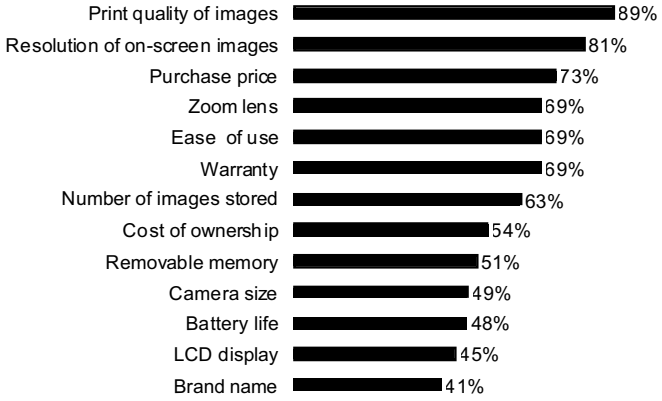

Figure 1. Consumer considerations in purchasing a digital still camera.

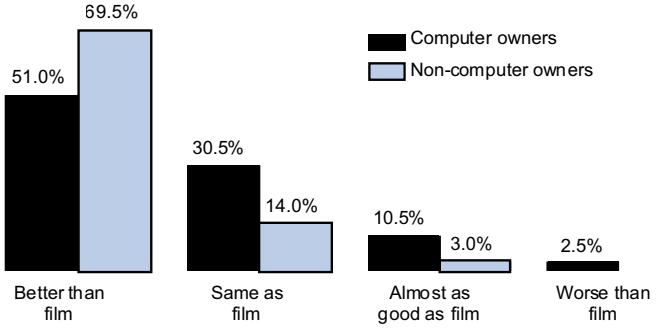

Figure 2. Consumer expectations of digital still camera image quality vis-à-vis film.

quality prints than prints from film. Of the respondents overall, only a handful had realistic expectations. Considering how important they had said print quality was, these consumers are in for a great disappointment.

These contradictions certainly do not minimize the potential of digital still cameras and their increasing role in the popular digitization of images. Rather, they illustrate that silver halide imaging just as certainly retains its own forte, and that what are most profitably emerging are not competing but complementary technologies. Digital imaging brings to the table the sheer volume of data that it can efficiently and inexpensively process, store, and transmit, while silver halide imaging's most conspicuous contribution is the supreme quality of its hardcopy prints. As a result, the trend in digital imaging actually presents silver halide imaging with an fine opportunity: the opportunity to serve the expanding demand for quality prints generated by the boom in imaging activity that digital imaging has created.

High image quality is thus essential to color paper's continuing role in modern imaging, and color paper's dominance here is well recognized among professionals, who often cite color paper's exceptional resolution and extremely fine gradation. But it must be remembered that superior image quality goes beyond these measures, for there are other parameters of image quality. There is also the surface gloss and surface transparency of color paper, which dramatically affects image perception. As Honjo has noted, to the human eye the surface of color paper suggests the surface of water or the surface of a mirror, allowing color paper to present images that most naturally resemble the original subject. [5]

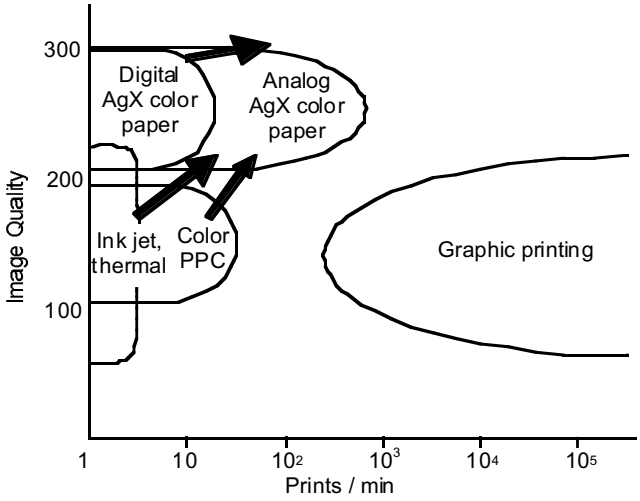

Figure 3. The need to increase digital AgX color paper productivity.

This measure of image quality is almost palpable and is as old as photographic paper itself. More than 100 years ago, ministers to the Emperor of Japan, expecting that students would show greater diligence beneath the Emperor's gaze, persuaded the Emperor to have his portrait displayed in schoolrooms across Japan.[6] The ministers wanted this portrait to be in the style of idealized realism typical of the European court portraiture of the day, so an actual photograph was dismissed. But the ministers also knew that photo portraits seemed almost magically alive to the public, and they wanted to capitalize on that perception. So, to solve this technical conflict, an accomplished Italian artist was commissioned to paint the Emperor's portrait, which was then photographed. When the prints were distributed, their image quality, unique to photographic paper, led all to assume that these were prints of an actual photo portrait — a nationwide example of the power of photographic paper.

That very same power to move people by the force of its imaging is found in color paper today. Of course, the refinement of such photographic properties as color representation and gradation and the improvement of surface properties such as gloss, transparency, and resistance to spotting must continue. But, overall, the imaging power of color paper today enjoys a well-earned and very clear dominance.

The immediate challenge to color paper therefore does not lie in image quality. Rather, it lies in productivity. Color paper must perform in pace with digital imaging, and that means that digital images must be able to be printed to color paper faster and more cheaply than they presently are. This need to boost productivity in digital-to-color paper printing can be seen by applying Takahashi's concept of a hardcopy galaxy[7] to several hardcopy systems as to compare their image quality and copy volume per minute (Fig. 3).

Here, the copy volume of analog silver halide printing, with its throughput of over 400 sheets per minute, makes very plain the superiority of silver halide systems in analog printing, both in image quality and in copy volume. In fact, analog color paper printing surpasses even the 40 sheets per minute of color plain paper copiers, not to mention the even lower throughput volumes of ink-jet, thermal, and other non-impact digital printing methods.

But the story changes with digital color paper printing. Here, the expected high image quality is maintained, but its copy volume of only 17 sheets per minute lags behind

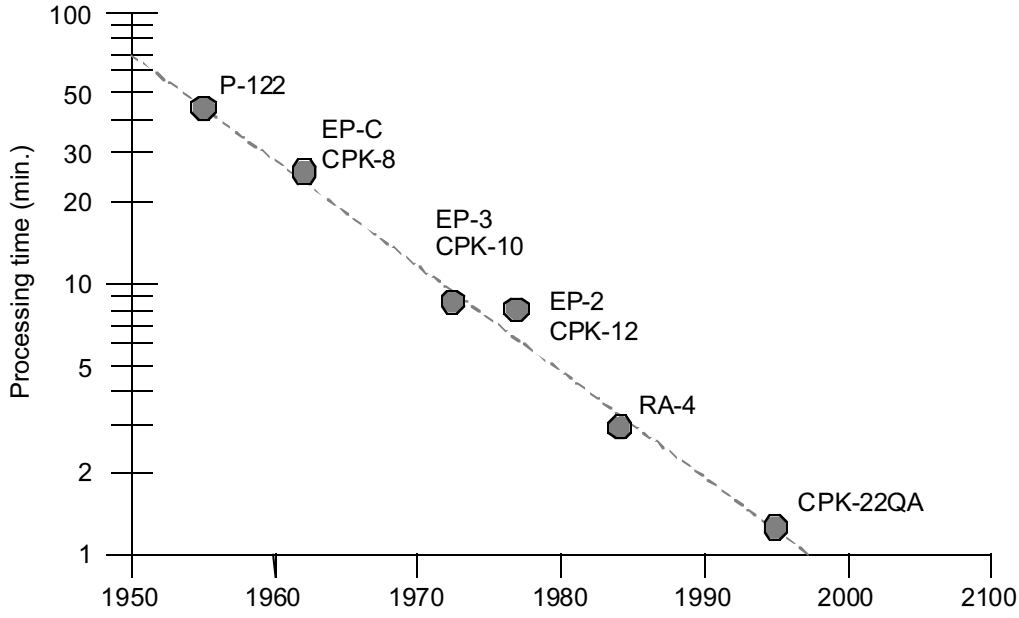

Figure 4. The steady advance of processing speed.

color plain paper copiers. Until this situation is improved, digital color paper printing will lack the productivity to make its high image quality as economically available as it should be.

This challenge is serious, but not insurmountable. To meet the challenge, attention must be focused on digital color paper systems designed for use in minilabs and color labs, for it is doubtful that the demand exists for silver halide color paper systems in the home, with consumers likely preferring to continue obtaining their photographic prints from the services they use now. Naturally, the future design of color plain paper copiers, ink-jet printers, thermal printers, and other non-impact technologies will aim to approximate the image quality and copy volume of analog color paper prints (Fig. 3, arrows). The main thrust of design efforts in digital color paper technology, however, must be toward higher productivity.

An example of how this productivity can be achieved is found in processing speed. The processing speed of color paper has increased steadily over the years, and one-minute dry-to-dry processing is now a reality (Fig. 4). Advances in productivity such as this must be nurtured so that silver halide color paper remains an efficient and viable technology whose superior image quality is enjoyed by more people than ever before.

The Need to Protect Our Ecology

Like all citizens, corporate and private alike, we who design and use sliver halide photographic systems must protect our planet. But for us in the silver halide photographic industry, this poses a special challenge, for the very basis of our technology is water. For us, water is both indispensable and problematic, and problematic beyond the mere inconvenience of working with a fluid. The central challenge is that while the proper disposal of waste products is expensive, it is also absolutely essential, because processing solutions carry such dangerous compounds as reducing agents, color developers, antioxidants, alkaline solutions, low biodegradable chelating agents, and chemicals that cause eutrophication.

Much has already been done to meet this challenge. For example, the replenishment rates of our processing systems have been dramatically reduced, as seen in the steady decrease of processing effluents (Fig. 5). Konica's Ecojet LR system of dry tablet processing chemicals alone succeeds in cutting the replenishment rate by 60%, and, combined with the ACR-40 effluent distillation system, it reduces waste water by over 90%. While this is a good example of collateral advantages from innovative design (the easy use of dry tablets dispensed from a cassette is highly appreciated by the system's operators), many would say that the Ecojet's central feature is its role in lowering replenishment rates. Progress like this and like that promised by amplification systems that reduce the silver content of color papers have brought us a long way. This has been steady progress through constantly evolving systems, and it must continue.

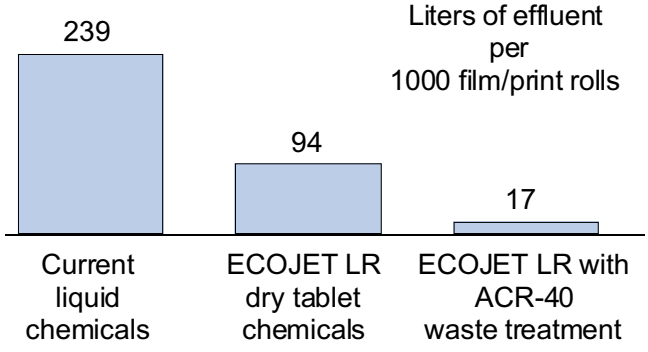

Figure 5. The steady decrease of waste water.

But what is the most promising approach to continuing this progress? The Holy Grail of a truly dry silver halide system has so far eluded us. Some nearly dry systems, such as Pictrography and the Ecojet system, do exist. But while the Ecojet system minimizes water, it doesn't eliminate it, and the Pictrography™ system is both limited in its applications and requires additional media for image fixing, media which present their own problems of handling and disposal. The search for a revolutionary dry system must not be abandoned, but our most promising

approach is evolutionary: steady progress toward drier and drier conventional systems.

Intertwining Trends

As we meet the challenges of the two trends I have explored — the proliferation of digital imaging and the need to protect our ecology — we will find that this is a complex task, for the two trends intertwine.

For example, digital imaging has meant the proliferation of electronic image displays. Electronic displays appear to be environmentally friendly, and, in many ways, they are. Yet, it is revealing to compare the ways in which hardcopy and electronic display devices consume energy: where the draw on energy to produce a hardcopy image is terminal, that to display an electronic image is continual (Fig. 6). Further, if the salient environmental costs of electronic displays and hardcopy are, respectively, the consumption of electrical energy and the consumption of paper, then it may be notable that electrical energy depends heavily on nonrenewable resources such as fossil fuels, while paper is provided by what can be, with proper stewardship, the renewable resource of husbanded forests.

Complexities such as these illustrate the need to explore carefully how the spread of digital imaging and the need to protect our ecology relate to each other.

Conclusion

The proliferation of digital imaging and the need to protect our ecology are central to the challenges that color paper faces from non-impact printing today. By raising the productivity of color processing systems, minimizing the systems demands on waste disposal, and by dealing with the interrelationships between the two trends, we can and will meet these challenges and assure that the beauty and power of color paper will be enjoyed more than ever before.

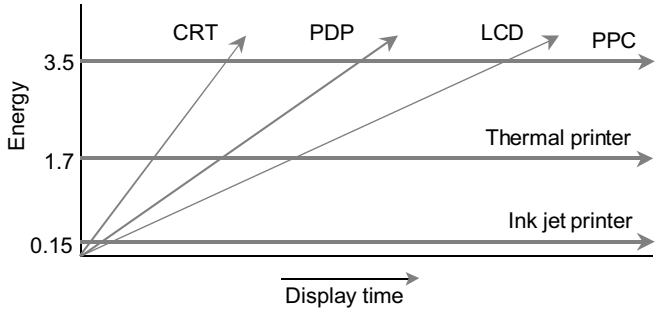

Figure 6. Energy consumption of electronic and hardcopy displays.

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