Direct Digital Color Proofing (DDCP): Close, But No Cigar

S. Thomas Dunn, Ph.D. and Tom Shipman*

As many of you know, Dunn Technology, Inc has been working in the area of direct digital color proofing (DDCP) activity for some time. We think we understand the needs and requirements for this technology from a systems production viewpoint. Most recently we finished a major study in this area entitled *The Markets and Technologies for Direct Digital Color Proofing* (DDCP) (1), in which we deal primarily with the **color proofing manufacturing** part of our industry.

We have seen on this conference program as well as on *Lasers in Graphics* and other conference programs over the last five or six years that as an industry, we have become truly discouraged with with the television screen soft proof for color feedback information in electronic prepress. There are continuous tone approaches to hard copy color proofing using both conventional photo papers and diffusion transfer materials. There are ink jet, thermal transfer, electrostatic, and many other technologies attempting to be applied to proofing and attempting to be called digital **color** proofing.

All of this has a great deal of confusion as to where things fit in regards to color hard copy involved with the creation and production prepress activities. In the process of preparing copy for the press there are many needs for color hard copy. Only a few of these needs are in fact **color proofs** as we know prepress proofs.

Presented: TAGA, 1986 Annual Meeting, April 15, 1986.
*Dunn Technology, Inc., Vista, California

Clarifying the Confusion in the DDCP Market

In conjunction with our DDCP report we developed the following market applications matrix, Figure 1.

Market Segments	Subdivisions of Markets
Creative	Concept Creation Art Modification Art Assembly (Layout)
Production (prepress)	Color Iteration (Getting it Right) Composition and Register Contract Proof
Printing	Plate Ready Film

Source: Dunn Technology, Inc., 1986

Figure 1: Market Segments for Digital Hard Copy within the Color Printing and Publishing Process

It shows how during the **Concept Creation** phase, the thumbnails, the roughs and other applications at the beginning phase of idea creation, have one kind of proofing mechanism, which is in the 50 line per inch range. This segment also has a different kind of color, mostly spot and cartoon types of color. **Art modification,** which is where the Hell CPR 403's and the MacDonald Dettwiler units are coming into play with the so called second generation original, or retouching business, is a part of image modification. This generally does not occur in prepress, although this is occurring more with prepress equipment, because of the functionality

of these electronic systems. **Art Assembly**, which includes the loose comp, the tight comp, and finally the keyline is, in general, black and white but occasionally is in color, as with automotive and liquor ads. Each of these subdivisions of the market have different requirements for hard copy proofs.

Each of the areas of the Creative Segment has some form of hard copy output need from the computer, as we put computers (image processing systems) in these various stages. This will happen as **real** designer terminals become available (we expect this year of next or next year). This is where a lot of "proofing technology" will find applications. **Though none of these are called color proofing applications.** That is, many of the products purported to be DDCP, are in fact solutions, waiting for the development of the application. Also within these subdivisions of the Creative Market segment the requirements for hard copy vary significantly as to resolution, color content, and size and functionality required.

Now we move into the Prepress Production activity where we have a **Color Iteration** cycle which is the dominant use of prepress color proofs. This is where we, as production people are trying **to get the color right** in the production process. I want to talk more about this process because it affects what is going to come out of the direct digital color proof activity. **Composition and Register** is the part of prepress production which is a check on registration and to see if you've gotten the design as per the keyline. The feedback and the approval cycle may or may use a color proof. It can be a line proof. It can be other forms of proof used to see whether or not you have met the design criteria as specified in the keyline (comprehensive).

Then you have the proof that is shipped; the proof that goes to a printer, whether you're a vertically integrated printer or a trade shop; and that proof is the **Contract Proof.** These are the dots on the film that is being shipped. This is the proof of those dots that the color will be made from.

And finally, there is the Printer Segment. The printer wants to be sure that the films can print, potentially before and after the **plate ready films** are assembled. So the the printer in general will make a proof before he goes on the press. And thus, there is

a final proof here. This proof generally is a position and register proof.

Keep in mind that as we move through market segments, we wander all over the map of required resolutions, required color fidelity and even the requirement for color. Basically though, we have considered the main DDCP application to be **real color proofing** e.g. **the Color Iteration** and **the Contract Proof.**

On all the rest of the applications, (Concept Creation, Art Modification, Art Assembly, etc.,) although they can be made in color and may be made by all kinds of ink jet, color paper, thermal transfer, etc., it is important to keep in mind that these in fact are **not color proofs.** If we get that clarified in our minds, then I think we will also be able to clarify the sizes required for all these applications, the resolutions, the speeds, the color fidelity or lack thereof, etc.

In talking about direct digital color proofing, we must understand **who is going to buy a direct digital color proofer.** Today's customers for DDCP are people who own color electronic prepress systems (CEPS) . We are not projecting that any of the color scanner people will in any significant way buy digital proofing systems to put on their color scanners. By the time this technology matures, in the 1988-1989 time frame, color scanners won't even be color scanners. Color scanners will be mini-CEPS systems. So we feel that whole concept of DDCP for color scanners is a nonvalid concept.

DDCP will be going into the high quality color market because that is the market that bought CEPS. That is where a lot of money is made in the printing industry. That's why people bought the CEPS. That's where the installed base is. That's where the installed base will continue to be. So we're talking about the high quality, single sheet, Cromalin/Matchprint proofing market.

This means that prepress digital proofing has no sacrifices. The watch word is that it has to be Cromalin/Matchprint-like, period, (note a later trend to compete with proof press and therefore an "ink on paper" look).

In prior, extensive surveys of this market, we found that the same proof is used throughout, i.e., the same proof off the scanner, the same scatter proof, the same proof after etching, the same proof after stripping, until it is finally shipped. If the customer specifies Cromalin, then Cromalin is used all the way through. If the customer says Matchprint, then Matchprint is used all the way through. It is important to keep this in mind.

Management of color prepress activities does not want to have its employees looking at several different kinds of proofs while trying to get high quality **color right.** Of course as is typical to the printing industry, there are always a few exceptions to trends. But generally speaking, the same proof is used from the time work is scanned to the time it is shipped. And, in fact, one of the pressures on DuPont and 3M has been to get the negative version of their materials to look like the positive. This, by the way, in my opinion, is not the thing that you would want to do from a technical viewpoint.

Now, there is another thing that began to bother us a couple of years ago. We had done our studies and we came to the conclusion that direct digital color proofers would consume about 10 percent of the prepress proofing materials in the next five years or so. **So, why all the research and development money?** Tens of millions of dollars are getting dumped into the development of direct digital color proofing.

The real reason behind this is because of the need for **the same proof throughout.** There is a real need for the digital proofer to have an **exact** analogue capability. Regardless of how you make the digital proof, electrophotographically or with photopolymers, you have to be able to make a proof from films using the same technology. This is due to the need to use the same proof throughout. This is mandated by the way business is done.

The technology for the DDCP, although not consuming much of the prepress proofing materials market, is the driver and the thrust of the change that you will see–from UV technology to visible technology in the next five years. This will occur throughout the prepress color proofing industry not just with those proofs that are made digitally. So, the entire high quality proofing market is up for grabs. All of these things should help explain why some

20 to 40 million dollars in research and development is being spent on new visible technologies this year alone. This is certainly significant for a market (DDCP) that promises not much more than half of that size at this point (in potential value of materials to be consumed).

Conventional manufacturing operations in the high quality color area, basically go through the following kinds of steps: (Figure 2) We do a loose color proof. We do an iterative color proof. We get the color right. We, at some point in that process, depending on our customer and our experience with the customer, etc., show him a proof and get his approval or his iteration. We strip and then make another proof. This cycle is fairly straightforward. There are people who strip before giving proofs to customers, etc., but generally the cycle I described is the dominant one in use. And that's the cycle that was disturbed by the CEPS systems.

To reiterate: We need the same proof throughout. This is the driving force in the consideration that what happens in digital world also must happen in analogue world. Also, the primary **color** proofing activity involved in the digital world is the game of **getting the color right.**

We have to keep in mind one other issue, which is that **color proofs represent the film shipped,** i.e., that it is a **contract.** We cannot get out of this issue. This is what brings in the need for the analogue proof of the films to be of the same technology as DDCP. Trusting two different electronic dot generators (one making proofs, the other making films) to make identical dots that are provable in court, as is the case with Cromalin or Matchprint today, is something I could not defend as an expert witness at this time. Maybe in three or four years, when we have had experience with parallel film making and digital proofing, we will be able to convince ourselves that the data coming from the same eight-bit word making that dot is indeed the same dot. But that's a long stretch right this minute, and it won't solve the problem of the trade shop which has to show proof of the dots that it manufactured and then shipped.

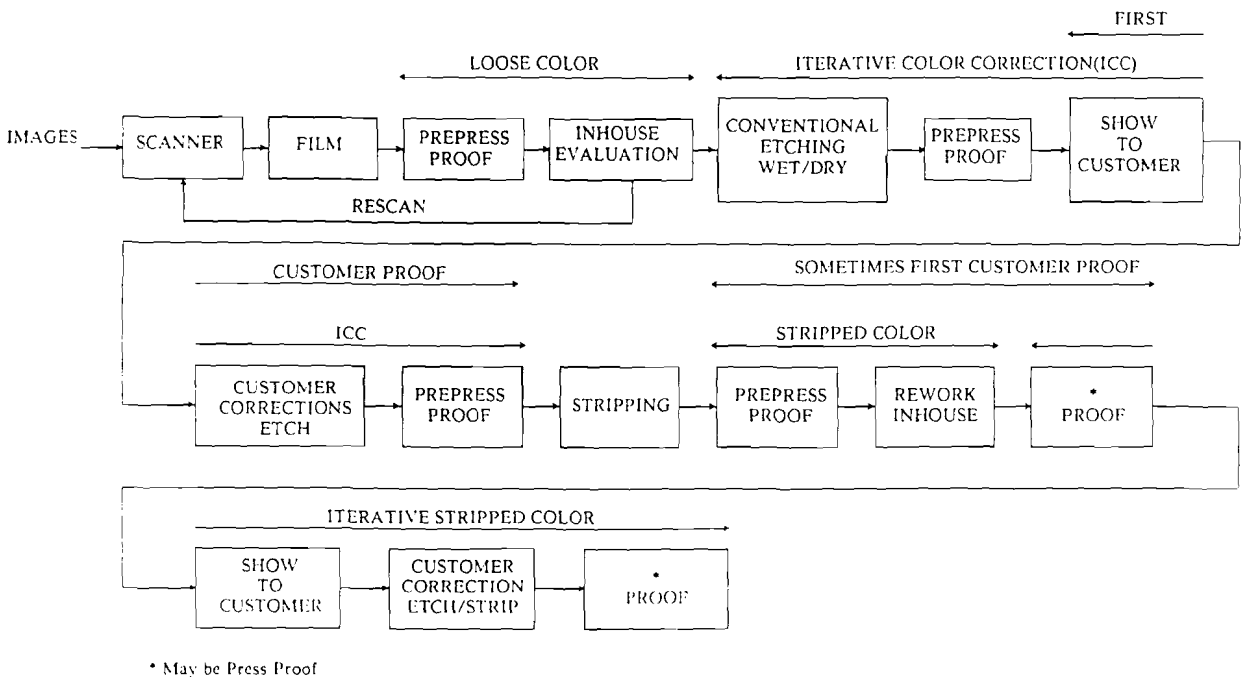

Figure 2: Conventional (Analogue) Color Proofing Cycles

Now we're going into the CEPS world (Figure 3). At one time we really thought the color monitor was going to handle all this iterative "get the color right" proofing; the so-called in-house color proof, and further eliminate that scatter proof off the scanner. **We in fact don't want to do that.** Many of our CEPS users today are getting this back, at great expense, by making films and making proofs of the input scan.

We generally come out with fully stripped pages and then do our proofing and iteration, the CEPS version of "getting the color right" after stripping, which may or may not be a very good place to be doing that. I suggest to you that it's not. Thus, with CEPS, we have generally lost the ability to **get the color right** at early stages in the process.

Now just as a background for the digital color proofing market (this does not factor in the mini-CEPS, all of which are basically going into full CEPS), mini-CEPS in our opinion are merely a first purchase step toward full CEPS. The wave of Pixet installations last year is merely a projection of the wave of Response installations of this year and next year. So we have essentially factored out mini-CEPS in this discussion and only talk about the million-and-a-half dollar systems. In 1987 there will be about 450 to 500 CEPS units at some 300 odd sites in the USA.

Now the need has come, and it's almost a 100 percent need, to find out what the color is at the beginning of the CEPS process. That is, to get back to that scatter proof which comes off the scanner and is used to make a rescan decision (inital color decision), and is handed to the terminal operator when he starts working with this color TV. This becomes a proof that is in fact a prepress color proof that can be printed to, so that an operator can know what the color is, change it on the screen, and then decide whether a further DDCP is needed, before outputting films.

In our opinion, the DDCP's will be laser exposed, and thus the consideration of lasers and material technology compatibility is important. The following (Figure 4) from the 1980-81 *TAGA* Proceedings shows the lasers that are available for exposure. Of this group, the only lasers that are reliable are the visible and the semiconductor lasers. Anything else is not a realistic

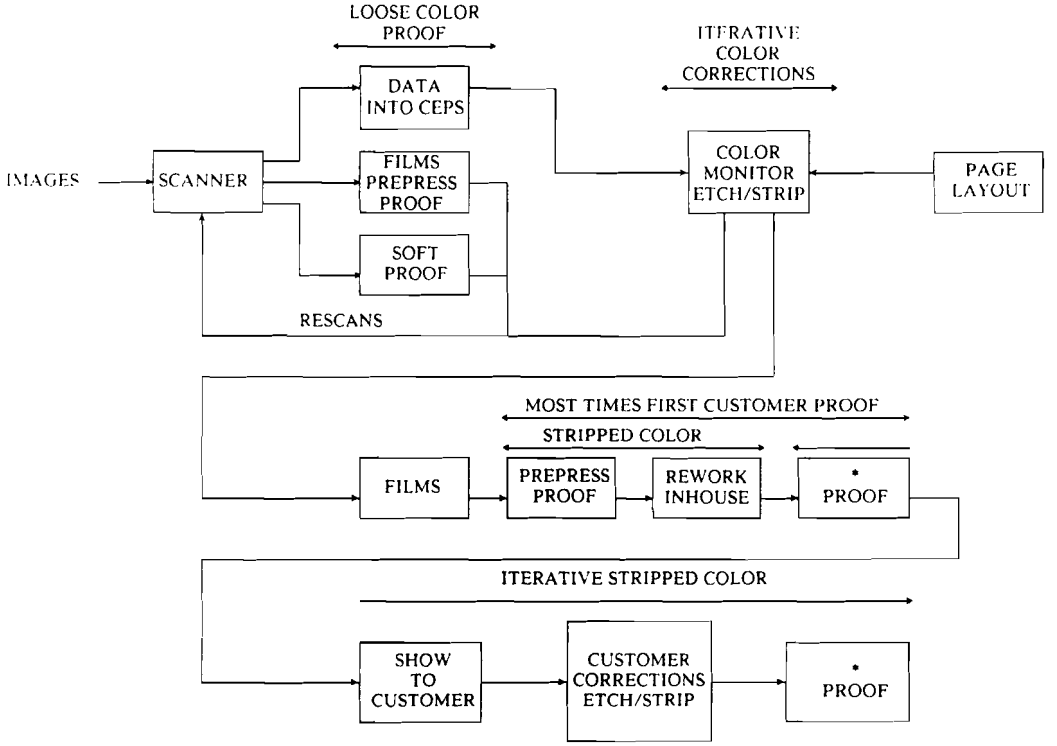

Figure 3: CEPS Prepress Color Proofing Cycle

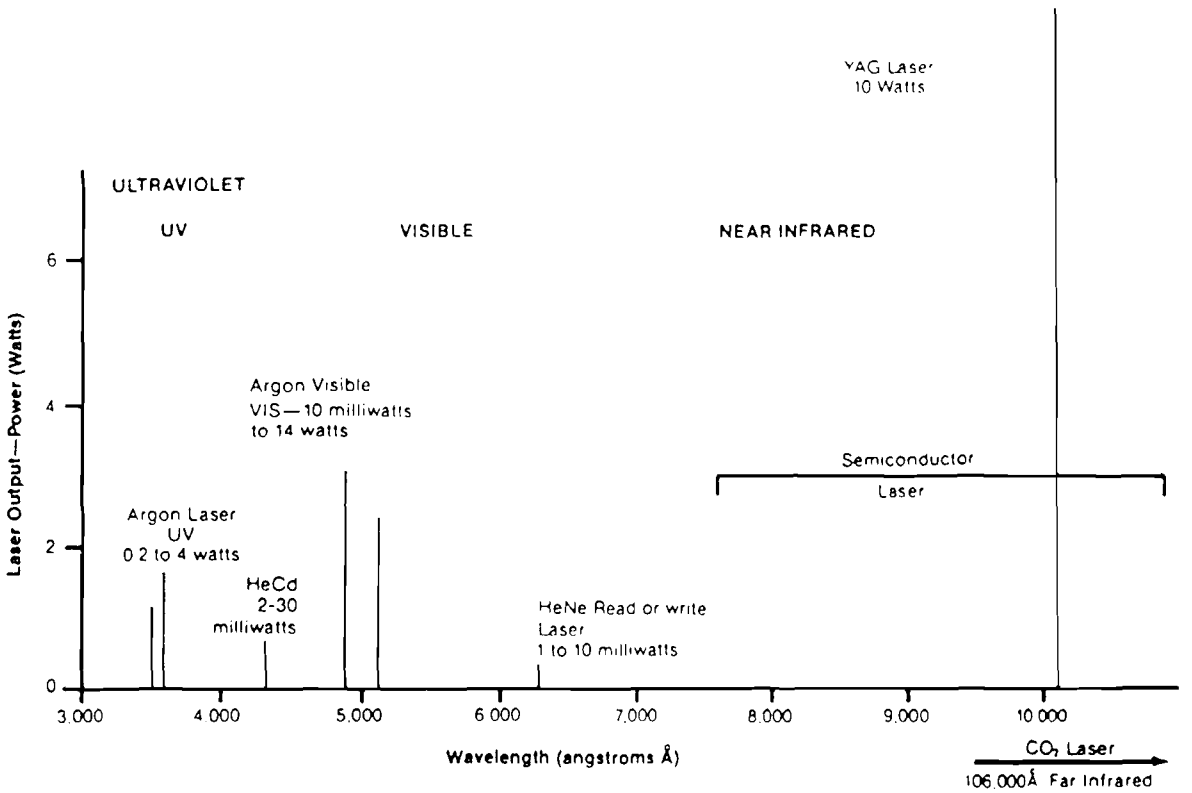

Figure 4: Lasers for Graphics Arts Imaging

choice. Remember that currently all halftone proofing is UV sensitive (that is argon, HeNe, and semiconductor lasers).

We also know all the performance parameters of lasers; their cost per hour, their reliability, etc. (Figure 5). It's been clear for four or five years now that UV lasers simply won't make it in our industry. So that totally precludes the direct laser exposure of Cromalin and Matchprint as these materials currently exist. The same holds true for Fuji, Sage or ENCO proofs; all of which are of the UV, sandwich, single sheet type.

This has left us with very few laser choices and very few technology choices. From Figure 6, we see that we are restricted to the silver halide, electrophotographic, and just at the bottom end of visible photopolymers.

For about seven years now, it has been well known that there are very few technologies that will permit realistic direct digital color proofing. One possibility is to convert the UV photopolymer based proofs to visible sensitized photopolymers, (which was one of our projections seven years ago because we knew about the visible photopolymers of Kodak and 3M which we'd tested at EOCOM) and the other is electrophotographic technique.

Now, (Figure 7) what is being called direct digital color proofing includes a variety of products and technologies such as those from Hell, IRIS, and MacDonald Dettwiler; the heat transfer systems, the Mead process, etc.

All of these technologies will find homes and wide uses in the graphic arts industry. Not all of them will be color proofs, and shouldn't be touted as color proofs. There is some concern on our part for some of these technologies. The closer these technologies get to "realistic" color the more trouble they may get us into. This is because people will then start making printing judgments on "almost good enough" color. They will tell us to print the color they see. And that could be dangerous, especially with ink jet and contone technologies.

In addition to the same proof throughout analogue/digital requirement, which has been underlined by the development programs that we're seeing in what we're choosing to call the **color proofing**

Laser	*Power (watts)*	*Dominant Wavelength (Å)*	*Costs ($000)*	*Operating Costs ($/hr.)*
UV argon, high power	1–3	3,511, 3,635	25–30	2–4
UV argon, medium power	0.05–0.2	3,511, 3,635	10–20	0.5–1
Visible argon, high power	15–20	4,880, 5,145	25–30	2–4
Visible argon, medium power	0.2–5	4,880, 5,145	10–20	0.5–1
Visible argon, low power	0.01–1	4,880, 5,145	5–10	0.1–2
Helium neon, low power	0.001–0.01	6,328	0.1–2	Negligible
UV krypton, high power	1–2	4,067, 4,131	25–30	2–4
Visible krypton, high power	4–6	Several good lines	25–30	2–4
Helium cadmium, low power	0.005–0.05	4,420	3–8	0.5–2
Infrared CO_2, high power	Several hundred	106,000	20–100	1–4
Semiconductor, lower power	0.001–0.015	7,000–13,000	0.1–2	Negligible
Infrared YAG, medium to high power	5–100	10,600	8–50	0.5–1

Notes: (1) Helium cadmium laser has a UV line at 3,250. (2) Argon and krypton have many less powerful lines and can be used in mixed-gas configurations. (3) Laser types vary in wall plug efficiency percentage and in water-cooling requirements. (4) Hourly operating costs include tube replacement and maintenance but not electricity and water.

Figure 5: Comparison of Lasers for Graphics Arts Imaging

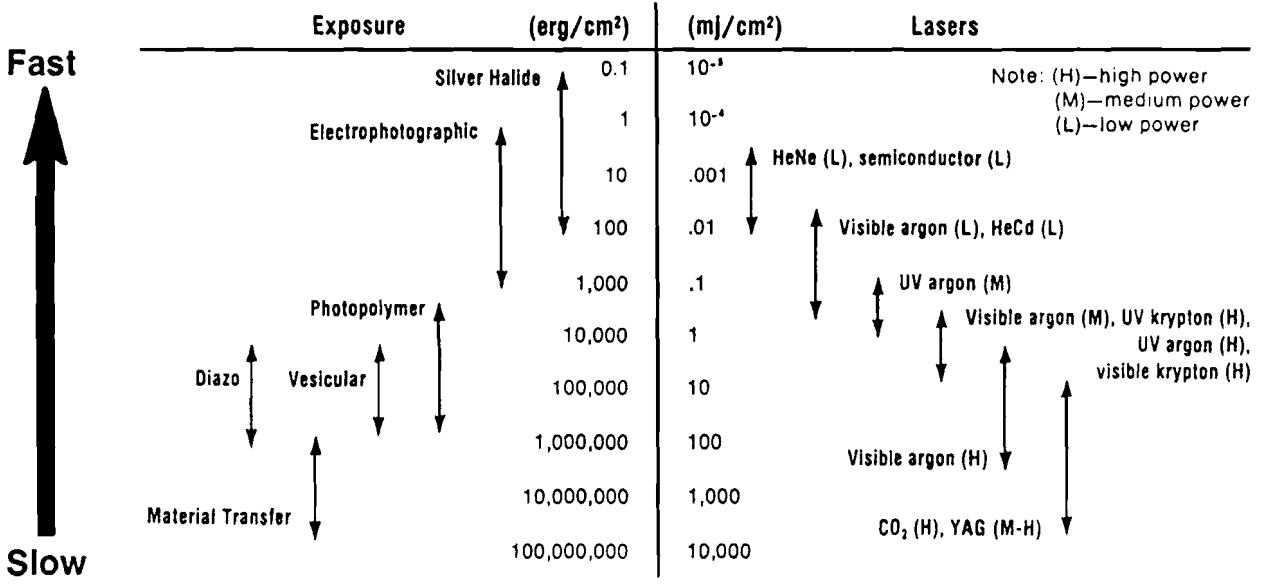

Figure 6: Comparison of Light Sensitive Technologies and Laser Energies

- Heat Transfer
- Electrostatic
- Color Photo Paper
- Diffusion Transfer Color Photo Paper
- Ink Jet
- TV
- Electrophotography
- Current Color Proofs

Figure 7: Touted Color Proofing Technologies

DDCP TECHNOLOGIES

* Expensive Equipment
* Lower Cost Proof?
* "Ink on Paper" Look
* Higher Speed

ATTACK PRESS PROOFING
MULTIPLE COPIES

Figure 8: Parameters of New Color Proofing Systems

war, there is also the multiple copy issue. What is being fought over is not only the current 25 million square feet of finished proofs in this business but also a significant expansion into the proof press area. This is being looked at to replace that multiple copy need, the 10-20 copy need. And that is a direct and deliberate target of some of the new proofing systems.

The ink-on-paper look offered by several of the new proofing systems also brings the Japanese market into the war because they do not currently use prepress proofs. They use press proofing.

So there are several underlying battles in this prepress proofing war. These are being stimulated by the technology required for the digital world and are also being driven, in practice, by the same proof throughout requirements. The vendors are all looking at much larger proofing markets, as the number of proofs per image produced goes down due to the use of electronics, and by replacing press proofing. This may be possible because of the potential lower cost and increased speed of making a prepress proof. At the same time the vendors are looking at entering the part of the European market which uses press proofing plus the entire Japanese market which is also a press proofing market. As you can see, there are a lot of factors at play to explain the rather broad dynamics occurring in the entire prepress proofing area.

What one can expect to see out of all of this is expensive equipment (Figure 8). The Coulter machine is $159,500; Kodak is saying, "under $200,000." You can expect all of these machines to be in the $100K to $200K range and maybe even higher. But roughly they will be in those kinds of price ranges as both direct digital color proofers and as analogue proofers.

The main difference between the digital proofer and the analogue proofer, aside from being driven by digital data, will be the format size. Generally there are restrictions both in how you want to use it as well as how expensive it is, to make very large scanners. So you can look at up to 12 x 18 inch scatter scanners for your digital proofer and the 30 x 40 inch image analogue systems, such as Kodak's Signature, to cover the scatter proofing and signature proofing end of the application.

The hope is that a lower cost proof will be produced to compete in that press proofing market. It should have an ink-on-paper look and be able to handle all of the stocks. An added nicety *for some* markets would be a double sided capability. However, everybody with electrophotographic proofers is currently the most comfortable with coated stocks. For the most part, uncoated stocks have been limited to testing under relatively good control. This includes Coulter, by the way, despite the fact that they suggest they can can any paper stock (2).

Another hope in this entire issue is that we'll get much higher speed in production. All of this then will lead to a significant market displacement in the press proofing arena. This will occur here in the United States as well as in Japan and Europe and Australia and New Zealand.

The proofing war is basically split into two kinds of wars (Figure 9). First, there are three companies that are attacking market share with look alike conventional UV technology; these are Sage, ENCO and Fuji Photo. Thus, 3M and DuPont are currently facing attacks in the area of new technology as well as from look alike technology. It is going to be interesting to see what will happen to pricing as people struggle for market share in basic competition in a mature technology, namely the UV sandwich proofs.

And then there is the technology war. The tip of the iceberg is really all we see, namely Kodak, 3M, DuPont and Coulter. Now we have all known about the Coulter system for quite some time. You've just been given a presentation on the Kodak system so I won't go into that (Figure 10). I want to remind you though, that when you buy one of these expensive proofers you are likely to buy two. You need back-up, you can't be out of the proofing business. So again, I stress that when you decide to discontinue using Cromalin and Matchprint and decide to get a $200,000 3M, DuPont, Kodak, Coulter wonder, you might have to have two of them. So keep in mind that when somebody says $200,000, it may really be $400,000 as a realistic entry into that technology with back-up. This will also double your floor space requirement, since most of these systems are fairly big in size.

COLOR
PROOFING WAR

* Technology
* Market Share

TECHNOLOGY
* Kodak
* 3M
* Coulter

MARKET SHARE

* Kodak
* 3M
* DuPont
* Sage
* ENCO
* Fuji Photo

Figure 9: Battlegrounds for the Color Proofing War

KODAK SIGNATURE

* Positive/Negative Switch
* 20 Minutes: 30 x 40 inch
* Select-A-Dot
* Density Control
* Selected Stocks
* 4 Colors
* $200K

Figure 10: Kodak Signature Overview Parameters

DUPONT

* 5 Colors
* 5 Minutes (1st Proof)
* Faster Multiple Copies
* Dot and Density Control
* Positive/Negative Switch

DDCP NEXT
BASED ON
SILVER/PC FILM

Figure 11: DuPont Electrophotographic Color Proofing

An important part of Kodak's announcement is that they are committed to having the next product in that product line be a direct digital color proofer. As such, Kodak now has an on-going onslaught of technology into the color proofing market which includes digital and analogue proofing using the same electrophotographic technology.

Now just to be sure that we've covered all of our technology bases, 3M appears to be bringing out a visible photopolymer version of Matchprint. If this is the case, then they have the "same proof throughout" concept, assuming that visible photopolymers in Matchprint dyes look like Matchprints with UV photopolymers. Their next choice may be to move their contact or conventional proofing into the visible range. Now this will have to be a laser that's larger in power than your current color scanner (probably in 100mw to 1 watt range) because the sensitivities of these materials are quite a bit less than film. They are more in the 1mj/square centimeter range, thus being about a 100 times less sensitive than color scanner film.

So 3M's current onslaught, in the digital proofing area, appears to be to continue full force by converting their UV photopolymers of the Matchprint process into visible photopolymer.

Now in the electrophotographic business of course, we have Kodak, DuPont and Coulter. The DuPont announcement we got last week because we were putting together a very large story for our newsletter, (3).

DuPont (Figure 11) is talking about an electrophotographic proofer using the Landa process, for which they obtained a license a couple of years ago. They're talking about a five minute proof as compared to the Kodak 20 minute proof. But more importantly there's a subset comment that multiple copies will come faster. So maybe what they have is five imaging stations to get the speed. Then once you go to replicate copies it would run five times faster. This could potentially result in a proofing technology that looks like one per minute, and thus begins a real pressure on the press proofing segment.

Again DuPont claims many of the same things as Kodak: dot and density control and positive/negative bi-modal photoconductors.

The interesting "gotcha" of their product is that it is based on a silver halide emulsion on a photoconductive film. That is, the scanner film on stripping is also a photoconductor. Because of the time, I'll leave you to think of many potentials in that type of process. But, it may be possible to make printing plates (by toner transfer) with the same process as the color proof.

I think we're going to have a very exciting five years in color proofing. We've got all the big boys fighting battles, with some of the smaller players in there as well. I think at the end of the next five years, the printing business itself is going to be much happier with color proofing than it is today, due to the immense amount of money that is squaring off right now in the technology issues and market share issues in color proofing.

---

(1) *The Markets and Technologies for Direct Digital Color Proofing*, A Dunn Report, copyright 1986, Dunn Technology, Inc. (Available from DUNN TECHNOLOGY Inc, 1855 E. VISTA WAY, VISTA, CA, 92084, 619-758-9460).

(2) *User Reports on the Coulter Proofing System*, **The Dunn Report,** (monthly newsletter), Vol. IV, No. 1, Jan. 1986, pg. 1-2.

(3) *DuPont Counter-Attacks*, **The Dunn Report** (monthly newsletter), Vol. 4, No. 5, May 1986.

Bibliography

Bruno, Michael H., *A Color Proofing Update*, **American Printer,** July, 1985.

Ceperich, Bill, *New Generation of Spectra Color*, **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 174-179.

Cloud, Ken, *Scitex's Color Output Options,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 245-256.

Dannenberg, Richard, *A Users View of the CPR403 Proof Recorder,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 234-235.

Dunn, S. Thomas, *Continuing Evolution of Electronic Publishing,* **TAGA Conference Proceedings,** 1981, pp. 394-421.

Dunn, S. Thomas, *An Update on Laser Imaging for the Graphic Arts,* **TAGA Conference Proceeding,** 1982, pp. 2-30.

Dunn, S. Thomas, *Historical Perspective of Electronic Prepress Systems,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 1-9.

Dunn, S. Thomas, *Color Proofing in the Electronic Environment,* **1985 Lasers in Graphics Conference Proceedings,** pp. 151-155.

Dunn, S. Thomas, *Current and Future Directions of Digital Prepress,* **TAGA Conference Proceedings,** 1980, pp. 279-304.

Fisch, Richard, *Need for Standardization for Graphic Arts Control,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 194-205.

Gilchrist, John, *Initial Use of a Coulter Proofing System,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 234-225.

Jordan, Brian, *Crosfield's Color Output Devices and Second Generation Originals,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 236-241.

Nims, David, *Digital Proofing: An Operational Reality,* **1985 Lasers in Graphics Conference Proceedings,** Vol. 1, pp. 156-164.

Ryan, Dennis, *Second Generation Color Corrected Originals,* **1985 Lasers in Graphics Conference,** Vol. 1, pp. 226-233.

Santos, Richard, *Is Ink-Jet Good Enough,* **1985 Lasers in Graphics Conference,** Vol. 1, pp. 165-173.