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Computer Imaging Technology: The Process of Identification

INTRODUCTION

In 1930, not anticipating the advent of the computer, Paul Valery said that the arts could no longer escape the influence of modern science and technologies. Great innovations would change all techniques of the arts influencing creativity and perhaps going so far in the end as to transform the concept of art itself.[1] Today, with it's wide spread use, the computer appears to have become an innovation of this sort.

Over time, many technological innovations have influenced the arts. No one would have anticipated how far reaching Senefelder's laundry list dashed off on an inking slab in 1796 would be, yet today we think of lithography not only as a means of commercial printing but also as a fine art print-making process. Similarly, with the advent of photography, the challenge of justifying an art which relied so heavily on a machine became real. Edward Weston said of photography "Wouldn't it be funny, if one could pierce the future, and find that [photography] was accepted as a great art form, because the mind— 'intelligence', that is —could be directed through a machine in a purer form, without the bungling interference of the hand!".[2] Warhol went further-not only did he advocate the use of modern technology in art, but commented that he'd actually like to *be* a machine. Unselfconscious about his reliance on machines, Warhol's soup cans and Coke bottles, both in their everyday subject matter and mechanical methods of execution, are prime examples of an artist working with, and reacting to, the technology afforded him by the time in which he worked.

The rapid growth of the computer graphics field, and the dramatic changes it has undergone, make it impossible to identify all of the processes one can employ. At times it is impossible to even ascertain if the computer has been used at all. Initially, output or hard copy was not of importance for computer artists, who in the 50's merely photographed their computer screen. By the 80's, many artists were outputting onto 35mm film and either projecting the image onto canvas, having it photoengraved or printing in traditional photographic format.

It will be, and for some of us already is, the responsibility of the conservator to maintain and care for these collections. To do that effectively we must understand, first of all, what we're looking at. The 'digital imaging' profession classifies these print technologies in a similar manner to traditional print-making processes—relief, intaglio, planographic and serigraphic. The four digital systems investigated here are: thermographic, ink jet, electrographic and fujix printing systems.

THERMOGRAPHIC PRINTING SYSTEMS

These systems rely on the application of heat to form an image. Specifically, *thermal transfer* systems, introduced in the late 1970's and early 80's, employ heat to transfer colorant from a carrier to a final substrate. Each color is transferred individually, the paper passing under the printhead three times allowing for the transfer of cyan, magenta and yellow colorants. There are a number of processes which fall into this broad class of printers. The two currently investigated are only related in their use of heat to transfer colorant.

Direct Thermal Transfer (commercially known as: thermowax)

This is an inexpensive system which produces fairly low resolution images. A sheet of smooth paper and a donor ribbon with a thermoplastic, wax containing ink layer, move in contact under a thermal printhead. The application of heat through the donor ribbon causes the ink to release and transfer onto the paper.

Identification

- The opaque thermoplastic ink has a high wax component, and under raking light the surface looks waxy.

- The image is visibly made up of cyan, magenta, yellow and often black dots, arranged in a pattern relating to the movement of the printhead.
- The individual colors can be seen laid down beside one another, requiring your eye to mix them (similar in concept to off set lithography)(fig. 1).

Identification

- These prints have a gloss.
- There is a distinct topography revealed in specular light (fig. 2).
- Poor registration in the transfer of dye layers may cause one color to be visible at an edge.
- Unlike the direct thermal transfer process where the image is made up of a regular pattern of dots, the image is constructed of square pixels (fig. 3).

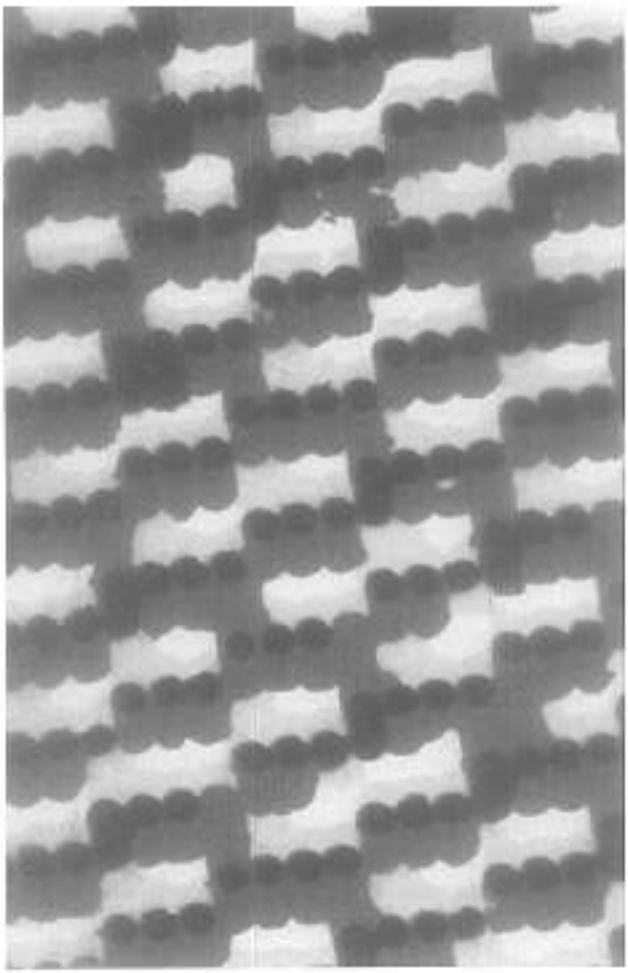

Fig. 1. Detail of direct thermal transfer print at 50x magnification

Fig. 2. Dye diffusion thermal transfer print in specular light

Dye Diffusion Thermal Transfer (commercially known as: dye sublimation)

Dye diffusion thermal transfer prints are billed as near photographic in quality. A ribbon, carrying dye based colorants, and a sheet of chemically-coated paper, move in contact under a thermal printhead. The application of heat makes the colorant gaseous, which then condenses on the support. The amount of dye transferred from the ribbon is determined by the amount of heat supplied by the printhead, allowing for what the industry terms 'continuous' tonality.

- A smoothly coated, midweight, bright white paper is used. The words *electronic imaging paper* may be printed on the verso.

INK JET PRINTING SYSTEMS

Ink jet systems are based on the emission of streams of colored ink from a nozzle, deposited on a support to form an image. Ink jet technology was invented in 1965 and finally became commercially available in the late 1970's. Two classes

of ink jet technology have been studied, differing in the system which controls the flow of ink.

Impulse Jet (commercially know as: drop-on demand, phase change)

Impulse jet printers are inexpensive machines which produce fairly low resolution images. These printers expel drops of colorant in response to an applied signal in the form of heat, pressure or a pulsed electric current. As the support moves under the print head, ink is projected from the nozzles to form an image. This technology often employs water based dyes, however, solvent based or hot-melt colorants which have a high wax component have also been used. A wide variety of supports are available, including: paper, coated plastic, glass, and metal.

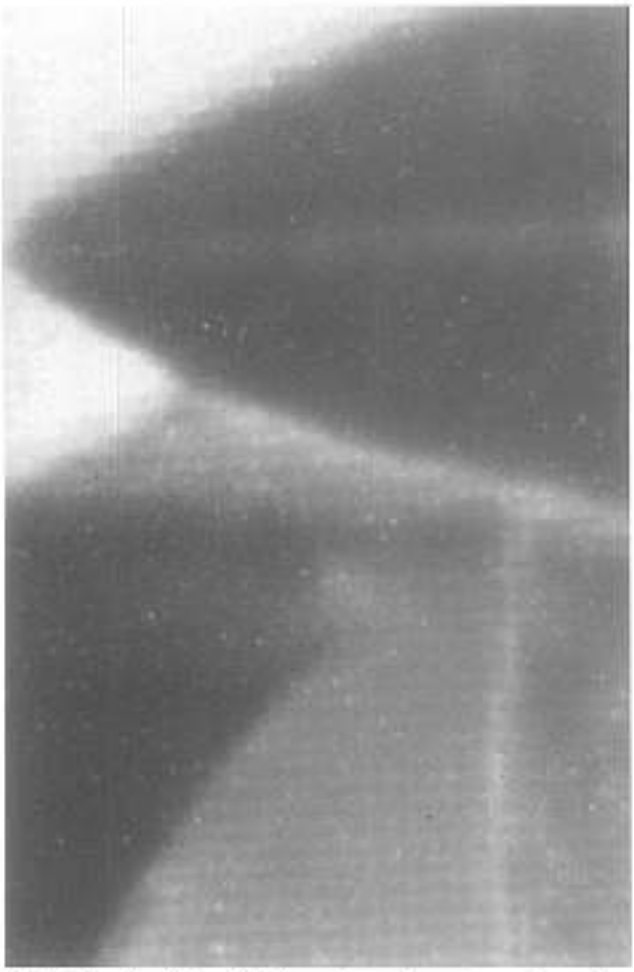

Fig. 3. Detail of dye diffusion thermal transfer print at 25x magnification

Identification

- The image is made up of drops of cyan, magenta, yellow and black colorant.
- The use of a range of supports causes a variety of characteristics, based on the absorption of the colorant into the support. Notable differences can be seen between images printed on paper compared to those on plastic (figs. 4 and 5).

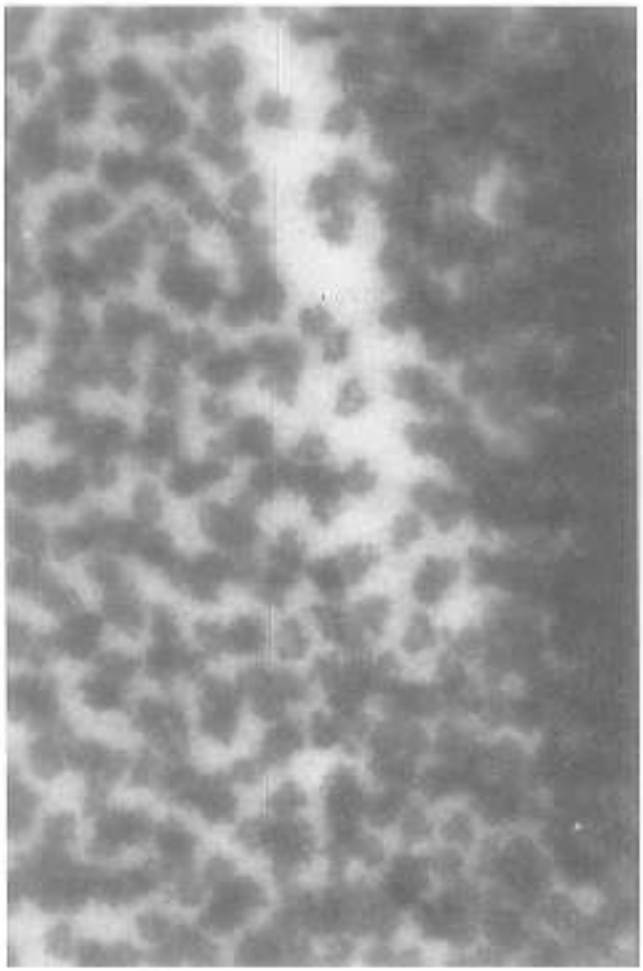

Fig. 4. Detail of impulse jet print on paper at 50x magnification

- These distinct dots don't necessarily conform to a pattern.
- Droplets, which splatter behind the drop of colorant, called "satellite" drops, are sometimes visible and easily identified (fig. 5).
- The use of hot-melt medium is visually very distinctive under the microscope. The raised drops easily identify this print technology, and are especially noticeable under raking light (fig. 6).

Continuous Jet (manufactures: IRIS, Stork)

Continuous jet printing, produces very high resolution images. The technology employs a steady emission of water based dyes through a nozzle. This stream of colorant is either allowed to break up naturally into individual droplets or separated by ultrasonic vibrations. Drops are selectively charged according to the image. They pass through a high voltage deflection field and are either deflected onto the support or collected in a reservoir for recycling. A range of papers or coated plastic supports can be used, although highly absorbent papers are often chosen to increase the visual resolution. Although it is conceivable to have pigment dispersions in water, rather than dyes, their use is presently limited due to the small size of the nozzles and problems of clogging.

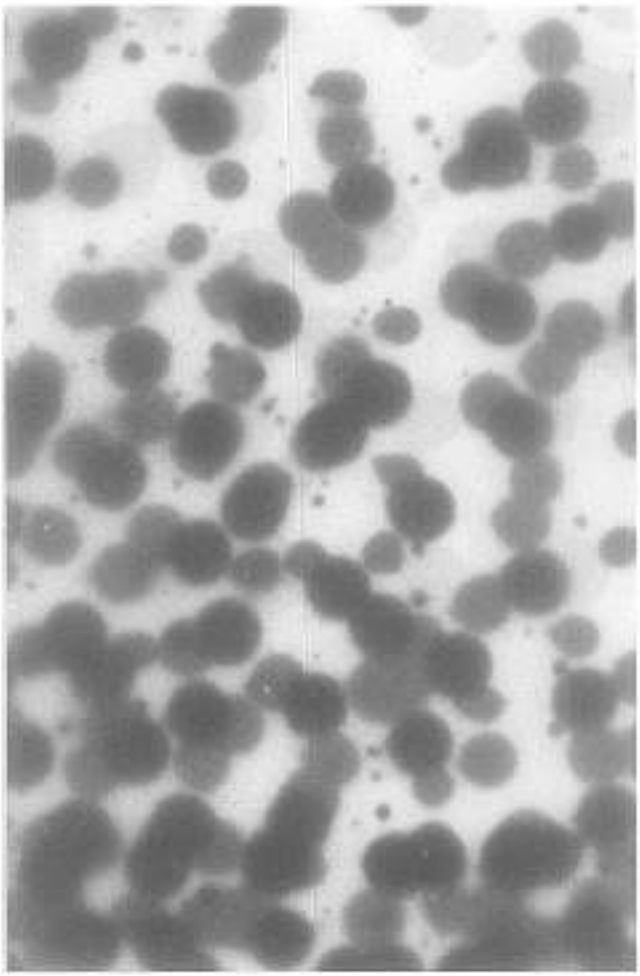

Fig. 5. Detail of impulse jet print on coated plastic at 50x magnification. "Satellite" drops are visible

Identification

- These works are made up of very small drops of cyan, magenta and yellow colorant. However, the use of highly absorbent paper produces an almost continuous tone image to the naked eye. This is exaggerated in areas of dark solid colors where the amount of dye is so great it disguises the dot construction (figs. 7 & 8).

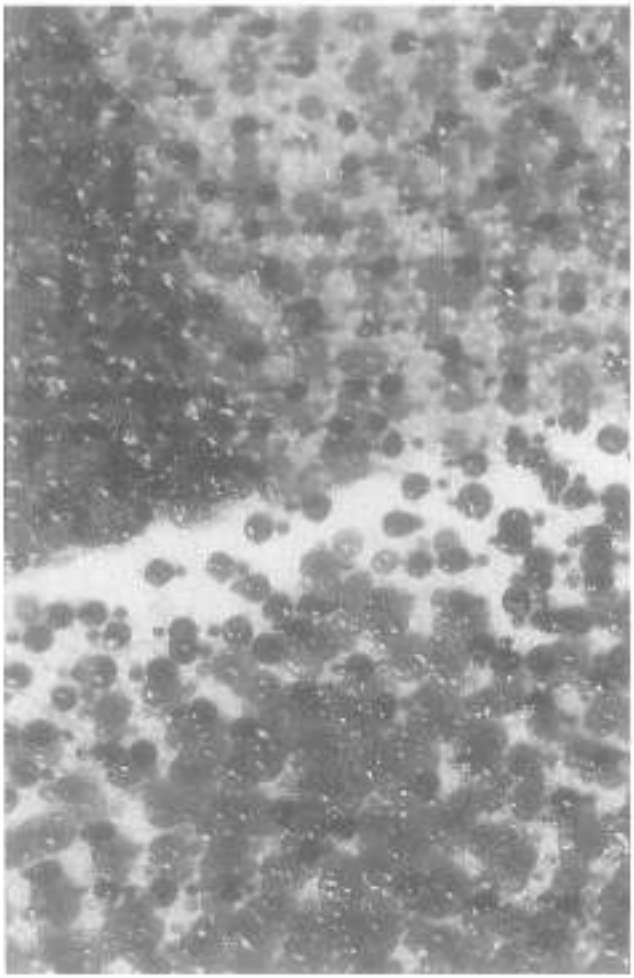

Fig. 6. Detail of impulse jet print, using hot-melt colorants at 25x magnification

- Slight faults or inconsistencies in the image are also sometimes found in continuous jet prints, such as a more pronounced horizontal line.

ELECTROGRAPHIC PRINTING SYSTEMS

In this process a charged drum or belt is selectively discharged to form a latent image. This electronic or latent image is rendered with opaque toner and fused to

paper. This type of imaging system was invented in 1938, and called xerography. In 1959 Haloid, now Xerox, produced the first commercially available automatic copier. There are a number of similar systems based on the same basic principle, with many different names: xerography, ionography, magnetography, and electrostatic printing systems. These can also be classified as *toner based* technologies. Electrophotographic (commonly known as: laser printers, standard photocopiers etc.)

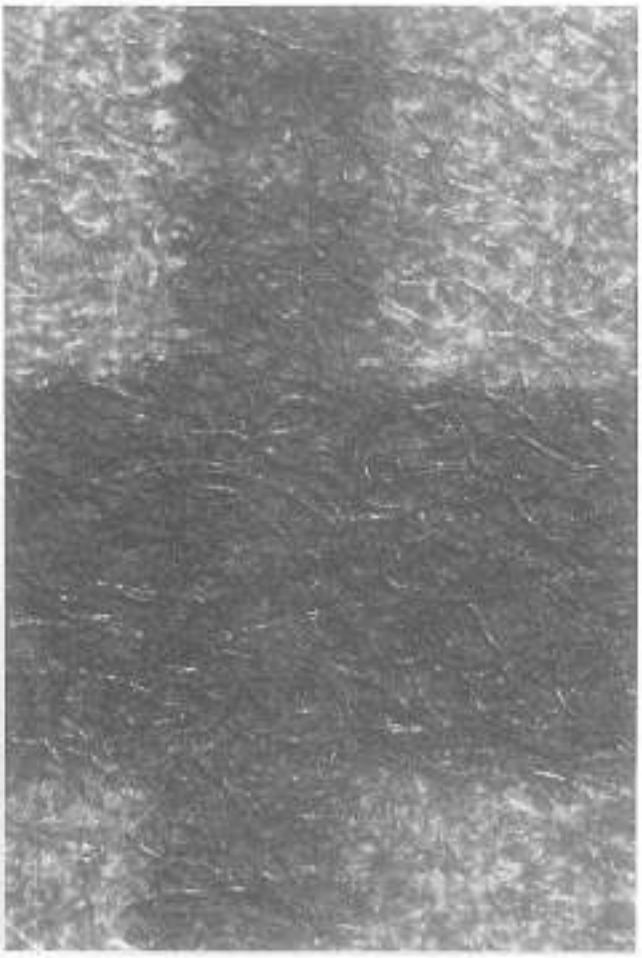

Fig. 7. Detail of continuous jet print on absorbent paper at 50x magnification.

Specifically, electrophotographic systems employ a light sensitive photoreceptor as the drum or belt. The colored toner is laid down in three or four passes, requiring the photoconductor to be sensitive over the entire visible spectrum. At each pass one of the colored toners is presented to the electrophotographic surface. As a final step the complete image is transferred to paper and fused by means of heat, pressure or a combination of the two. The colorants used are synthetic dyes in thermoplastic resins, and the support is often plain paper. Although a range of papers can be used, the fusing subsystem is most effective with a relatively smooth paper.

Identification

- The image is made up of small round plastic particles which are clearly visible under magnification.(fig. 9).
- The layering of plastic particles causes a topographical buildup of the medium, and gloss can be seen

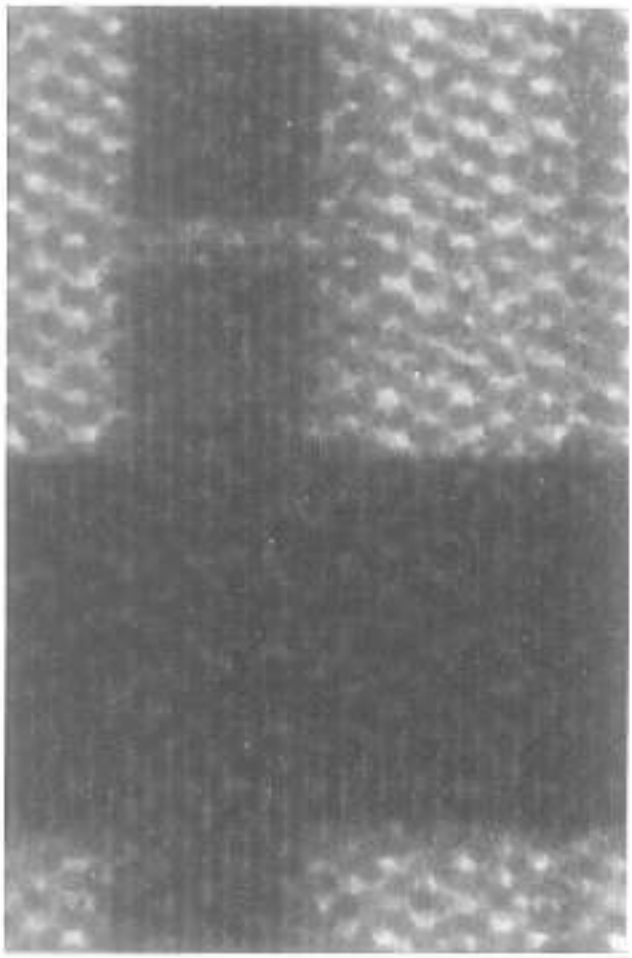

Fig. 8. Detail of continuous jet print on coated paper at 50x magnification

in raking light. This is especially noticeable in areas of dense dark medium (fig. 10).
- Many images produced in this process are constructed of lines caused by the linear scanning of the photoreceptor (fig. 9).

FUJIX SYSTEMS

Fujix systems are silver halide photographic processes which do not require chemicals for image development.

Sometimes referred to as 'thermal silver development dye diffusion color imaging'. There are two processes: the *pictrograph* and the *pictrostat*. Both use the same photographic process, however, the pictrograph outputs from digital image data and the pictrostat prints from transparencies, negatives or positive originals. In both, photosensitive donor paper is exposed by laser diodes at levels which correspond to the input image. There is a small amount of silver in the donor paper which aids in the capture of light.

Fig. 9. Detail of electrophotographic print at 50x magnification

Heat and a small amount of water is applied to create a dye image in the donor paper, which is then transferred to the receiver sheet. The dyes in the receiver sheet do not contain any silver.

Identification

- This process produces images of photographic quality.
- Unlike the dye diffusion thermal transfer print, a one pass process means there are no potential registration problems as the layering of the different colored dyes occurs in the donor paper, transferring a solid color to the receiver sheet.
- The Pictrograph system is identified by its visibly pixelated nature.
- The Pictrostat system is identified by its continuous tonality, comparable to other color photographic processes.
- The current maximum size paper available for the Fujix processes is 8 1/2" by 11 3/4 inches.

Fig. 10. Electrophotographic print in raking light

- It is likely the words *Fuji Film Pictro Paper* are printed on the verso.

CONCLUSION

The computer has become an instrument for contemporary artists. In this arena, digital imaging technology is being employed to produce hardcopy art. The identification of these works is crucial to understanding their storage, handling and display needs as well as treatment options and limitations. Identifying all of the

digital imaging processes currently available is an enormous task, and despite our best efforts, the rapid development of this technology will continue to make that a challenge.

NOTES

1. Crone, R. (1989). "Form and Ideology: Warhol's Techniques From Blotted Line to Film" in *The Work of Andy Warhol: Dia Art Foundation* #3. Seattle: Bay Press, page 70.

2. Stainback, C. (1993). "From Those Wonderful People Who Brought You Innovation" in *Iterations: The New Image.* Massachusetts: The MIT Press.

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