GILLIAN MARCUS

Caring for Electrophotographic Art: A Case Study of the Pati Hill Archives at Arcadia University

INTRODUCTION

Not long after Chester Carlson's Xerox 914 copy machine was first marketed to the business world in 1959, the photocopier found its place on the cutting edge of art production. Carlson's invention made life easier for office workers who had previously relied on slower and messier processes, such as the mimeograph system, for duplication. It also ushered in a new type of reproduction technology that was fast, cheap, and accessible (Xerox 1999). Almost as quickly as they were employed for more mundane tasks, photocopy machines were turning out electrophotographic (EP) prints destined for galleries and contemporary art museums.[1] The machine's simplicity and speed, as well as its ability to produce both abstract and hyperreal images, made it attractive to artists seeking to repurpose the technological conveniences of modern life as an extension of their artistic practice. When advances in technology made these machines smaller and more affordable to operate, copy shops staffed by "key operators" began opening up in cities and towns across the United States, making the grainy instant EP print accessible to almost anyone. Perhaps most significantly, the convenience of these machines allowed people who had not previously had access to traditional printmaking tools to quietly explore the possibilities of mass production.[2]

Artists with practices rooted in more traditional media, as well as members of the avant-garde Fluxus and International Mail movements, explored the newly available technology to produce what popularly came to be called Copy Art.[3] As with the initial embrace of any new technology, many artists experimented with electrophotography before moving on to other materials and modes of production, while a few became loyal to the medium. Pati Hill (1921–2014), an American writer and visual artist, found a home in the tactile process of making EP prints (Bailey 1980). Although she was not among the earliest adopters of the medium, Hill was one of the most prolific—producing an extensive body of EP work that spanned four decades, while also championing the work of younger artists experimenting with photocopy machines. In the spring of 2016, two years after her death, Arcadia University Art Gallery mounted a show of her early work, *Pati Hill: Photocopier, A Survey of Prints and Books (1974–1983)*. This event coincided with an announcement that the university would receive the entirety of Hill's archive, including thousands of black-and-white EP prints, through an initiative supported by Dorothy Lichtenstein.

Black-and-white EP prints are extremely common in archival document collections, where they are often considered secondary resources or copies of primary source material. However, there is a dearth of preservation and conservation literature providing a protocol for their care as art objects. Although the material composition of EP documents and fine art prints is often exactly the same, documents and art objects usually lead very different lives and, as a result, have different preservation needs. Preparing for this large acquisition provided the opportunity to examine the artist's methods and materials in order to begin establishing a set of guidelines for the care and preservation of black-and-white EP art. Although Hill experimented with digital electrophotography, color printing, and more traditional printmaking processes in the last decades of her career, for the majority of her practice she preferred to work with black toner on analog machines. This research focuses on the self-described "black pictures" of the artist's early career, ca. 1974–1983 (Torchia 2017).

PATI HILL: METHODS AND MATERIALS

By the early 1970s, Hill was already well-known for producing a significant body of written work; as a journalist and poet, she published one memoir, three novels, and one book of poems, as well as articles in *The Paris Review, Harper's Bazaar*, and *Seventeen*. After a break from writing and public life to raise a daughter, Hill began experimenting with the photocopiers that were available at copy shops near her Stonington, Connecticut home. The artist described her introduction to the photocopy machine as accidental; she was

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interested in keeping impressions of small objects she had saved over the years for sentimental reasons, but now wished to dispose of. Copying "bars of soap, zippers, fruit…and parts of old clothes—underwear and linen dresses" during regular visits to the copy shop led her to consider a more experimental approach to the machine's capacity for replication (Hill 1979, 156). She began feeding the copy shop machines with large amounts of black toner to increase the contrast of her prints, a practice that caused enough concern to key operators at her local copy shop that she was asked to leave. A sympathetic friend allowed her access to IBM offices in New York, enabling her to spend weekends using their copying devices as she pleased; she used this time to produce work for a show at the Kornblee Gallery in New York City. Hill's work was regularly featured at Kornblee Gallery, owned by art dealer Jill Kornblee, throughout the '70s; correspondence between the two women provided the basis for Hill's book, *Letters to Jill: A Catalogue and Some Notes on Copying* (1979). This text serves as both an artist statement and an insight into Hill's working methods.

In 1977, the designer Charles Eames, whom Hill met while traveling, provided her with an official introduction to IBM. Through this connection, Hill was able to secure an extended loan of the IBM Copier II to use at her home in Connecticut. Hill continued to focus her subject matter on the objects and detritus from everyday life, producing striking, simple images made from placing a single object on the copy platen. Her first series of prints, *Common Objects* (ca. 1975–1979) (fig. 1), was exhibited in the show *Common Alphabet* #1 (1978) at Franklin Furnace in New York City. This series focused on the objects of domesticity—eggs, hair curlers, socks, and cabbage, among other items—intended by Hill to serve "as a kind of de-Freudianized series of symbols that suggested language" (Hill 1979, 80). This interest in creating a visual language expanded upon her concurrent work *Proposal for a Universal Language of Symbols* (ca. 1975–79), in which she suggested the use of small runelike figures as a substitute for written speech (fig. 2).

Hill spent hours in the studio with the loaned IBM Copier II, reproducing commercial photographs, fruit, flowers, and even copying parts of a dead, frozen swan that she had dissected and placed on the copy platen (fig. 3)—all appearing to emerge from a tangible darkness. Alongside other artists working with the EP process, Hill earned a place in the state-of-the-medium show *Electroworks* (1979–80) at George Eastman House in Rochester, New York (and later Cooper Hewitt in New York City). Other group and solo shows followed, both in Europe and the United States. In the early 1990s, Hill's husband, the gallerist Paul Bianchini, opened two branches of Galerie Toner in Sens and Paris, France; these spaces were solely devoted to exhibiting art made using the photocopier (Torchia 2017).

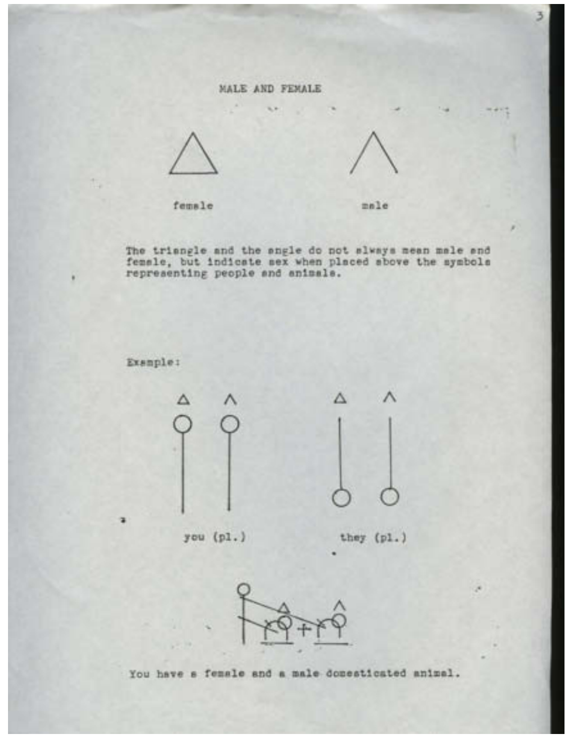


Fig. 1. Detail from *Proposal for a Universal Language of Symbols* (1975–79), black-and-white copier print, 28 cm × 21.6 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

Fig. 2. Pati Hill, *Alphabet of Common Objects* (ca. 1975–79). Forty-five black-and-white copier prints, each 28 cm × 21.6 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

DARK MATERIALS

The IBM Copier II became Hill's copier of choice, even after she was exposed to other models and manufacturers, and she favored this machine for its production of images, which were "grainier" and had "a greater range of tones and greater depth perception" in comparison to copies produced with other machines (Bailey 1980, 24). Introduced in 1972, the

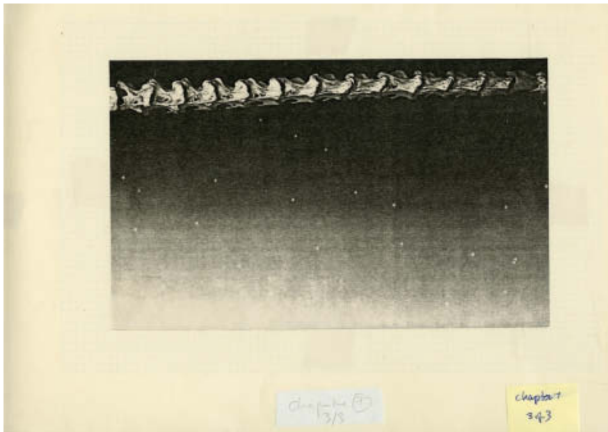


Fig. 3. Pati Hill, Detail of *Chapter 7 of A Swan: An Opera in Nine Chapters.* 1978. Electrophotographic print dry-mounted to mat board with artist's notes. One of a series of 32 captioned black-and-white copier prints, each 21 cm × 34 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

Fig. 4. The artist at work in *Contact* Magazine, May 1980. Courtesy of the Estate of Pati Hill.

Copier II was large, heavy, and expensive to rent, but it also had a faster throughput rate than previous models, at roughly 6 seconds per copy. It was also one of the first copy machine models to be advertised as suitable for photocopying three-dimensional objects (IBM 1972). The Copier II was key to the development of Hill's working process and early aesthetic, as it allowed her to have full control over the amount of powdered toner fed into the machine and the resulting darkness and contrast of the final print. Hill favored the deep, textured blacks she was able to produce by spooning in more than the recommended amount of toner into the machine, the same practice that had seen her banned from her local copy shop for "the excessive use of dark materials" (Torchia 2017) (fig. 4).

Almost all of Hill's prints made on the Copier II feature a signature pattern of seemingly random spots of white—areas without toner—which Hill referred to as "stars." These were especially prominent in the wide swathes of darkness of Hill's prints, and in fact she preferred prints in which the tiny white spots were most striking (fig. 5a). "Since I want this picture to be showy," she wrote in a letter to Jill Kornblee, "I think I'll make it very dark and try for some stars—holes, they are really—so I open the powdered ink till and shovel in the black" (Hill 1979; McCray 2017, 24). These stars, known as "trash marks" in the photocopy trade, appear in the same location in a run of prints of the same object (figs. 5b and 5c). Although Hill's writing suggests that they were enhanced by her heavy use of toner, they are likely the result of a defect on the photoconductor drum or dust, toner, or paper debris in the machine or on the copy platen (Young 2018; Day and Davies 2005). Eventually, out of necessity, Hill went on to use other copiers. This included the Rank Xerox 2600, which was smaller and allowed for sharper detail, and the Xerox 3107. Still pining for the deep blacks of the overfed Copier II, she sprayed the Xerox prints afterward with fixative to saturate the images and intensify the darkness (Hill 1979, Bailey 1980). There is no record of the fixative the artist used, although her assistant recalled her "spraying paper with glue" (Chakour 2017).

DETERMINING PRINT ORDER THROUGH VISUAL EXAMINATION

Although Hill was extremely prolific—reportedly collecting the day's work by sifting through dozens of prints on the floor of her studio—she recognized each print as a unique object. Hill wrote in her journal that "the possibility of anyone making more than one identical—or even very similar—analog print is small…they are original separate prints" (Ferrari 2017, 108). This is illustrated in an anecdote shared by Fouzia Chakour, a neighbor of Hill's in Paris who worked as the artist's assistant in the early 1980s. She remembers Hill teaching her to recognize the "original" versus the "copy" through examining the toner density and clarity of each print:

> Pati let me figure out my own way of categorizing and then explained to me the different themes and how to distinguish between the originals and copies by examining the various shades of grey and density of the toner. She taught me to see how the grain of an original becomes slightly 'dilated' when copied a second time. I learned that each time you make a copy of a copy, the quality of the image deteriorates (Chakour 2017, 58).

The phenomenon Chakour refers to is known as degeneration, or generation loss, and occurs as an analog photocopy

Fig. 5a. "Stars" can be seen in this print as small white dots scattered throughout. Pati Hill, detail of *Chapter 9* from *A Swan: An Opera in Nine Chapters.* 1978. From an installation of 32 captioned black-and-white electrophotographic prints, 21 cm × 34 cm. Courtesy of the Estate of Pati Hill.

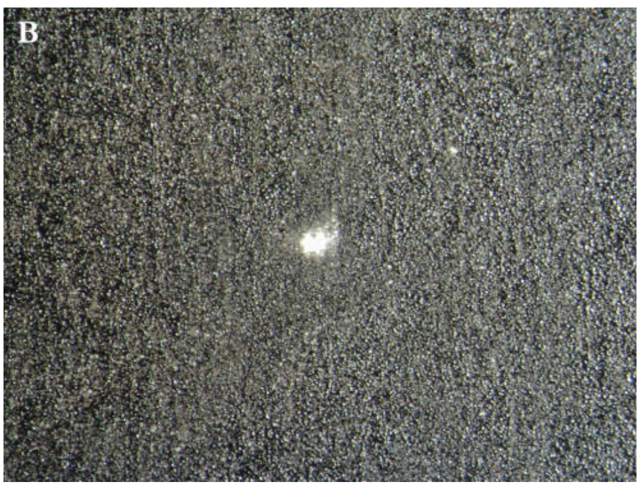


Fig. 5b. Stereo micrograph of a "star" at 60×. Courtesy of the author, Estate of Pati Hill.

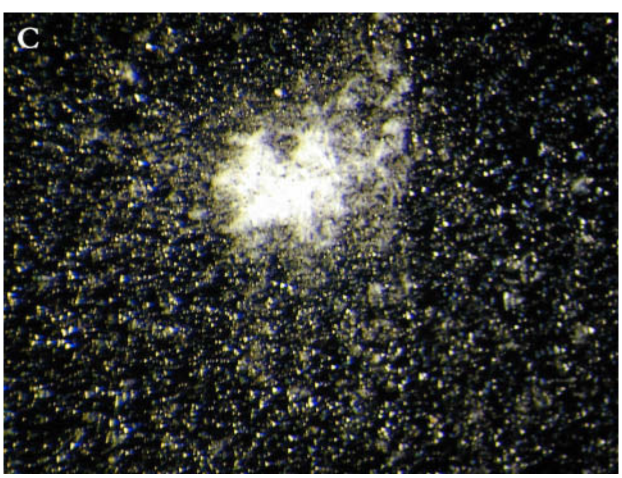


Fig. 5c. Stereo micrograph of a "star" at 310× under raking light, showing a complete absence of toner. Courtesy of the author, Estate of Pati Hill.

is reproduced multiple times. Each print became slightly "fuzzier," as defects were magnified with every subsequent print (Poissant 2002). In *Letters to Jill*, Hill also noted that the darkness decreased with each copy she made, as the toner stock depleted. In a medium that was celebrated for its ability to be used for the mass production of identical images, Hill took care to determine the sequence of production at the end of a day's work. Examining a detail from successive prints of the same configuration of objects under the microscope can clearly highlight visual differences caused by both image degeneration and the resulting changes in toner distribution patterns (fig. 6a). This is useful to identify the order that prints were made, and helps to identify whether an artwork is a "first print" of objects on the copy platen, or one of a series of copies of the first print (figs. 6b, 6c, and 6d).

The extent of generation loss visible in photo micrographs can be partly explained by a size discrepancy between the original object or image on the copy platen and the printed image. Most copy machines manufactured prior to 1980 were not able to produce images that were exactly true to size. Although the IBM Copier II was closer to exact size reproduction than

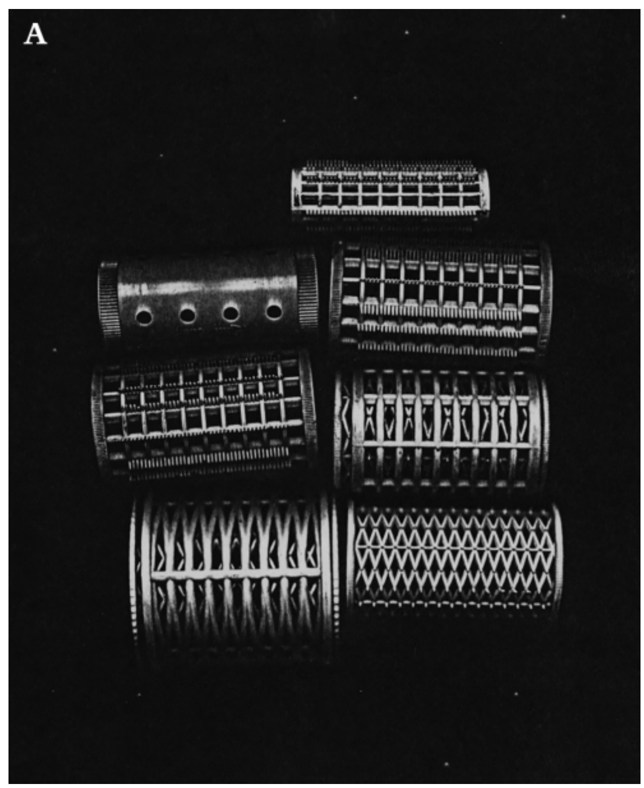
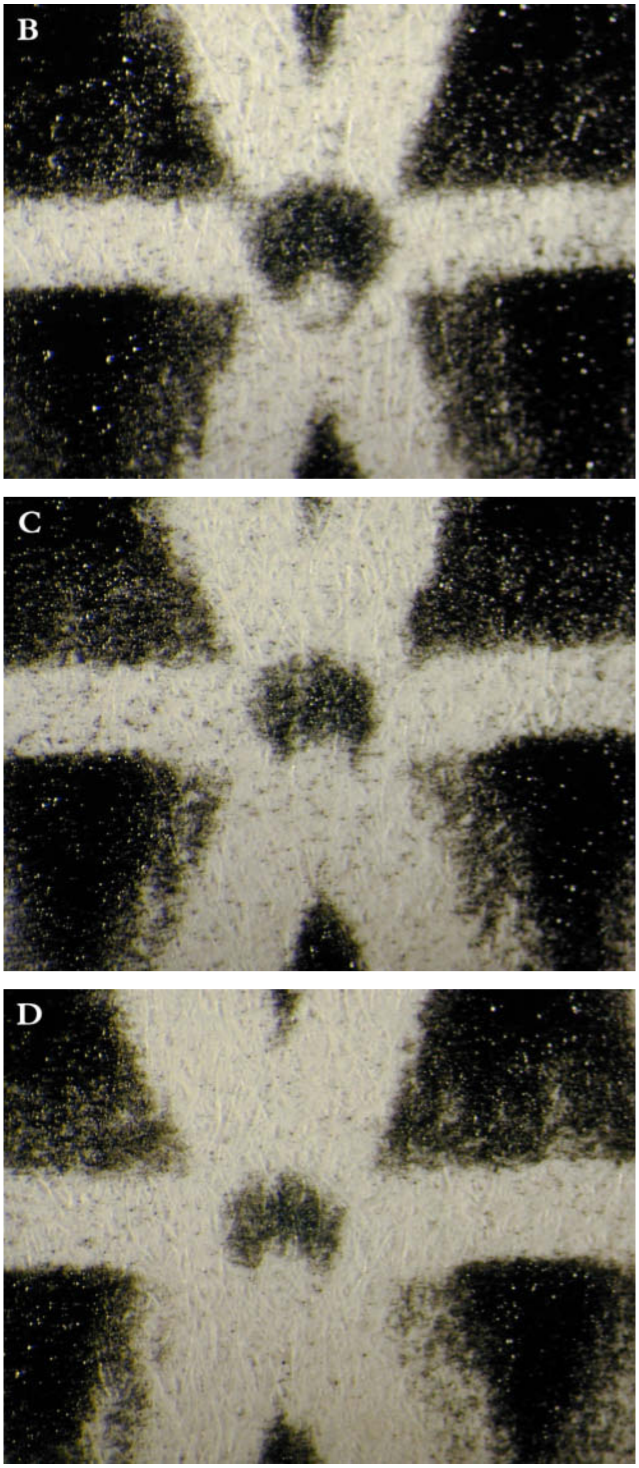


Fig. 6a. Pati Hill, black-and-white print of curlers from *Alphabet of Common Objects,* ca. 1975–1979. 28 cm × 21.6 cm. Multiple versions of this print exist, each with different configurations of curlers on the copy platen. Several prints, likely to be one first print and several copies of this print, were examined for signs of generation loss and changes in toner distribution (figs. 6b–6d). Courtesy of the Estate of Pati Hill and Arcadia University.



Figs. 6b–6d. Stereo micrographs (250×), detail of the print of curlers in figure 6a. Successive copies of the same image shows that toner distribution appears to become diffused and edges of details appear to lose sharpness with each print, characteristic of degeneration of the image. Courtesy of the author and the Estate of Pati Hill.

many other copiers, including Xerox models available at the time, there was still a slight discrepancy between the size of the object on the platen and the size of the image produced on paper. This was partly a result of the limitations of technology at the time, but was also an attempt by IBM engineers to reduce the potential for counterfeiting or fraud (Brewer 2015).

HOUSING AND ASSEMBLAGE

Hill appears to have done much of her own mounting and storage. Her very earliest work was of small objects, such as hairpins, keys, buttons, and other tiny odds and ends that had been cut out from their original sheet of copy paper. Some of these prints were as small as a postage stamp and were loose, unmounted, and housed in glassine envelopes at the time they arrived at Arcadia University. Many of these small prints had been adhered to larger sheets of paper in assemblages, using rubber cement as well as pressure-sensitive tape of various types (including masking tape, linen tape, cellotape, and other unidentified pressure-sensitive adhesives). As a result, many of these assemblages exhibited yellow or amber adhesive stains that appeared to have migrated from the verso to the recto; several of the small prints had become detached from the secondary support due to adhesive failure (fig. 7). The artist regularly mounted prints selected for exhibition directly to matboard using a dry-mounting press, a step that would have exposed the prints to a great deal of heat and pressure.

THE ELECTROPHOTOGRAPHIC PROCESS

Chester Carlson first patented his electrostatic printing process in 1939, using the term electrophotography—an amalgamation of "electrostatic" and "photography." However, the process was not made commercially available until 1950, when the Haloid Company (later renamed Xerox) manufactured the first commercial copy machines. The 1950 Haloid machine was difficult to use and was marketed mainly to copy letters, after the Battelle Memorial Institute, an American scientific research organization, had unsuccessfully attempted to market selenium-coated paper and plastic surfaces as photographic plates (Zachary and Rosenthal 1950). In 1959, the Xerox 914 became the first photocopy machine to be mass marketed to the public; before long, other companies picked up and expanded upon this technology and produced copiers of their own (Batterham 2008).

The multistep EP process is complex but can be broken down into a series of stages (fig. 8). In the first stage, an object or image is placed on the glass platen (the copying surface). Prior to 1987, analog copiers functioned by reflecting light from an illuminated image and projecting it onto the photoconductor drum (Hays 2003). (Post-1987, when photocopier manufacturers shifted to digital technology, the image was exposed on the photoconductor drum with a scanning laser or LED image bar.) Lighter areas of the image reflected more light, while darker areas reflected less light. An "electrical

Fig. 7. Pati Hill, untitled assemblage, ca. 1974–1979. Black-and-white electrophotographic prints adhered to translucent paper with pressure-sensitive adhesive, 28 cm × 42.5 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

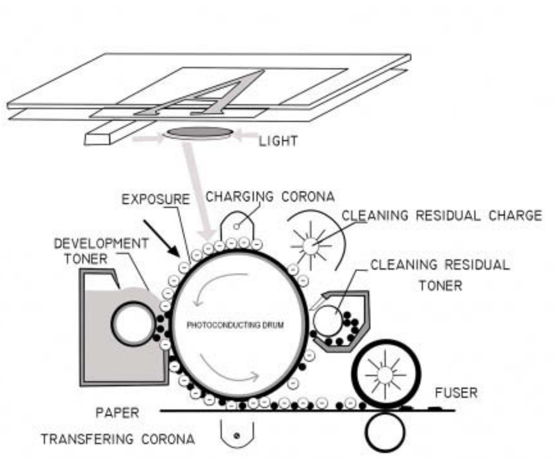


Fig. 8. Diagram of the analog electrophotographic process. Courtesy of www.photocopier.org.uk.

shadow" of the object was cast onto the photoconductor, a rotating conveyor belt or metal drum with a layer of a photoconductive material (usually selenium, germanium, or silicon). Functionally, this meant that areas exposed to light gained an electrical charge, while areas not exposed to light did not gain a charge. An ink drum carrying charged toner particles coated the photoconductor drum with toner, after which the sheet of paper was given a strong electric charge; as it passed near the toner-coated photoconductor drum it picked up the toner particles. This transferred the image from the photoconductor to the paper. In the final step, the toner-covered paper passed through hot rollers, which used heat and pressure to fuse the toner image onto the paper surface, after which excess toner was brushed from the photoconductor surface in preparation for the next print. The final product was the copy: an image formed from a layer of toner fused to a support through heat and pressure (Mizes et al. 2015).

MATERIALS

DRY TONER COMPOSITION

Dry toner powder is composed of a colorant (either dye or pigment), a polymeric resin, and other additives, often plasticizers or fumed silica. The polymeric component makes up 40–95% of the toner and, as it acts as a binder, the qualities of a particular polymer strongly influence the stability of the final print (Galliford 2001). Early copiers, including the IBM Copier II, used a two-component development system, in which carrier particles ferried the toner to the paper (Jürgens 2009). IBM patents show that toners manufactured contemporaneously to the IBM Copier II were composed of a polymeric resin, a modified polyester, plasticizer, and carbon black pigment, although it is not known if Hill used one or either types of toner for her work (Kukla and Munzel 1974).

COPY PAPER

The majority of paper manufactured for copy machines (often referred to as "plain paper" or "copy paper") was not generally designed for permanence, particularly prior to the mid-1980s. Properties such as moisture content, resistance to electric charge during the copy process, and low cost drove material selection for producing copier paper stock (Batterham 2008). It can be very difficult to identify the manufacturer of a particular copier paper but, regardless of brand, most American papers produced prior to the mid-1980s contained processed wood pulp and had a high lignin content. Copier paper was, and continues to be, manufactured with dyes or optical brightening agents (OBAs), depending upon whether the paper is colored or (more commonly) white.

Prior to the mid-1980s, copy paper was internally sized with a fortified rosin or rosin-alum sizing during manufacture (Grattan 2000). Many European copy papers were manufactured with CaCO3 (calcium carbonate) as a filler, which had the added benefit of serving as an alkaline reserve; however, copy papers manufactured in the United States did not have an alkaline reserve and were fairly acidic. Paper production techniques shifted around the early-to-mid-1980s, when rosin sizing was replaced with alkylketene dimer sizing and alkenylsuccinic anhydride sizing (Hubbe 2004).

RISKS TO ELECTROPHOTOGRAPHIC PRINTS

VISIBLE LIGHT AND ULTRAVIOLET RADIATION

The carbon black pigment in black toner is fairly lightfast; however, the pigments and dyes in colored toner or colored paper are often very light sensitive. Colored copy paper, used by Hill used for several of her series—including *Men and Women in Sleeping Cars* (1979) and *Garments* (1976)—is also extremely vulnerable to fading from visible and ultraviolet (UV) light. Photolytic degradation can occur quickly in poor-quality paper, causing the paper support to become brittle and discolored. UV radiation accelerates degradation of styrene/n-butyl methacrylate resin, a component of some carbon black toners. Polyester-based toners are also susceptible to damage from high levels of UV radiation, although they are slightly more stable (Subt 1987). OBAs added during manufacture are particularly susceptible to photolytic degradation, which can result in an increasingly yellow appearance as the brightening agent is depleted (Mustalish 2013).

HIGH HUMIDITY AND MOISTURE

Although very low relative humidity can result in brittle EP prints, the primary concern most collections face is relative humidity that is very high or fluctuates between extremes. Rapid fluctuations in temperature and relative humidity can cause physical damage to the paper support and result in planar deformations. Toner areas of EP prints are prone to cracking or delamination when the paper is exposed to high humidity or moisture and then dried; as the paper substrate swells and contracts, the resulting tension can disrupt the mechanical bond between the paper and toner. High relative humidity can result in blocking of EP prints and promote mold growth, as well as affecting the lightfastness of OBAs in copy paper (Mustalish 2013).

MECHANICAL DAMAGE

Inconsistencies in photocopier maintenance and operation can result in variations in the temperature at which toner is fused to the paper surface, which may be problematic for toner adhesion as a print ages. Prints with improperly fused toner are especially vulnerable to friction (for example, from a crowded storage box), which can result in abrasion and the dislodging of toner particles from the surface of the paper (Subt 1987). The toner-paper bond can be further compromised if the toner components break down with age through exposure to UV radiation or heat. Folding or creasing an EP print may result in cracking or delamination of printed toner areas, as the mechanical bond between the toner and paper is broken (fig. 9). It is unknown whether Hill's heavy application of black toner has had an effect on the mechanical stability of her early prints; it is possible that a heavy toner load may impact toner-paper bonding by insulating against the fusing process, or by changing the material properties of the print into something more plastic-like (Burge 2018). However, this remains conjecture until further toner-adhesion testing can be undertaken on Hill's prints.

HEAT AND PRESSURE

High temperatures accelerate acid hydrolysis and can result in significant changes to the toner areas of a print. Polymers most commonly used in toner manufacture have a glass transition temperature (Tg) of 122°F to 158°F. For prints exposed to high heat, this can result in separation, distortion, and dislodging of toner particles. It can also lead to softening at room temperature (Galliford 2001). This can result in prints blocking together or to other objects in close contact, especially in combination with increased pressure.

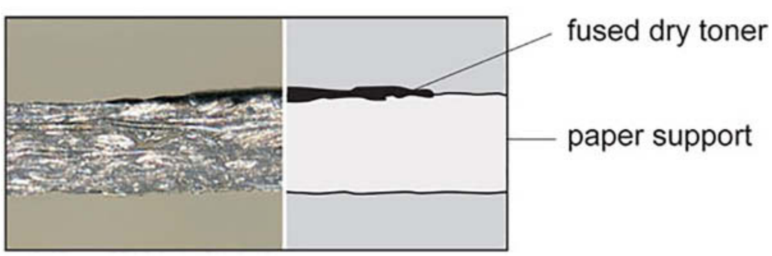


Fig. 9. Dry electrophotographic toner sits on the surface of the paper rather than penetrating. Courtesy of Image Permanence Institute and the Digital Print Preservation Portal, http://www.dp3project.org.

The closer the temperature in storage gets to the toner's Tg, the more likely blocking is to occur. Conversely, the lower the temperature, the less likely EP prints are to begin adhering to one another. A similar phenomenon can also occur if the copy adheres to the plastic or glass surface of an enclosure or frame (Jürgens 2009). Due to Hill's heavy application of toner, her prints have exhibited this phenomenon in storage.

PLASTICIZERS IN HOUSING MATERIALS

The use of polyvinyl chloride (PVC) storage sleeves or envelopes can result in plasticizer migration from the PVC into the toner, causing the toner to soften. This results in image transfer from the print to the PVC (Lowell and Nelb 2006). PVC storage materials should be replaced with polyester sleeves, which are chemically stable.

ORGANIC SOLVENTS

EP prints are sensitive to several organic solvents; in an early study of toner sensitivity, tests on IBM Copier II images showed that the toner layer dissolved upon application of ethyl acetate, toluene, trichloroethylene, and acetone (Porter 1980).

PAPER ACIDITY

Paper quality is one of the biggest factors affecting the longevity of EP prints. Poor-quality paper deteriorates over time, as acid hydrolysis of the cellulose weakens the paper. Even in the case of paper manufactured with an alkaline reserve, using acidic housing materials or poor-quality mat board for storage or display will result in acid migration; this can also contribute to the degradation of the acrylic components of the toner (Subt 1987).

DEGRADATION OF OPTICAL BRIGHTENING AGENTS

The majority of office copy papers manufactured in the mid-20th century and later were produced with OBAs (also known as fluorescent whitening agents or optical bleaches). These "colorless dyes" work by absorbing light at the near-UV range, while emitting light in the violet-blue range of the spectrum; this has the effect of making paper appear whiter. Examining Hill's prints under a longwave UV light source (365 nm) confirmed the presence of OBAs in at least some of the copy paper the artist used for her early work. Brighteners are often sensitive to heat, high pH, some pigments, bleaches, and polar solvents, depending upon formulation. The degradation of OBAs will often visibly change the appearance of paper and may make white paper appear to yellow over time; migration of these substances can also discolor areas of a print. Migration may not necessarily always be visible under UV light, depending upon the stage of degradation the OBAs have reached (Mustalish 2013).

GUIDELINES FOR STORAGE AND ENVIRONMENTAL CONDITIONS

OPTIMAL ENVIRONMENTAL CONDITIONS

Although cool storage (defined as 54°F or below) is ideal for long-term storage of EP prints, room temperature (approximately 68°F) is acceptable. In general, efforts should be made to maintain a stable environment within the following parameters: 40–68°F and 20-50% relative humidity (Burge 2014).

HOUSING AND EXHIBITION

ISO 18902 (*Imaging Materials – Processed Imaging Materials – Albums, Framing, and Storage Materials*) provides appropriate guidelines for the selection of housing materials for EP prints. This standard specifies chemical and physical requirements for all storage and display materials that are in direct or close contact with many traditional and digital hardcopy photographic materials, including EP and inkjet digital prints. All products used for storage should have passed the Photographic Activity Test (PAT). Envelopes and other housing materials constructed using adhesive should use non-rubber-based adhesive. Paper products used for storage should be alkaline (pH 7–9.5) and lignin-free (with a Kappa number of 7 or below, equivalent to a lignin concentration of no greater than 1%), with a 2% calcium carbonate reserve. Dyes or pigments used to color paper housing or labels must past the colorant bleed test. Plastic materials should be plasticizer-free, and should not be chlorinated, nitrate, or acetate plastic.

Of particular concern to EP prints is the possibility of damage through incorrect storage. Housing prints directly on top of one another may result in the verso of one print abrading the recto of the print below; a polyester sleeve or sheet will, in most cases, lower the risk of abrasion on a black-and-white EP print (Nishimura et al. 2009). Although stable EP prints may be stored in polyester sleeves to prevent abrasion, the electrostatic nature of polyester sleeves may make them inappropriate for friable or brittle surfaces. Glassine degrades quickly, and use of this material in storage can cause blocking and dislodging of toner particles that stick to the surface. Regardless of the housing materials used, care should be taken to avoid stacking too many prints on top of one another, and at a minimum they should be separated with acid-free, buffered, PAT tissue paper or interleaving paper. Poor quality matboard, interleaving paper, or other storage materials used for housing or exhibition may result in acid migration and the subsequent deterioration of both the paper support and toner. When framing a print, spacers should be utilized to ensure that the print does not stick to the glazing. Using UV-filtered glazing during framing is recommended when possible;

windows and non-LED light sources in exhibition and storage areas should be outfitted with UV-filtering sleeves.

CONSIDERATIONS FOR MATERIAL SENSITIVITY DURING CONSERVATION TREATMENT

The thermoplastic nature of toner's polymeric components should be kept in mind when planning conservation treatment of EP prints, especially when considering the introduction of heat or pressure. Treatments such as adhesive removal, backing removal, and flattening of the paper support using weight—for example, while drying—should be carried out with a minimum of heat and pressure. Use of heated spatulas or heat-set tissue during repairs should also be avoided. As toner is sensitive to some organic solvents such as ethyl acetate, toluene, trichloroethylene, and acetone, care should be taken to avoid the use of any of these solvents during adhesive removal, dry mount removal, or other conservation treatments near or on the toner areas.

Migration of OBAs in copy paper is an especially problematic issue where conservation treatment is concerned. Visual examination under UV light can indicate the presence of brighteners; however, OBAs may still be present without fluorescing if they are degraded or exist in very small concentrations. As a result, their presence may not be noted prior to treatment. Areas of paper with severe OBA migration may appear to have blue or yellow rings under natural light, although this too is dependent upon lighting and stage of degradation (Mustalish 2013).

Finally, exposure to moisture during aqueous treatments can result in cracking or delamination of the toner layer due to tension between the toner and paper as the paper swells and contracts. The introduction of moisture should be carefully controlled whenever possible (table 1).

Risk	Treatment	Sensitivity
High temperature	Adhesive/dry mount removal	Toner Optical brightening agents (OBAs)
Pressure and friction	Backing removal Flattening Surface cleaning	Toner
Organic solvents	Adhesive Removal Stain reduction	Toner OBAs
Aqueous treatments	Washing Humidification Backing removal	Toner OBAs Paper-toner adhesion
Bleaches (hypochlorite, chlorine, and peroxide)	Stain reduction	OBAs
High humidity	Humidification	Paper OBAs Paper-toner adhesion

Table 1. Conservation Treatment Risks to Black-and-White Electrophotographic Prints

CONCLUSION

It is hoped that the technical study of Pati Hill's working methods and materials will illuminate some of the unique preservation concerns of black-and-white EP art. Curators, conservators, and collections care staff should endeavor to reconsider the idea that EP prints are simply identical copies. As with any traditional printing process, each print is a unique object. Visual analysis suggests that generation loss, expressed through diffused toner density and distribution, can help identify the order of production. It can also help indicate whether a print is a direct copy of an object, or a copy of a copy. When acquiring EP art, detailed, descriptive records should be made not just of the artist's materials and methods, but also of the machine, process, and toner used, whenever possible. In the case of fine art EP prints, understanding the sensitivities of proprietary materials can help prevent significant visual changes from occurring. Similarly, thorough testing should be carried out when attempting conservation treatment of any EP print, even if similar prints have been encountered and successfully treated in the past.

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NOTES

1. Several terms are used in technical literature to describe the electrophotographic (EP) print, including photocopy, xerograph, Xerox, and electrostatic print.
2. One of the most notable examples of the photocopier facilitating access to printmaking is the artist Barbara T. Smith, who leased a Xerox machine after she was rejected by a lithography studio. (Mizota, S. 2013. Review: Barbara T. Smith's photocopies reveal an artist in transition. *Los Angeles Times*, March 01, 2013.)
3. The term Copy Art, or Xerox Art, is often used as a blanket term to describe art produced using an electrostatic printing process, either analog or digital. Although it is sometimes referred to as a "movement," work made using electrostatic processes encompasses a wide range of

aesthetic choices, materials, modes of production, and political and social origins.

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