15. Framing Materials, Storage Boxes, Portfolio Cases, Albums, Cabinets, and Shelves

The photo album, storehouse for the treasured memories of many of the nation's 64 million families, often damages the images it holds. The materials and construction of many new imported albums, as well as millions of albums purchased in years past, create a harsh environment for photographic prints, research has shown.

At risk are black and white photographs and the color snapshots that have documented the lives of millions during the last four decades.

"An essential part of many families' heritage is in danger of being lost, and yet few are aware of it," said James M. Reilly, director of the Image Permanence Institute of the Rochester Institute of Technology.

"People think that by putting these family treasures in an album, they're being preserved forever, to be passed down to future generations," said Judith Fortson, the conservation officer at the Hoover Institution of Stanford University in California. "Yet in many cases these albums are helping speed their deterioration."

In some albums, "photographs are ruined much more quickly than they would be if you just left them in a shoe box," said Douglas Severson, a conservator at the Art Institute of Chicago. He is chairman of the photography group of the American Institute for Conservation, the national organization of professional conservators and researchers.

The situation is increasingly serious, said Mr. Reilly, "because the materials in the photo albums are getting cheaper and cheaper" as stores sell low-priced albums imported from the Far East.

The Rochester Institute's most recent research shows that "the level of damage from poor-quality materials is much worse than we had imagined," Mr. Reilly said.[1]

Glenn Collins
The New York Times
October 3, 1987

See page 511 for Recommendations

Framing Color and Black-and-White Prints

Displayed photographs should always be framed under glass for protection against physical damage and accumulation of dirt, grease, and insect residues. Tars and other components of cigarette smoke in homes and offices produce yellow and brown stains on unframed and uncovered prints; in poorly ventilated public buildings, severe stains can occur in only a few years. Cooking food generates airborne droplets of oil and grease which travel throughout a home. Photographs, unlike furniture, carpets, and walls, cannot easily be cleaned. Framing under glass can also give prints and mounting materials significant protection against moisture fluctuations as well as oxidizing gases and other air pollutants.

Examination of large numbers of old black-and-white photographs leaves no doubt that proper framing with an overmat — and hanging the framed photograph in an area free from excessively high relative humidity — is one of the best ways to preserve a print. Frames with glass (or Plexiglas acrylic plastic sheet in short-term applications) give prints outstanding physical protection, totally preventing the surface abrasions, dirt, fingerprints, scratches, and cracks often found on older photographs that have not been framed.

With the exception of UltraStable Permanent Color prints and Polaroid Permanent-Color prints, both of which are made with extraordinarily stable color pigments, prolonged exposure to light on display will ruin color photographs — framed or not. Consequently, valuable color prints should not be displayed except for limited periods of time under moderate lighting conditions (such as in short-term museum exhibitions). For extended display, an expendable duplicate or copy print should be obtained and the original color print stored in the dark.

When having professional portraits or wedding pictures made, the customer should be certain to purchase a duplicate (even if in a smaller size) of each print that will be displayed and to store it in the dark. Many portrait photographers dispose of their color negatives within a few years (or *immediately*, in the case of most low-cost department store and school photographers), so it will probably be impossible to have replacement prints made in the future.

Framing Black-and-White RC Prints: A Word of Caution

Many framed black-and-white RC (polyethylene-resin-coated) prints have become severely discolored and faded after only a few years of display, even though the prints were properly fixed and washed. When RC prints are sealed

1982

Exhibition galleries at the Art Institute of Chicago. Frames provide photographs with a semi-sealed environment that offers excellent protection against dirt, physical damage, and (to some extent) the effects of air pollutants. Carefully chosen frames also enhance the appearance of displayed photographs.

in a frame, oxidants produced by the deteriorating effects of light and UV radiation on the RC base can accumulate inside the frame and attack the silver image, causing either localized or overall yellow or orange-red discolorations. High-humidity conditions accentuate this type of image deterioration. There is also evidence that black-and-white RC papers are more susceptible than fiber-base papers to image discoloration caused by other sources, such as atmospheric pollutants, surface contaminants, or reactive substances in framing and filing materials.

The most important single factor that determines whether — or how soon — a displayed RC print will discolor is the *type of paper* with which the print is made. This author has seen countless prints from the 1970's and early 1980's made with Kodak Polycontrast Rapid RC Paper, Kodak Polycontrast Rapid II RC Paper, and Ilford Ilfospeed Paper which became severely discolored as a consequence of exposure to light on display. Most of these prints had been framed; however, some were simply tacked to a wall and were exposed to the open air. The Corcoran Gallery of Art in Washington, D.C., the Art Institute of Chicago, and the National Archives of Canada in Ottawa, among other well-known institutions, now have black-and-white RC prints in their collections that became severely discolored after only a few years of display and storage; with the passage of time, it is inevitable that huge numbers of prints worldwide are going to be affected.

Image deterioration of Polycontrast Rapid RC prints is characterized by extreme yellow and orange discolorations and formation of silver mirror-like deposits along density gradient lines (e.g., at the junction of white and black image areas). Some Polycontrast Rapid RC prints have also developed large numbers of small, circular orange-red discolorations (known as redox blemishes, or microspots); previously associated primarily with microfilms and astronomical plates, such defects have not, to this author's knowledge been encountered in any fiber-base prints. Some Polycontrast Rapid RC prints have also suffered from cracking of the emulsion-side RC layer; many Ektacolor RC prints from the late 1960's and early 1970's also have suffered from RC base cracking.

Image deterioration of displayed Ilford Ilfospeed prints is generally characterized by an overall yellow-brown discoloration, which is quite different in appearance from the discoloration seen with Kodak RC prints. Many Ilford RC prints from the late 1970's and early 1980's also suffer from pronounced brownish discoloration of the RC paper base; the discoloration, believed to be caused by developer chemicals incorporated into the paper's emulsion during manufacture, is most obvious on the backside of the prints.

Recommendations

Framing Materials

- **Frames:** Aluminum section frames are inert, inexpensive, lightweight, unaffected by moisture fluctuations, and otherwise ideally suited for framing photographs. Stainless steel and brass are also safe, but are expensive and heavy. Wood frames should not be used for black-and-white photographs, although they probably will not harm color prints. Museums and archives should avoid wood frames altogether.

- **Glazing:** Glass and high-quality acrylic plastic sheet (e.g., Plexiglas or Lucite) are recommended for color photographs. UV-absorbing grades of acrylic sheet offer little if any additional protection against light fading for most types of color photographs. Glass — although it is subject to breakage — is less expensive and has much greater resistance to scratching than plastic. Although Plexiglas and other plastics are satisfactory for framing in short-term exhibitions and traveling shows, they should be avoided for long-term use with black-and-white photographs.

- **Prevent contact between prints and framing glass:** Overmats are recommended to lessen the possibility of prints sticking to framing glass or plastic over time.

- **Frame moisture barriers:** Aluminum foil or polyester (e.g., DuPont Mylar or ICI Melinex) should be placed between the mount board and backing board of framed prints, except for black-and-white RC prints; for these, the author tentatively recommends that a vapor barrier be omitted to allow peroxides generated by the RC print base during prolonged exposure to light to gradually diffuse out of the frame. Frames should not be "vented."

- **Backing boards:** Aluminum sheet, high-quality mount board, corrugated polypropylene "cardboard," and Lig-free Type II box board (Conservation Resources International) are recommended. Ordinary cardboard, chipboard, plywood, and Masonite should all be strictly avoided. Fome-Cor and other polystyrene-foam laminate boards are probably satisfactory for backing (and mounting) expendable color prints intended for display, but should be avoided for valuable black-and-white prints.

Storage Containers

- **Cardboard storage boxes:** Lig-free Type II boxes (Conservation Resources International) are recommended for general storage of prints and negatives. Ordinary cardboard boxes, including those in which photographic manufacturers package and sell their paper, should not be used for other than temporary storage. Wood boxes should be strictly avoided.

- **Portfolio cases and clamshell boxes:** Because all currently available print storage boxes of this type are constructed with low-quality, lignin-containing (and usually acidic) binders board, none can be recommended for long-term storage of black-and-white photographs, although they probably are safe enough for color prints. Several firms, including Portfoliobox and Museum Box Company, can supply custom-made boxes (at extra cost) in which 100% cotton fiber mount board has been substituted for binders board; these boxes should be satisfactory for long-term applications. Pyroxylin-impregnated cover fabrics should be avoided; acrylic-coated fabrics are recommended.

- **Solander boxes:** These boxes are made with wood frames and binders board (usually covered with pyroxylin-coated fabrics) and are not satisfactory for the long-term storage of black-and-white photographs, especially photographs made by some of the historical processes, such as albumen prints. The boxes are probably safe for color prints. Also called "museum cases," these boxes are sold by Spink and Gaborc, Light Impressions, University Products, and others; they are found in most major museum collections. On special order, Spink and Gaborc can substitute 100% cotton fiber mount board for binders board and replace the pyroxylin-coated fabric with an acrylic-coated fabric; the wood frame is still used, however. Should a Solander box be required, this somewhat more expensive box is recommended. Extruded aluminum or an inert plastic such as polypropylene could be used to replace the potentially harmful wood frames in Solander boxes; at the time this book went to press, however, such an improved box was not commercially available.

Photograph Albums

- **Recommended:** High-quality albums with paper pages and polyester-covered pages are available from Light Impressions, University Products, and Photofile; often referred to as "archival" albums, these fairly high-priced albums appear to be quite satisfactory for museum and other long-term applications. Well-designed but much less expensive albums consisting of good-quality paper pages with Melinex polyester-covered "Picture-Pockets" are supplied by Webway Incorporated under the Webway Family Archival Album name. These expandable albums, many of which have an ample writing area below each print for captions, are available in sizes for 3½ x 5–inch and 4 x 6–inch prints. Webway Family Archival albums are the author's primary recommendation for general home and amateur use for both color and black-and-white photographs. Probably also satisfactory are albums with polypropylene-covered pages available from the Holson Company. Hallmark Cards supplies albums with cellulose acetate pages; these appear to be suitable for small amateur prints.

- **Albums to be avoided:** Albums with self-stick, plastic-covered "magnetic" pages can be extremely harmful and should **not** be used. If, however, one insists on using a self-stick album, the FlashBacks brand photo albums supplied by the 3M Company are recommended by this author as the safest album of this type. Also to be avoided are surface-treated, heat-sealed polypropylene pages (e.g., C-Line, 20th Century Plastics, and Light Impressions notebook pages); pages containing polyvinyl chloride [PVC] (e.g., 20th Century Plastics notebook pages); low-density polyethylene pages (e.g., Print File, Vue-All, and Clear File pages); and albums with pages made of low-grade paper, especially cheap black paper.

Cabinets and Shelves

- **Recommended construction materials:** Steel or aluminum coated with baked enamel, chrome- or nickel-plated steel, anodized aluminum, and stainless steel. (Baked-enamel-coated steel cabinets, shelves, filing cabinets, and blueprint files of the kind widely sold for office use are generally satisfactory.)

- **Materials to be avoided:** Wood, plywood, particle board, Masonite, Formica-covered plywood, and particle board. If wood must be used, well-dried hardwoods such as maple, birch, and basswood are provisionally recommended.

Paints

- **Recommended:** Oven-baked enamels and lacquers; latex paints.

- **To be avoided:** Alkyd or other oil-base enamels dried at normal temperatures (not oven-baked).

Carol Brower – 1987

The Museum of Modern Art in New York City displays photographs in a variety of frames, including those made from aluminum, brass, Plexiglas, and various types of wood that has been painted, varnished, or lacquered.

Among Current Black-and-White RC Papers, Kodak Polymax RC Paper Is Recommended

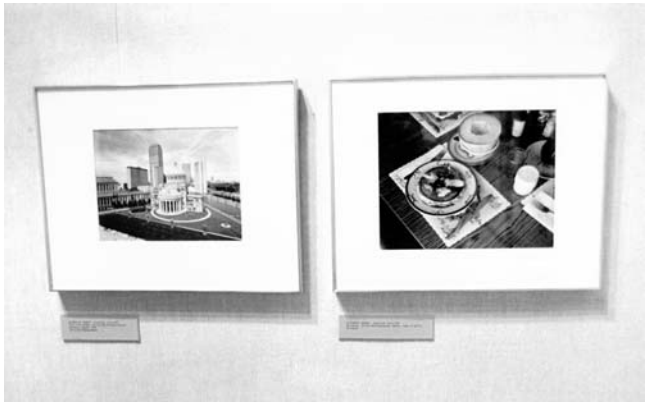
Polycontrast Rapid RC Paper, introduced in October 1972 (Ektacolor RC paper was introduced in September 1968), was Kodak's first general purpose black-and-white RC paper and is the product that started the trend away from fiber-base papers. Now, the great majority of black-and-white prints are made on RC papers. Kodak has made various improvements in the stability of its RC base materials (and also, apparently, the stability of the silver image itself), and it seems certain the current Kodak black-and-white papers such as Polymax RC Paper and Polyprint RC Paper will last much longer when framed and displayed than the Kodak RC papers from the 1970's and early 1980's. *How long* is not presently known. Nothing has been published on the comparative image stability of framed and displayed black-and-white RC prints.

Kodak has, however, published an article describing improvements made in the stability of Kodak RC base paper (which is related to the stability of the silver image with displayed prints) and has described accelerated test methods used by the company to evaluate the stability of Kodak RC base papers.[2] To date, none of the other major manufacturers of black-and-white RC papers, including Agfa-Gevaert, Fuji, Ilford, Oriental, and Mitsubishi, have published *anything* meaningful concerning the stability of their products.

There is no doubt that for some years Kodak has been aware of the image stability problems of displayed black-and-white RC prints and has devoted considerable effort toward improving the products. Much less is known about how other manufacturers have attempted to deal with these problems, and for this reason, this author recommends Kodak black-and-white RC papers in preference to other brands. Among Kodak RC papers, Kodak Polymax RC Paper and Kodak Polyprint RC Paper are this author's primary recommendations because — unlike Polycontrast III RC Paper and other current Kodak RC papers — Polymax RC and Polyprint RC papers are conventional-emulsion (non-developer-incorporated) papers. Prints made with some developer-incorporated RC papers have developed objectionable brownish stain within the paper base after only a few years of storage following processing, and use of conventional-emulsion RC papers eliminates concern about this particular problem.

The reader is cautioned *not* to apply test data or other information supplied by one manufacturer to the products of another. There likely are large differences in the image and/or RC base stability between the products supplied by the many manufacturers of black-and-white RC papers.

This author concurs with Kodak's suggestion that RC prints intended for display be treated with a protective toner (e.g., Kodak Rapid Selenium Toner or Kodak Poly-



1979

Ektacolor prints by Nicholas Nixon (left) and Stephen Shore (right) displayed in Kulicke welded aluminum frames at the Museum of Modern Art in New York City.

Toner) to help protect the image. Although in recent years treating RC prints with a toner has often been recommended, in practice it is rarely done. People use RC papers because of their speed of processing and drying, and a toner treatment with the required additional wash is an unwanted and time-consuming bother.

This author strongly recommends that fiber-base black-and-white papers be used in preference to RC papers when the longest-lasting prints are desired, especially if the prints are to be displayed for long periods. Ideally, both fiber-base and RC prints should be treated with an image-protective toner. Valuable black-and-white RC prints — especially those made prior to about 1982 — should not be displayed. For a further discussion of light-induced image degradation of black-and-white RC prints and image-protective toners, and for a list of recommended fiber-base papers, see Chapter 17, *Display and Illumination of Color and B&W Prints.*

There is also evidence that under normal display conditions, framing has increased the fading rates of some RC color prints. This phenomenon — one aspect of which this author calls "RC base-associated fading" — appears to have been a major factor in the rapid fading and staining observed in many displayed Ektacolor RC prints made during the early 1970's; this author's tests indicate that under certain processing and display conditions, most of the current, improved RC color prints can be similarly affected (see Chapter 2). Special considerations when framing black-and-white RC prints will be discussed later.

Frames and Mounting Materials Must Be Inert

All materials used in framing photographs, including backing boards, should meet strict requirements of permanence and chemical inertness. Noncorrosive metals, such as anodized aluminum, aluminum finished with oven-baked enamel, and stainless steel, are ideally suited for frames.

In a discussion of the harmful effects of many common materials on black-and-white photographic images, William Lee *et al.* of Eastman Kodak cautioned:

> . . . until a new material has been evaluated and judged safe for use in storing or filing photographic products, it would be considered prudent to avoid using it for this purpose. It has been shown that certain materials almost always adversely affect image stability and should be avoided. They are: **(1)** wood and wood products, especially plywood; **(2)** varnish and lacquers, especially those that contain cellulose nitrate; **(3)** untempered hardboard; **(4)** synthetic foam materials, especially expanded polyurethanes; and **(5)** adhesives that emit oxidizing species.[3]

Lee *et al.* recommended that "the manufacturer or vendor must initiate a series of accelerated aging tests designed to predict long-term stability of the photographic product in contact with the packaging or filing material in question." (Refer to Chapter 13 for a description of tests for mount boards and other paper products.) By the late 1980's, a number of manufacturers and distributors of mount boards, paper envelopes, interleaving materials, and photograph storage boxes had begun conducting such tests, at least to some extent, in an effort to evaluate the long-term suitability of their products.

A noteworthy example is Light Impressions Corporation, a large mail-order supplier of conservation materials located in Rochester, New York. In 1990 the firm announced that it had started a testing program for paper products carrying Light Impressions brand names using the Photographic Activity Test (P.A.T.) described in *ANSI IT9.2-1991* to "insure that our papers are safe in contact with photographic materials." According to Light Impressions, it would test "all papers that come in direct contact with photographic emulsions. This would include envelopes, folders and album pages, but may not include boxes and cases unless direct contact with the emulsion is anticipated."[4] The tests were being performed by the Image Permanence Institute in Rochester, under contract with Light Impressions.

Aluminum Frames

There is a large variety of well-designed aluminum section frames available at moderate prices. Aluminum can be economically extruded into the complex, internally grooved shapes required for mouldings. It is nonreactive with photographs; it is strong and will not warp or become distorted with fluctuations in relative humidity; and it can be anodized or easily finished with safe, oven-baked enamels or lacquers. Aluminum frames are usually constructed of four extruded sections which are secured at the corners with hidden screw-tightened or pressure-fitted hardware. Some of the more expensive aluminum frames are welded and polished at the corners, giving the appearance of one-piece construction. From a conservation point of view, aluminum frames are excellent — they avoid all of the problems inherent with wood frames.

One of the first museum applications of aluminum frames for photographs was in the 1959 Alfred Stieglitz retrospective exhibition at the Museum of Modern Art in New York City; these brightly polished frames were designed by Robert Kulicke of Kulicke Frames, Inc. — later known as A.P.F./Kulicke, Inc., and subsequently called simply A.P.F.,

Inc. — in New York City. The original Kulicke aluminum frame, now known as "The Classic Welded Frame," is still produced by A.P.F., Inc. and is made of either polished aluminum or brass, with welded corners. The frames have a wood strainer (retainer) placed behind the backing board and secured with screws through the sides of the frame to hold the matted print and glass in place.

In 1968 Kulicke began marketing the first design of the now very popular extruded aluminum section frame. Aluminum section frame pieces are sold in pairs in a wide range of lengths and finishes. Almost any size frame can be quickly assembled from two pairs of pieces of the desired length. For example, for a 14x18-inch frame, a pair of 14-inch sections and a pair of 18-inch sections are needed. Most section frames have removable corner hardware and can be taken apart for storage or to reuse the pieces in frames of different sizes. Aluminum section frames are now produced by a number of manufacturers; probably the best known maker of aluminum mouldings is Nielsen & Bainbridge (formerly Nielsen Moulding Design), a division of Esselte Business Systems, Inc., located in Paramus, New Jersey. Nielsen frames are marketed through retail stores as well as by mail-order outlets such as Light Impressions Corporation, and are used by many framing shops.

Anodized Aluminum Frames

Aluminum frames are supplied with either an anodized, lacquer, or enamel finish. Anodizing is a process of electrolytically forming a thin, nonabsorbent oxide layer on the surface of aluminum. During the anodizing process, the aluminum can be treated with special salt solutions to produce certain permanent "metallic" colors, including black, gray, bronze, gold, and chrome. Organic dyes may also be used to produce colors such as metallic blue, green, red, etc. The dyes are not permanent and will slowly fade on exposure to light and ultraviolet radiation. An anodized finish is resistant to scratches and much easier to clean than the somewhat absorbent "natural" oxide layer formed on untreated aluminum in the course of manufacture and during use. The surface of untreated aluminum easily picks up dirt, oil, fingerprints, etc., which may transfer to photographs and mount boards. Untreated aluminum may be polished to a bright, smooth finish, but, unlike anodized aluminum, the surface must be protected with a clear lacquer to prevent dulling, because the absorbent oxide layer picks up dirt.

Low-Cost Plated or Painted Steel Frames

Metal frames in small sizes have been sold for home use for many years. These frames, which are usually very inexpensive, are made of rolled steel which has been plated or painted. The frames themselves appear to be satisfactory; however, the mats and backing boards supplied with them are of poor quality and should be replaced.

Wood Frames

Wood, especially resinous softwoods such as pine and fir, should not be used to frame black-and-white photographs because wood releases peroxides and other harmful substances which, over time, can cause discoloration and fading of silver images.[5] Kodak has said: "Frames made of wood, especially bleached wood, may cause problems. Varnished, stained, or oiled frames should be avoided: there are no known 'safe' wood sealers."[6] Another drawback of wood as a framing material is that it cannot be oven-baked at high temperatures after painting or lacquering.

Examination of historical collections suggests that ordinary wood frames are probably not a major cause of deterioration of fiber-base black-and-white prints. Improper processing and washing, poor-quality mount board, and harmful mounting adhesives appear to be much more significant factors leading to deterioration of framed fiber-base prints. Untoned black-and-white RC prints are another matter, however, and these should never be put in wood frames.

Wood frames do have the advantage of being easy to "seal" on the back side with paper attached with glue or gummed tape to keep out dust, dirt, and insects. Bleached wood frames should never be used because there may be residual bleaching compounds in the wood which can harm photographic images; it may be difficult, however, to determine whether a frame has been made of bleached wood. "Oiled" wood frames should also be avoided.

Wood frames probably do little if any damage to color prints; keep in mind, of course, that displayed color prints will fade as a result of exposure to light regardless of the type of frame. For museum collections, wood frames are not recommended for any type of photograph.

Hermetically Sealed and Nitrogen-Flushed Frames

Hermetically sealed frames are of obvious benefit for displaying photographs in the tropics or other humid areas (including, for example, bathrooms and kitchens). In 1982 the PermaColor Corporation of Broomall, Pennsylvania introduced an acrylic, hermetically sealed frame under the Photo-Saver name. According to the company:

> The Photo-Saver works in a unique manner by filtering out the most damaging wavelengths of light while simultaneously sealing out the atmospheric elements that catalyze both dark fading and light fading. This concept is an important breakthrough because it is now possible to preserve color prints while they are kept on display. That's what people really want to do, rather than be told to keep their color prints in the refrigerator to preserve color.[7]

PermaColor distributed graphs of accelerated test results and comparison pictorial prints made on Ektacolor 78 Paper (apparently the pre-1982 type that was manufactured without an ultraviolet-absorbing emulsion overcoat, which left the unprotected cyan dye very UV-sensitive); those tests indicated that the frames approximately doubled the stability of the prints compared with glass-covered prints under similar conditions.

When sample frames were provided to this author, they were tested with prints made on Ektacolor 74 RC Paper Type 2524 and a prototype version of Ektacolor Professional Paper (both of these papers were made with an ul-

Carol Brower – 1987

Photographs on display at the Museum of Modern Art in New York City.

traviolet-absorbing emulsion overcoat). The frames were found to provide little protection for these papers.

For the amateur market, the high cost of the frames (e.g., $14.95 for a 5x7-inch frame) proved to be prohibitive. The product could not *stop* the fading of displayed color prints, and since the frames cost more than replacement prints, there was little incentive for the average person to purchase them. Despite extensive advertising, "The frames simply didn't go over in the marketplace," according to Joseph M. Segel, chairman of PermaColor. Segel, the entrepreneur who founded the Franklin Mint (which was subsequently acquired by Warner Communications), liquidated PermaColor in September 1983 and quickly moved on to other ventures. He sold his test equipment, rights to the frames, the laminating films he was developing, and the PermaColor trademark to MACtac (a division of Morgan Adhesives Company) of Stow, Ohio. Re-named MACtac Permacolor, the company currently markets a variety of "cold mount" pressure-sensitive laminating films and adhesives (but not the original PermaColor frames) under the Permacolor name (see Chapter 4).

From time to time it has been suggested that photographs be stored — or framed — in an inert atmosphere in hopes that this would reduce, or even eliminate, color fading. This rests on the theory that light fading cannot proceed without the presence of adequate oxygen and/or water vapor. Pursuing this approach, Light Impressions Corporation in 1986 circulated a questionnaire to people in the museum and fine art photography fields asking for opinions on a vaguely described frame that this author speculates is a large-format, glass-front aluminum frame with an aluminum sheet backing. The glass is probably edge-sealed to the aluminum backing with silicone rubber or a similar substance after a print has been inserted, and the frame is then flushed with nitrogen to remove all air (the photographer likely would have to send prints to Light Impressions for installation in the frame). It is assumed that such a framing and print installation service would not be inexpensive.

In a letter accompanying the questionnaire, the company said:

> At Light Impressions Corporation we are currently developing a framing and display technique for color photographs that would provide protection from the damaging effects caused by extremes in relative humidity, temperature, atmospheric acidity, and ultra-violet radiation. In addition, our new system would potentially resolve the light-fading problem of color photographic material in a display situation.[8]

Like the earlier PermaColor Photo-Saver frame, a nitrogen-flushed frame would probably be of little benefit for

Carol Brower – 1987

Photographs in aluminum, brass, Plexiglas, and wood frames side by side at the Museum of Modern Art.

Ektacolor and other chromogenic materials;[9] however, data published by Ilford on the protection afforded to Ilfochrome (called Cibachrome, 1963–1991) prints by embedding them in a polyester resin[10] suggests that a moisture-starved, nitrogen-flushed frame would substantially increase the useful display life of Ilfochrome prints. Light Impressions declined to answer questions about the frames and would not supply data in support of its contention that the frames "would potentially resolve the light-fading problem of color photographic material in a display situation." When this book went to press in 1992, nothing further had been heard about the frames.

Kodak Keeps Data on the Behavior of Its Color Prints in Nitrogen-Flushed Frames Secret

Since about 1982 it has been rumored that Kodak discovered that Dye Transfer prints in nitrogen-flushed frames "simply didn't fade" in accelerated light fading tests. But when asked, Kodak refused to provide data on Dye Transfer prints tested in this manner — and would not even confirm whether such tests had in fact ever taken place.

Lending credence to these rumors was the announcement that on May 19, 1987, David Kopperl *et al.* of Kodak would present a paper entitled "Light Stability of Kodak Color Products Irradiated in Air and Nitrogen" at the annual conference of SPSE, The Society for Imaging Science and Technology, in Rochester, New York. However, shortly before the conference was to begin, the paper was withdrawn without explanation and the subject has remained shrouded in secrecy.

The behavior of various types of color and black-and-white photographs in nitrogen-flushed frames certainly merits investigation. For example, tests might indicate that the frames can be used for protecting daguerreotypes and photographs made by some of the other early processes. But possible adverse effects of the frames on displayed RC prints of all types — and black-and-white RC prints in particular — should also be carefully studied.

If the frames prove to substantially improve the light fading stability of Kodak Dye Transfer fiber-base prints and Ilford Ilfochrome (Cibachrome) polyester-base prints — and *long-term* testing would be required to confirm this — it will be a very important development, at least for the museum field. If, however, UltraStable Permanent Color or Polaroid Permanent-Color prints become generally available at reasonable cost, the need for such frames would be reduced.

At the National Archives in Washington, D.C., the original copies of the United States Declaration of Independence, the Constitution, and the Bill of Rights are displayed under very low-level tungsten illumination in helium-filled, yellow-filtered, bulletproof display cases (in 1986, the documents survived without damage an attack by a man wielding a hammer).

Framing Procedures

A stiff backing board should always be placed behind a mounted print in a frame. This serves to keep the mount flat, to prevent punctures through the back, and to keep the back of the mount clean and free of scratches. Some frames are designed with a deeper recess to provide adequate room for a print that is unusually thick or to allow a greater separation space between the print and the glass when a mounted but unmatted print is "floated"; when the print is not unusually thick, or a fillet is not placed within the frame to regulate the space between the glass and the floating print, additional backing material is required to fill up the channel (recess). With most aluminum section frames, such as those manufactured by Nielsen & Bainbridge, spring-steel tension clips are provided for fitting into the four channels of an assembled frame behind the backing material, mat, print, and glass; the clips press the various layers together and help to ensure a tight fit inside the frame.

Frame mouldings should be selected with sufficient depth to accommodate the thickness of all the materials and to have enough space left so the spring clips will not exert too much pressure on the backing board. When a photograph is mounted and overmatted with 4-ply boards, and a moisture barrier sheet and backing board are included, the package may be too thick to fit properly *with the spring clips* in a standard frame moulding such as the Nielsen #11 size, which has a 7⁄16-inch channel. A moulding with a wider channel, such as the Nielsen #12 with a 5⁄8-inch channel, is more satisfactory. This author has seen many instances of the spring clips distorting the backing and mount board at the points where the clips contact the backing sheet; it may take several years for this type of damage to manifest itself. This is another reason why a separate, expendable backing board should always be included: to prevent the spring clips from directly contacting — and scratching or distorting — the mount board and print.

It would be a considerable improvement if, with each moulding section, frame manufacturers provided strips about 3⁄4-inch wide and made of thin aluminum or stainless steel; the metal strips would be placed on the rear edges of the backing board, with the spring clips installed over the strips. The metal strips would prevent board distortion caused by the spring clips and more effectively seal the frame against dust and insects; they would also minimize internal moisture fluctuations when moisture barriers are used between the backing material and the matted photograph.

Where possible, framing should be done in a room separate from matting activities and storage of mount board. After frame mouldings and glass have been cut to size, they must be carefully cleaned before a print and backing board are installed. Aluminum and glass fragments from cutting operations are extremely abrasive and can easily scratch emulsion surfaces or become embedded in the surface of a print. It is important to regulate both matting and framing environments. Smoking, eating, and drinking should be prohibited at all times. Clean and moderate conditions — approximately 70°F (21°C) with a relative humidity of 40–50% — should be consistently maintained to minimize the possibility of putting contaminated and/or moisture-laden materials into a frame, and to minimize later warpage of prints, mats, and backing boards.

Should Frames Be Sealed, or "Vented"?

It has sometimes been advocated that frames be provided with small holes, or "vents," in the backing material, print mount, and even the overmat of framed prints. Kodak has advised:

> Small air vents should be arranged so that there will be an airflow between the print and the glass. If fumes from a varnished frame are trapped against a print surface, especially an untoned print, some dark areas may develop a red color as black metallic silver grains change to colloidal silver. This is especially likely to happen to prints made on resin-coated [RC] paper.[11]

Kodak did not explain how one would go about venting the cut-out area inside an overmat, and it is not apparent to this author how such holes could be made, short of piercing the print itself (assuming that the overmat extends to the edges of the image, as is normally the case). It might also be inferred from Kodak's statement that vents are not needed with anodized or baked-enamel aluminum frames. Kodak declined to answer this author's inquiries concerning the company's venting recommendation.

Keefe and Inch, in their 1990 book *The Life of a Photograph*, gave another rationale for providing vents:

> A sudden increase in heat — caused, for example, by having the frame hang several hours in direct sunlight — can force moisture trapped in the paper to form vapor. When the frame cools, this moisture condenses inside the frame in liquid form instead of dissolving back into the mat board and print. Water stains result if the moisture cannot escape.[12]

In addition to recommending a polyester or aluminum-foil moisture barrier between the backing board and the print mount, Keefe and Inch suggest providing a small "venting gap" in one corner of the polyester or aluminum foil sheet and, presumably, the backing board.

This author recommends that in general frames *not* be vented. Examination of photographs framed in a variety of ways, and displayed in a wide range of environments, has convinced this author that frames with *overmatted* prints are not subject to moisture condensation on the interior of the framing glass — except, perhaps, in certain extreme circumstances. If a framed print were hanging against a very cold wall in a room with warm and humid air, it is possible that condensation could occur inside the frame (under this condition, moisture condensation would also occur on the surface of the wall itself). In a test, this author placed a framed and overmatted Ektacolor print (which had been preconditioned for several months at 70°F (21°C) and 50% RH) into a freezer at 0°F (–18°C). While in the freezer, the framed photograph was examined every few minutes until the temperature had stabilized. Interior moisture condensation was not observed at any point during this test.

Within the normally encountered range of temperature

and humidity, the edges of the overmat board, and the surface of the print itself, act as a "moisture buffer," rapidly absorbing water vapor from the small amount of air in the overmat cavity should the temperature inside the frame suddenly drop — thereby preventing the relative humidity from becoming high enough for moisture to condense on the framing glass.

While it appears unlikely that actual moisture condensation inside of a frame will occur, *elevated* moisture levels inside a frame can indeed cause other problems when a frame is hanging against a cool wall in a room with warm and humid air. Under these conditions, a "zone" of high relative humidity will be created in the air near the cool wall, especially directly behind a frame where the wall will usually be somewhat colder than wall surfaces which are freely exposed to warm room air. The moisture level inside the frame usually will not become high enough to reach the dew point (where liquid condensation occurs on the cool surfaces), but over time the moisture level can become sufficiently high to cause warping of the print, mount board, and overmat. If the print emulsion should contact the framing glass, ferrotyping or even sticking can occur. Sustained high moisture levels can enable fungus to grow on the photograph or mounting materials. Venting the frame will not help in this situation and may even exacerbate the problem.

Ideally, photographs should not be hung on outer walls in cold climates, especially if the walls are poorly insulated and/or if the building is humidified during cold periods. As will be discussed later, placing an unvented polyester or aluminum-foil moisture barrier between the backing board and the photograph will significantly reduce the likelihood of moisture-caused damage.

The question of frame vents also involves whether the long-term effects of airborne contaminants outside a frame can cause more damage to a photograph than harmful substances existing — or generated — inside a more-or-less sealed frame. Sources of oxidizing gases and other harmful substances inside a frame are mount boards and adhesives, plastic substitutes for framing glass, wood frames (including paint or varnish on wood frames), and, in the case of RC prints exposed to light on display, the titanium-dioxide-pigmented polyethylene "RC" layer beneath the print emulsion. With fiber-base black-and-white prints mounted and overmatted with suitable materials and housed in aluminum frames under glass, this author believes that internally generated contaminants pose much less of a threat than external, airborne pollutants.

The Best Way to Frame Black-and-White RC Prints Remains Uncertain

At the time of this writing, how best to frame black-and-white RC prints remained an unanswered and troubling question. Tentatively, this author recommends framing black-and-white RC prints using an overmat, but without vents and without a polyester or aluminum-foil moisture barrier. The absence of a moisture barrier will permit slow diffusion of RC-base-generated oxidants through the mounting and backing boards. The absence of vents (actual holes in the mounting and backing boards) affords protection against dirt and insects entering the frame. With black-and-white RC prints in particular, wood frames should never be used. Black-and-white RC prints intended for display should be treated with Kodak Rapid Selenium Toner or Kodak Poly-Toner or other image-protective solution[13] to help protect the silver image from oxidants produced by the RC base, evolved from framing materials, or entering the frame from external sources (see Chapter 17). Valuable black-and-white RC prints, especially those made before 1982, should not be displayed, even if they have been treated with a protective toner.

Polyester and Aluminum-Foil Moisture Barriers

For fiber-base black-and-white prints, and unlacquered RC color prints, this author recommends that a nonvented moisture barrier be placed between the print mounting and backing board. With these prints, a moisture barrier should be a normal part of everyday framing — not something that is reserved for "conservation framing." Color prints which have been lacquered probably should not be framed with a moisture barrier, as entrapped fumes evolved from the lacquer over time can be harmful to color images. Lacquering is not advised for black-and-white prints of any type.

If the aluminum-sheet or Lig-free Type II backing materials discussed below are not used as backing materials, a separate polyester or aluminum-foil moisture barrier should be placed between the print mount board and backing board. Thin, uncoated polyester sheet, such as DuPont Mylar D or ICI Melinex 516, is recommended. It may be purchased pre-cut in common framing sizes from Light Impressions Corporation; uncut rolls are available from a variety of sources. Thicknesses of 1 to 3 mils are adequate, though more expensive 5- and 7-mil polyester is easier to handle and provides a somewhat more effective barrier against migration of contaminants.

Aluminum foil sold in food stores is also satisfactory as a moisture barrier; foil intended for use with food has been treated to remove all oil or other dirt accumulated during manufacture. Industrial grades of aluminum foil should be avoided. Aluminum foil is readily available and may be less expensive than polyester in small quantities; if free of pinholes, aluminum foil is a totally impermeable vapor barrier and for framing purposes may be somewhat superior to polyester. On the other hand, some people have expressed concern that, over time, aluminum foil might slightly soil the back of a mount board or might even react harmfully with paper materials, although to date this author has seen no evidence to support either contention. More expensive anodized aluminum foil would lessen the chance of any such problems occurring, however. Both polyester and aluminum foil can easily be cut to size (the same size as the frame backing board) with an ordinary paper cutter. With care, scissors can also be used.

In addition to reducing the infiltration of airborne pollutants, a moisture barrier will greatly slow moisture fluctuations inside a frame. For example, in homes — which virtually never have effective humidity control — the relative humidity may be very high for a period of hours or days when it is raining outside. And as discussed previously, framed photographs hung on outer walls in cool cli-

mates may be in a zone of temporarily elevated relative humidity. A moisture barrier will prevent sudden changes in the moisture content of a print, its mount, and overmat; this in turn will minimize expansion of the boards and photograph, thus reducing the tendency of the mount and overmat to warp. The likelihood of an emulsion ferrotyping or sticking to framing glass will be greatly reduced.

Moisture barriers cannot totally stop moisture penetration, however. Water vapor can enter the frame along the exposed edges of the mount board and overmat inside the frame; in the case of polyester barriers, the plastic itself slowly transmits water vapor. The effect of the barrier is to even out year-round fluctuations in ambient relative humidity so that the moisture content of the print and mount will reflect the average humidity, over a period of several weeks, in the display area. Short periods of very high — or very low — ambient relative humidity will cause little change in the moisture content of the print and mounting materials inside the frame if a moisture barrier is included.

In a test conducted by this author, two 8x10-inch prints, dry mounted on 11x14-inch 4-ply 100% cotton fiber mount board and then overmatted with 4-ply board, were preconditioned in a room with 30% relative humidity for a month. The overmatted prints were then framed under glass in Nielsen #11 aluminum section frames; 4-ply backing boards were placed behind the mounted prints in both frames (the backing boards had also been preconditioned at 30% relative humidity). One print was framed with an aluminum-foil moisture barrier (placed between the backing board and the print mount), the other without.

Micro Essential Laboratory humidity indicator paper strips were placed at several locations inside of each frame, under the glass, to allow continual observation of changes in interior relative humidity (do not try this test with valuable photographs, as the humidity indicator strips will permanently stain anything they are in contact with). The framed prints were then hung in a room with circulating air and a relative humidity of 60%. The relative humidity inside the frame without the moisture barrier rose from 30% to about 45% in 3 days and appeared to reach equilibrium at 60% RH in 5 days. In contrast, the relative humidity inside the frame with the aluminum-foil moisture barrier required 35 days to reach equilibrium with the 60% RH conditions in the room — this is about seven times longer than the frame without the moisture barrier! Thus, moisture barriers can effectively protect a print and its mount against short-term changes in relative humidity.

If the ambient relative humidity is high over long periods of time, such as in the tropics, the moisture level inside a frame with a moisture barrier will, after a few weeks, reach the same level it would if no moisture barrier were present. A moisture barrier is, however, of benefit in most situations, and will also allow display of expendable photographs in locations such as kitchens and bathrooms, where there are periodic — but not sustained — high levels of relative humidity and air pollutants. Of course, a unique or valuable photograph should never be displayed in such areas, even if a moisture barrier is used.

If it is necessary to back framed photographs with low-quality materials, such as corrugated cardboard, chipboard, strawboard, plywood, or Masonite, a polyester or aluminum-foil moisture barrier serves the additional function of protecting the photograph from harmful chemicals and vapors emitted by the backing material. With low-quality backing materials, the best protection can be obtained by wrapping the backing board with a large piece of heavy aluminum foil such as the "broiler foil" available at food stores (sheet polyester does not handle well as a wrapping because it is difficult to fold sharply). The foil should cover the entire board next to the photograph as well as the edges of the board; the edges may be taped to the outside of the backing board with 3M Scotch No. 810 Magic Transparent Tape. If possible, a single sheet of foil should be used. Care should be taken to prevent punctures or pin holes in the foil during handling.

A polyester or aluminum-foil moisture barrier may be attached along all four edges to the framing glass with a stable polyester tape or 3M No. 810 Magic Transparent Tape — so that the photograph and matting materials are inside a sealed package — following a procedure suggested by the Conservation Center for Art and Historic Affairs.[14] As pointed out by Keefe and Inch, tape seals are particularly useful for traveling exhibitions of photographs: "Inspection of many traveling shows frequently turns up little slivers of glass and glass crumbs that break off edges because of repeated stressing. Tape eases some of this stress and contains the particles so they cannot penetrate the frame's interior."[15]

This author does not recommend taping as a general practice, however, as the tape adhesive will contaminate the edges of the mount board and overmat, and possibly even contaminate the photograph itself if the print extends to the edges of the mount board. And, as previously discussed, this author advises against sealing black-and-white RC and lacquered color prints in frames.

Paper "Barrier Sheets"

Cotton fiber papers and mount boards, and alkaline-buffered papers such as Howard Permalife, have often been used as "barriers" between photographs and low-quality backing materials. Compared with aluminum foil or polyester, paper products are more expensive and not nearly as effective in preventing migration of potentially harmful chemicals. Barrier papers and boards are totally ineffective in preventing moisture transmission, and this author does not recommend their use.

Good and Bad Backing Materials

Corrugated cardboard, gray chipboard, strawboard, binders board, plywood, Masonite, extruded polystyrene-foam laminates such as Fome-Cor, and a variety of other potentially harmful materials have traditionally been employed for backing framed photographs. All of these materials are potentially harmful to photographs and generally should be avoided.

With black-and-white prints, one should be especially careful to avoid wood products as well as any paper or board that contains groundwood or lignin, or is acidic. Lignin (a common constituent of low-quality wood pulp paper products) has been shown to produce damaging peroxides and acids during aging. Ordinary corrugated cardboard is

particularly harmful and is unsuitable as a backing material. A number of "acid-free" alkaline-buffered corrugated cardboard sheets are available which have been recommended as backing materials;[16] even if these proved to be stable and nonreactive with photographs — and no test data were available at the time of this writing — corrugated cardboard, in this author's opinion, is not rigid enough, especially for large frames and in high-humidity conditions, to be satisfactory as a backing material.

Acceptable backing materials include high-quality mount board, Lig-free Type II boxboard, natural or anodized aluminum sheets, and — for color prints only — Plexiglas and other acrylic sheets. Glass is also satisfactory for backing framed prints but has the disadvantages of being heavy and easily broken.

For the best economy in general applications, this author recommends alkaline-buffered wood cellulose "conservation board" with a polyester or aluminum-foil moisture barrier. More expensive alkaline-buffered 100% cotton fiber "museum board" is of course also suitable. For backing in frames for both black-and-white and color photographs that have been overmatted and mounted with the appropriate materials, alkaline-buffered mount boards are preferred over nonbuffered boards. (See Chapters 12 and 13 for further discussion of mount boards.) Four-ply boards (about 1/16 inch thick) are satisfactory for small and medium-size frames; 8-ply boards (at least 1/8 inch thick) or thicker should be used with large frames to provide needed rigidity.

Lig-free Type II Boxboard

Lig-free Type II boxboard, introduced by Conservation Resources International, Inc. in 1984, is a relatively new type of paper board which this author believes to be a very good backing material for both black-and-white and color prints. Designed for archival storage boxes, Lig-free Type II is made with a thin sheet of Mylar polyester laminated between a sheet of lignin-free, alkaline-buffered wood cellulose boxboard (with a cream-colored surface) on one side, and white, nonbuffered, near-neutral, lignin-free paper on the other; the polyester sheet acts as an internal moisture barrier and eliminates the need for a separate polyester or aluminum-foil barrier sheet. A PVA (polyvinyl acetate) adhesive is used in the lamination process. Conservation Resources says the board meets ASTM specifications for nontarnishing paper (not more than 0.0008% reducible sulfur)[17] and is nonreactive when tested with the Collings and Young silver tarnishing test.[18] Results of Lig-free Type II tested in contact with photographic materials using the Photographic Activity Test specified in *ANSI IT9.2–1991* were not available. The board is available in two thicknesses, 40 pt. and 60 pt.; the heavier board has about the same thickness and stiffness as 4-ply mount board. Unfortunately, Lig-free Type II board is expensive, costing more than an equivalent size of 100% cotton fiber board with a separate polyester moisture barrier. The white, nonbuffered side of the board should probably face out; keeping the thicker, cream-colored alkaline-buffered side facing the interior of the frame will help minimize warping during periods of fluctuating humidity.

Aluminum Backing Sheets

Although fairly expensive and difficult to cut smoothly without special metal-shearing equipment, anodized aluminum sheet appears to be the best of all currently available backing materials. It is lightweight, nonreactive, nonsoiling, unbreakable, and rigid. Unlike boards and other paper products, aluminum sheet will not sag or warp with moisture fluctuations and aging (an important advantage with large frames), and it provides an effective barrier against migration of moisture and air pollutants. Aluminum backing sheets also prevent damage to mats and photographs caused by localized pressure of the spring tension clips found in most aluminum section frames. Anodized aluminum sheet is supplied in a variety of thicknesses by a number of manufacturers; an example is the Anoclad sheet made by ALCOA.[19]

Unfinished aluminum, which has not been anodized, is relatively inexpensive and may also serve as a backing sheet; however, it is necessary to place a sheet of aluminum foil, uncoated polyester, or high-quality paper between the unfinished aluminum sheet and the back of a mounted print to prevent the mount from becoming soiled by transfer of small amounts of dirt or oil from the oxidized surface of the aluminum over long periods. Most commercially available natural aluminum sheet products have a residual oil film on the surface left from rolling operations; it is not, therefore, recommended for backing high-quality and valuable prints.

Aluminum sheet in large sizes is difficult to cut flat and smoothly with ordinary tin snips. A bench-mounted sheet metal shear works well, however, and the expense of one should not be excessive for most frame shops or exhibition departments. Hand-operated sheet metal "nibbling" tools may also be used for small jobs. The thickness of the aluminum required will depend on the size of the frame; 1/32 to 1/16 inch (0.8 to 1.6 mm) should be sufficient for sizes up to about 20x24 inches.

Fome-Cor and Other Polystyrene Foam Laminate Boards

Extruded polystyrene-foam laminates such as Fome-Cor, Gatorfoam, Artcor, and Prime-Foam-X are widely used both as backing materials for framed photographs and as substitutes for mount board when mounting black-and-white and color prints. These laminates are very lightweight, easy to cut, and surprisingly rigid for their thickness; foam laminates are especially popular for mounting murals and other large prints. Monsanto Plastics and Resins Company, the maker of Fome-Cor, had this to say about its product:

> We do not recommend that Fome-Cor in its current composition be used in conservation framing in direct contact with works of art. However, the product is suitable for use as a backing material behind an appropriate thickness of conservation ragboard, due to its relatively low acid content. The commercial grade of Fome-Cor has a pH of 5.5–6.5.[20]

Original-type Fome-Core is faced on both sides with bleached white clay-coated kraft paper (kraft paper is a common wood pulp paper produced by the sulfate process). Brown natural kraft paper facings are also available. In 1983 Monsanto introduced Acid-Free Fome-Cor, faced with alkaline-buffered paper, "designed to be used in direct contact with artwork in conservation quality framing, allowing you to remove protective ragboard barriers. By having one backing sheet do the work of two, Acid-Free Fome-Cor can save you as much as 25% of your backing materials cost."[21]

Gatorfoam, manufactured by the Uniwood Division of the International Paper Company, is laminated on both sides with sheets of moisture-resistant, resin-impregnated wood fibers. Concerning the "archival quality" of Gatorfoam as a mounting material for photographs, Uniwood says:

> The pH on the composite panel of Gatorfoam is an average of 5.5 to 6.5. However, pH on the face material is closer to 6.0. While this may seem to be slightly acid, Gatorfoam has been tested and is used by several top museums as mount board for fine prints. If archivability is critical we suggest having tests made to determine acceptability of the panel.[22]

An ad for Gatorfoam which appeared in a number of publications in 1983 said:

> The stability of Gatorfoam makes it especially suitable for mounting fine photographic prints. Its pH is within a safe range for even the most chemically sensitive mounted materials. Several major museums that use Gatorfoam have commented on its ability to keep prints from fading and discoloring.[23]

The pH level of polystyrene-foam laminates is only one of many considerations that determine their suitability for mounting photographs; more important are the possible adverse effects from facing materials, and from aging products of the polystyrene foam core and laminating adhesives. On inquiry from this author, neither Monsanto nor Uniwood had any test data on possible adverse effects their respective products might have during long-term use with photographs; Uniwood could offer no evidence to support its contention that Gatorfoam helped keep prints from "fading and discoloring."[24]

When used to mount black-and-white photographs, Gatorfoam's "resin-impregnated wood fiber" facing sheets are a source of particular concern. William Lee *et al.* of Kodak have claimed that synthetic foam materials and wood products are among "materials that almost always adversely affect image stability [of black-and-white images] and should be avoided."[25] Polaroid Corporation has advised against polystyrene foam (Styrofoam) products such as Fome-Cor, noting that they are among the materials "containing substances that are harmful to photographs."[26]

Artcor, a product of Amoco Foam Products Company, is faced with thin sheets of acrylonitrile-butadiene-styrene (ABS) plastic. Prime-Foam-X, made by ICC Industries, Inc., is faced with white, clay-coated paper; it is similar in appearance to original-type Fome-Cor.

For Ektacolor, Fujicolor, Konica Color, Agfacolor, and similar chromogenic color prints intended for prolonged display, Gatorfoam, Acid-Free Fome-Cor, Artcor, and Prime-Foam-X appear to be satisfactory as backing or mounting materials. Pending more information on their aging characteristics and potential adverse interactions with silver images, however, these products are not recommended for use in contact with, or near, valuable black-and-white photographs.

Corrugated Polypropylene Backing Sheets

A relatively new and very inexpensive plastic material that may prove to be a satisfactory backing material is polypropylene "corrugated board." It is a lightweight material with a structure similar in appearance to ordinary corrugated cardboard. Available in a variety of colors, it has found application as a high-quality, moisture-resistant substitute for corrugated cardboard in box manufacture; since it is plastic, a separate moisture barrier would not be needed in framing applications. Polypropylene board is made using extrusion techniques developed in Japan and Europe. Sheet corrugated polypropylene is available from Coroplast, Inc. in Canada.[27] In the absence of accelerated test data, this author does not recommend the material for backing valuable photographs; however, there is no doubt that Coroplast polypropylene board is superior to conventional corrugated cardboard and chipboard products widely used in commercial framing.

Prints Must Be Separated from Framing Glass

Photographs to be framed should be overmatted to prevent direct contact of the print emulsion with framing glass or plastic sheets. Some frame mouldings are designed to keep the artwork away from the glass by holding them in separate, closely spaced grooves; Nielsen #44 and #55 mouldings are examples. Artwork can also be separated from the glass by specially designed plastic spacers (fillets), such as the Framespace.[28]

Prolonged contact of a gelatin emulsion with glass (especially under pressure) in conditions of high relative humidity may produce sticking or "ferrotyping," which results in irregular areas of altered surface gloss. This appears to be particularly likely to occur with some types of color prints. Studio portrait and wedding photographers usually lacquer color prints in an attempt to prevent them from sticking or ferrotyping when in contact with framing glass. Kodak has recently recommended that even lacquered prints be overmatted to preclude contact with framing glass — both to prevent sticking of the lacquered surface to the glass (which Kodak says can occur, although this author has never seen an example of this) and to minimize yellowing should a color print be lacquered with a product containing ketones or other solvents which produce peroxides on oxidation. Lacquering should be avoided for any black-and-white or color print intended for long-term keeping. Print lacquers and pressure-sensitive laminates are discussed in Chapter 4.

Plastic and Glass Framing Materials

In general framing, glass is preferred to plastic sheets. Acrylic sheet such as Plexiglas scratches much more easily than glass, and care must be exercised in handling and cleaning. Both DuPont Lucite SAR (Super Abrasion Resistant) acrylic sheet and Rohm and Haas Plexiglas G UltraShield have much greater abrasion resistance than regular grades of acrylic sheet. Especially when the relative humidity is low, acrylics and most other transparent plastics have a pronounced tendency to develop static charges, which in turn attract airborne dust; glass does not have this drawback. Plexiglas and similar acrylic products are also considerably more expensive than glass.

Almost all current color papers, including Ektacolor, Fujicolor, Konica Color, and Agfacolor, are overcoated with an ultraviolet-absorbing layer during manufacture, so in most display situations where the print or illumination source is covered with a sheet of glass, there will be little if any reduction in fading by using ultraviolet-absorbing plastic materials such as the UF-3 grade of Plexiglas acrylic sheet made by the Rohm and Haas Company. (Polycast Technology Corporation Polycast UF-3, DuPont's abrasion resistant Lucite SAR UF-3, and CYRO Industries Acrylite OP-3 appear to have UV-absorption characteristics that are generally similar to Plexiglas UF-3.)[29] Even though Ilford Ilfochrome (Cibachrome) prints do not have an ultraviolet-absorbing emulsion overcoat, this author's long-term 1.35 klux fluorescent light fading tests with the prints showed that the increased protection afforded by UF-3 is relatively small (see **Table 3.3** in Chapter 3).

Plexiglas UF-3 has a slight yellowish tint as a result of the incorporated ultraviolet filter material which absorbs essentially all radiation below 400 nanometers, and, unavoidably, also absorbs some visible blue light in the 400–425 nanometer region. When UF-3 is used for framing, its yellowish tint somewhat changes the appearance of photographs and mat boards; UF-3 will therefore not be acceptable for critical museum applications. Polycast UF-4 and other UF-4 sheets are almost completely colorless; UF-4, however, does not completely absorb UV radiation in the 385–400 nanometer region and is therefore somewhat less effective than UF-3 as a UV filter.

Plexiglas G and other "standard" grades of acrylic sheet typically absorb most UV radiation below about 350 nanometers. Ordinary window and framing glass completely absorbs wavelengths below about 320–325 nanometers. Glass effectively absorbs the 313 nanometer mercury vapor emission line which is radiated by most fluorescent lamps; significant UV radiation at this wavelength is very harmful to color materials that do not have a UV-absorbing emulsion overcoat, such as Ilford Ilfochrome (Cibachrome) prints, Kodak Dye Transfer prints, Fuji Dyecolor prints, Polacolor 2 and ER prints, pre-1983 Ektacolor prints, and Kodak Ektatherm and most types of thermal dye transfer still video or digital electronic hardcopy prints.

Fortunately, glass windows absorb much of the UV radiation present in daylight in the potentially very harmful 300–350 nanometer region. Were it not for this fact, upholstery fabrics, dyed carpets, wallpaper, black-and-white photographs, and many other objects found in homes and offices would not last nearly as long as they do! Fluorescent

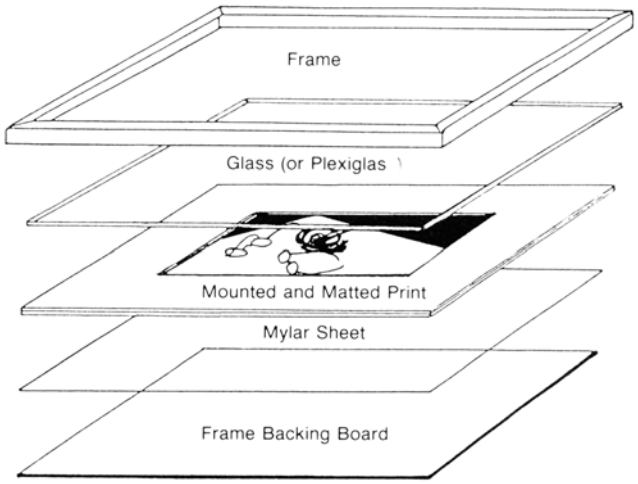


Figure 15.1 Disassembled Frame

lamps also have a mercury vapor emission at 365 nanometers, which glass freely transmits; however, such long-wave ultraviolet radiation does not adversely affect the overall fading rates of most types of color photographs.

To completely exclude UV radiation from display areas, one can install sheets of Plexiglas UF-3 over windows, fluorescent lamps, quartz halogen lamps, and other light sources which emit significant UV radiation. This eliminates the need to frame prints with UF-3 — they can be framed with glass instead (see Chapter 17). Filtering the light source instead of the prints also avoids the problem of the sometimes disconcerting yellowish tint of UF-3. When UF-3 is used to frame a photograph, light must pass through it once to illuminate the print, and a second time when reflected back to the viewer. This accentuates the yellowish tint of UF-3; the effect is made all the more obvious by unavoidable visual comparison with walls, frames, and other objects in the viewing area which are not covered with UF-3. When the light source itself is filtered with UF-3, the yellowish coloration cannot be detected.

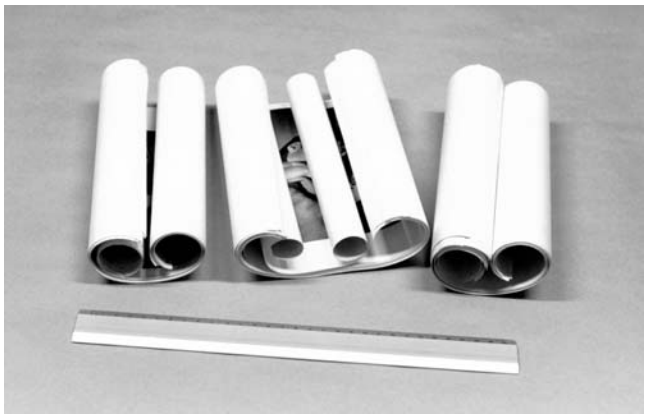
Pending further information, this author does not recommend Plexiglas or other brands of acrylic sheet for long-term use with black-and-white photographs. Acrylic plastics are based on methyl methacrylate and are manufactured using a peroxide-catalyzed polymerization system. The final product may contain residual peroxides and/or unreacted acrylic monomers which over a long period could harm the silver images of black-and-white photographs.

While the long-term effects of acrylic sheet on photographs are not presently known, the work of Weyde,[30] Pope,[31] and others would certainly suggest caution in this area. The problem is complicated by the fact that levels of residual peroxides and unreacted acrylic monomers vary from batch to batch, and some manufacturers of acrylic sheet have lower quality control standards than others. Kodak has recommended that acrylic plastics be avoided;[32] however,

Polaroid Corporation considers them to be acceptable.[33]

Although this author has not yet seen any examples of image deterioration which appear to have been caused by Plexiglas brand acrylic sheet, the long-term display of black-and-white prints with plastic frames or cover sheets made of acrylic, polystyrene, or other currently available clear plastics is not recommended. Products of this type include the Kulicke FK Plastic Frame, WK Warhol Kulicke Frame, Trap Frames, Slip Frames, and frames of similar design made by other manufacturers.

Acrylic sheet is probably satisfactory for short-term contact with black-and-white photographs in situations where breakage of glass might be a problem, such as in traveling exhibitions. Acrylic plastics are also suitable for use with color photographs; color image dyes appear to be much less sensitive to trace levels of peroxides and other chemicals than are silver images.



March 1991

Subjected to widely varying relative humidity (caused by seasonal fluctuations in humidity) over a 25-year period, these photographs gradually became severely curled during storage. The prints were made on single-weight fiber-base Kodak Polycontrast Paper in 1966.

March 1991

Also stored for 25 years, these prints were made on the same type of fiber-base paper and kept under identical conditions, except that the curl has been restrained by storage in a snugly fitting box. For these illustrations, both groups of prints were allowed to equilibrate in an environment with a relative humidity of less than 20%. Even in this very dry condition, the prints that had been kept in the box curled only slightly when they were removed from the container.

For some years, the International Museum of Photography at George Eastman House in Rochester, New York framed salted paper and albumen prints with Plexiglas UF-3 in an effort to reduce the damaging effects of the daylight illumination that was present in many of the museum's display areas at the time.

Textured non-glare glass should be avoided in framing because it reduces visual definition of the image. Also, textured glass must be in direct contact with the photograph, unless the print is lacquered, and this may result in sticking or ferrotyping of the emulsion over time. If textured glass is separated from the photograph by an overmat, the loss of image definition, contrast, and color saturation will be visually unacceptable.

Some types of non-glare glass are manufactured with a vacuum-deposited, optical anti-reflection coating which functions in a manner similar to the anti-reflection coatings on camera lenses. Unlike conventional non-glare glass, anti-reflection coated glass can be used with overmatted prints with no loss in image clarity.

Suppliers of framing glass with optical anti-reflection coatings include Viratec Tru Vue, Inc. (Tru Vue Museum Glass), and Denton Vacuum, Inc. (Denglas).[34] Both Tru Vue Museum Glass and Denglas are available with UV-absorbing coatings. While specular reflections are largely eliminated by the anti-reflection coatings, the faint glare images from sources of bright light can have a somewhat disconcerting iridescent appearance. In display situations, however, where objectionable glare is present, these special (and fairly expensive) types of glass will markedly improve the appearance of photographs and other works of art.

Cleaning Glass and Plastic

Glass and plastic sheets must be washed to remove dirt before placement in a frame. After swabbing with a solution of water and a non-ionic detergent such as Ivory Liquid, the sheet should be thoroughly rinsed with warm running water and dried with clean paper towels.

Glass or plastic sheets already in a frame should be removed from the frame for cleaning; otherwise, the cleaning solution could seep under the edges of the frame and contaminate the mount board or photograph. If it is not possible to remove the glass for cleaning, the frame should be laid horizontally on a table. The glass should be wiped with a paper towel which has been moistened (but not soaked) with a non-ionic detergent solution; great care must be taken to prevent any of the cleaning solution from seeping under an edge of the frame. Then — working quickly to prevent any of the cleaning solution from drying on the glass or plastic — all remaining solution should be wiped off with paper towels. Superficial dust can be removed with a soft brush.

Glass cleaners containing ammonia, such as the popular Windex Glass Cleaner with Ammonia-D, should be used with great care because residues of the cleaners can cause serious damage to photographs should some of the solution seep under the edges of a frame or come into contact with nearby, unframed prints. This author has seen a number of Kodak Ektacolor prints which have suffered almost total localized dye loss as a result of contamination with droplets of ammonia-containing glass cleaners.

General Storage Considerations

For storage, unframed prints and large sheet films should be placed horizontally in flat boxes (preferably about 2 inches deep and never more than 4 inches deep) with drop-fronts or drop-backs. Keeping stacks short and minimizing the weight on prints or films near the bottom of the stacks will lessen the chance of dirt becoming embedded in emulsions, minimize physical damage that can occur when mounts of varying sizes are stored together, and reduce the possibility of ferrotyping under humid conditions if plastic sleeves are used. Prints and films should never be pulled from the center of a horizontal stack; instead, the prints on top of the desired photograph should be lifted off and set aside.

When prints are stored in regular office file cabinets, as is often the case in publication or commercial archives, the photographs should be prevented from curling excessively over time by taking up the free space in each file drawer. Most file cabinets have adjustable metal partitions for this purpose; if possible, partitions in the file drawers should be placed about 8 or 10 inches apart (additional partitions can be purchased from the manufacturer of the file). Prints should be inserted or removed from file drawers by pulling out the entire file, placing it on a work table, and carefully lifting out or inserting the photographs.

Prints and films should never be crammed into sleeves or envelopes that are already in a file cabinet; this will inevitably result in scratches, creases, and cracked emulsions.

Preventing Excessive Curl in Fiber-Base Prints

Gradually, sometimes over a period of many years, unmounted fiber-base prints can develop excessive curl; the curl is almost always toward the emulsion side of a print and is most acute in single-weight prints. When prints without envelopes or sleeves are stored together — in the drawer of a file cabinet, for example — the entire batch may develop curl as a unit. Aside from the curl characteristics, which are inherent to a given print material, there are two principal factors that affect the amount of curl which ultimately will develop:

1. **Cycling Relative Humidity.** An environment in which the relative humidity cycles over a wide range — from very low to very high — will, over time, cause much more curl to develop in unrestrained fiber-base prints (even if the average RH is very low) than will storage at a more constant relative humidity. Why cycling relative humidity increases the curling tendency in fiber-base prints (and, to a lesser extent, in RC prints and in 35mm and other narrow-gauge films manufactured without a gelatin anti-curl coating on the base side) is not understood; however, there is no doubt that it does. In temperate climates, indoor relative humidity will drop to a very low level in cold periods of the year unless humidifiers are available to increase the moisture level. In warmer parts of the year, on the other hand, indoor relative humidity levels may periodically become very high, even if air conditioners are in operation.
2. **Physical Restraint of the Curling Tendency.** If a fiber-base print is maintained in a flat position by mounting it in an overmat, by placing it in a frame, by storing it in a filled box, or by inserting it into a plastic sleeve (with a reinforcing mount board backing behind the print, if necessary), excessive curl will not develop even if the relative humidity does cycle over a wide range.

In homes and offices in temperate climates, it usually is impossible to maintain a low — and reasonably constant — relative humidity without costly special equipment of the type that only a few museums and archives have at present. It is therefore essential that prints be held flat if excessive curl is to be avoided. This — in addition to protecting photographs from dust, dirt, fingerprints, scratches, creasing, cracking, and other physical damage — is an essential element of a good storage system.

If prints have already developed unacceptable curl, great care should be exercised in attempting to flatten them in order to avoid cracking the emulsion; with valuable prints, an experienced photographic conservator should be consulted.

Housing Valuable Photographs

Storing unprotected or sleeved prints, negatives, and transparencies in file cabinets or stacked in discarded Kodak paper and film boxes (or those supplied by other photographic manufacturers) is not recommended, particularly for museums, archives, galleries, important commercial and documentary collections, or fine art photographers. To properly store valuable photographs, the following approach is suggested:

1. Place individual prints or films in uncoated polyester or untreated polypropylene top-flap sleeves (see Chapter 14 for discussion of the various types of sleeves and envelopes for storing photographs). The transparent plastic sleeves allow visual examination of prints and films while at the same time preventing fingerprints and scratches on the photographs themselves. The sleeves also prevent transfer of rubber-stamp ink from one print to another and eliminate the possibility of contaminating films and prints with migrating residual thiosulfate and other harmful chemicals from poorly processed photographs that might be present in the box.

2. Sleeved prints and films, either individually or in small groups (e.g., all of the cut strips of negatives from a roll of 35mm or 120 film), should be placed in high-quality paper envelopes to protect them from dust and to provide a place upon which to write the date and other identifying information with a pencil or pen, or to mark with a rubber stamp. The sleeves and paper envelopes also offer a significant amount of physical restraint to fiber-base prints and help prevent them from developing excessive curl over time.

3. For protection against physical damage and dust, and to further physically restrain fiber-base prints so as to keep them flat, the paper envelopes should be placed in suitable boxes. Prints and sheet films larger than 5x7 inches should be stored horizontally in boxes not more

than about 4 inches deep. It is essential that the boxes have drop-fronts or drop-backs to minimize the chance of physical damage to prints when they are removed from the boxes. Prints and films 4x5 inches and smaller (including 35mm and 120 films) may be stored vertically in fixed-front boxes not larger than about 10 inches deep if they are in envelopes. It is important that the boxes be full so that the contents fit snugly and are not allowed to sag or develop curl over time; filler made of high-quality mount board may have to be placed in a box to fill extra space. Pieces of plastic foam should never be used for filler because over time these materials may evolve harmful gases.

4. The boxes should be placed on metal shelves coated with baked enamel — or better still, for additional protection against dust and physical damage, on shelves within closed metal cabinets. Wood fixtures in general, and plywood, particle board, chipboard, and Masonite in particular, should be avoided. For ease of access and to avoid excessive weight on the contents of a box, the boxes should not be stacked on top of one another.

Mounted prints should also be stored in boxes. Mounted prints are not normally placed in sleeves or envelopes; however, the prints should be interleaved as they are placed in the box. This author believes that a smooth, 100% cotton fiber paper, such as Atlantis Silversafe Photostore (see Chapter 13), should be used to interleave mounted prints that do not have overmats. For prints that do have overmats, a sheet of Mylar D or ICI Melinex 516 polyester (or suitable translucent interleaving paper), cut about one inch smaller than the dimensions of the mat, should be placed between the print and the overmat. This will protect the surface of a print while permitting viewing without the need to remove the interleaf sheet.

Storage will be simplified if prints (and the mounts of mounted or overmatted prints) are all of the same size or are segregated into several standard sizes, such as 8x10, 11x14, and 16x20 inches, and if boxes of the appropriate size are used. Small prints tend to slide around during handling if they are filed with larger prints; this is especially true when groups of prints receive rough handling when being shipped. If mixing prints of different sizes cannot be avoided, small or odd-size prints can be protected by placing them in a standard-size sleeve along with a backing sheet of a good-quality mount board (preferably of 2-ply thickness) the same size as the sleeve.

Very large prints should be grouped by size in small stacks and stored horizontally in metal blueprint files or on large shelves within metal cabinets. Large prints require special handling, and no attempt should be made to incorporate them into regular subject or alphabetical files. Cross-reference cards or small copy photographs can be inserted in the regular files, as required.

Contact between different types of photographs (e.g., Fujicolor prints, Kodak Dye Transfer prints, Ilford Ilfochrome prints, black-and-white prints, color negatives, instant prints, etc.) should be avoided; if various types of photographs must be kept together in the same file or box, they should be placed in individual polyester sleeves to prevent migration of chemicals between adjacent films and prints.

Glass photographic plates should be stored vertically, resting on the long edge, in vertical files or in vertically compartmented shelves. Cabinets and shelves for glass plates should be constructed of steel coated with baked enamel, of anodized aluminum, or of other suitable nonreactive and noncombustible materials; wood, plywood, Masonite, particle board, chipboard, Formica, and similar products should be avoided. Great care should be taken that fragile glass plates are not subjected to undue pressure or allowed to slide off shelves. Information on proper storage containers for glass plates may be found in *ANSI PH1.45-1981, American National Standard Practice for Storage of Processed Photographic Plates*.[35]

Storage Containers

Boxes, cabinets, and shelves for storing photographs should be made of materials which do not chemically react with photographs over long periods, are opaque (to protect the contents from light), do not absorb moisture, are impermeable to gases, do not deteriorate with age, and, if possible, are noncombustible. Suitable materials are stainless steel, heavily chrome- or nickel-plated steel, aluminized steel, aluminum, anodized aluminum, and aluminum or steel coated with oven-baked enamel.[36]

Containers can be molded of a suitable plastic material, such as polypropylene. Any plastic material used in storage environments must have very good aging characteristics and be nonreactive with photographs during long-term storage. Acrylics, unsaturated polyesters (the plastic base for many fiberglass-reinforced articles), and other plastics which may contain residual peroxides should be avoided. Phenolics (such as Bakelite), which may release formaldehyde, should not be used. Decorative plastic laminates (such as Formica) are usually made with a thin melamine-formaldehyde top-sheet laminated to a phenolic base and are unsuitable for storing photographs because both the plastic laminate itself and the contact adhesives that adhere the materials to countertops and cabinets can cause deterioration of silver images. All chlorinated plastics, such as polyvinyl chloride (PVC), should be avoided.

Wood, especially resinous softwoods such as pine or fir, should not be used for containers because wood may release peroxides or other chemicals which, over time, will harm photographs.[37] Well-aged hardwoods, such as maple or birch, are less of a problem, but these too should be avoided if possible. Plywood, particle board, chipboard, Masonite, and other glued or laminated wood products are unsuitable because of potentially harmful substances in the bonding adhesives (most of which are made with formaldehyde as a primary ingredient) and in the wood itself.

Cardboard Boxes

Most types of cardboard boxes are not satisfactory for long-term storage because cardboard, containing groundwood and lignin, is usually acidic and relatively unstable; decomposition products of cardboard may adversely affect photographs, particularly black-and-white prints. Lignin has been cited as a "powerful cause of fading and staining during long-term storage."[38] A wide variety of glues and pastes — many of which are hygroscopic — are used in

Hollinger metal-corner boxes containing negatives, transparencies, and prints in the cold storage vault at the Gerald Ford Library in Ann Arbor, Michigan. Working in the vault is Richard Holzhousen, curator of photography at the library. Administered by the National Archives and Records Administration's Office of Presidential Libraries, the library collection focuses on Ford's years as President of the United States.

January 1982

cardboard box construction; the effects of these adhesives on photographs are not known. Boxes in which photographic papers and films are supplied by the manufacturers, while probably not harmful for short-term storage, are unsuitable for long-term storage of black-and-white photographs. These boxes have commonly been used by photographers because a ready supply of them is usually available — in proportion to the number of prints processed — and because they precisely fit the common print sizes. Carol Brower has seen dye stains on prints and mounts which have been stored for a few years in these boxes before being delivered to her for matting; for example, a distinct blue and orange staining sometimes occurs on the exposed surfaces and edges of prints when stored inside the familiar orange photographic paper boxes manufactured by Agfa-Gevaert. Agfa removed the dark interior papers sometime after 1983; prints stored in the current boxes are exposed to gray chipboard, which is still unsuitable for long-term storage.

This author tested a variety of photographic paper and film boxes for pH, groundwood content, and presence of alum, using the Tri-Test Spot Testing Kit for Unstable Papers.[39] Of the samples tested, all except some Kodak black-and-white paper boxes of recent years indicated groundwood content and were quite acidic. Kodak has advised: "Cardboard boxes in which unexposed film, plates, and paper are packaged should not be used for enclosure materials. Packaging material which is suitable for unexposed sensitized materials may not be inert to processed materials."[40] It would be extremely helpful if manufacturers supplied film and paper in good-quality boxes made with stable and photographically nonreactive cardboard; the added cost would be slight and the benefits great since so many photographs are stored in these boxes.

Hollinger Metal-Corner Boxes

Primarily used for long-term storage of documents and photographs in archives and museums, the first boxes of this type were produced in 1954 by the Hollinger Corporation, a packaging and box manufacturer now located in Fredericksburg, Virginia, near Washington, D.C., for the

February 1987

Members of the Photographic Materials Group of the American Institute for Conservation study photographs in the Historic New Orleans Collection during the group's 1987 meeting in New Orleans, Louisiana. Much of the collection is matted, both to enhance the presentation of the photographs and to reduce physical damage during handling and study. Drop-back Solander boxes allow matted prints to be lifted out easily without damage to the edges of the mats. Cotton gloves are made available to all visitors.

National Archives and Records Administration. Originally made with a low-groundwood, nonbuffered cardboard with a pH of about 7.5, and sized with Aquapel, the boxes were fabricated with baked-lacquer-coated steel corners, which avoided glues or pastes. A gray pigment-coated paper with good light-fading stability was bonded to the cardboard to keep the boxes looking "new" with the passing years.

Boxes of this design became commonly known as "The Hollinger Box" and can be found in archives and museums throughout the world. Current boxes supplied by the Hollinger Corporation have the same construction as the originals but are now made with alkaline-buffered cardboard with a stated minimum pH of 8.5. The calcium carbonate buffering agent is dispersed throughout the cardboard; an alkaline-buffered gray facing sheet is laminated to the outside of the box and a buffered white paper to the inside. At the time of this writing in 1992, no test data were available concerning the suitability of Hollinger boxes for long-term storage of photographs. For storage of prints and large sheet films, flat boxes with drop-fronts should always be used; the boxes preferably should be about 2 inches deep, and never more than 4 inches deep.

Boxes similar in physical design to those originated by Hollinger are now supplied by Conservation Resources International, Inc., Light Impressions Corporation, Century Division of Pohlig Bros. Inc., and a number of other companies; they are often called "metal-edge" or "metal-corner" boxes.

Conservation Resources Lig-free Type II Boxes

Probably the best currently available cardboard storage boxes are the Lig-free Type II boxes manufactured by Conservation Resources International, Inc. of Springfield, Virginia. Introduced in 1984, the boxes are made with the previously described Lig-free Type II board, which has a polyester moisture barrier laminated between a sheet of white, nonbuffered, lignin-free paper on the inside and a sheet of alkaline-buffered, lignin-free boxboard with a cream-color facing sheet on the outside. The boxes come in low-cost "fold-up" designs as well as in the traditional metal-corner Hollinger design fabricated with staked metal corners; both designs are free of glued seams. The boxes are also made with a lower-cost, alkaline-buffered, lignin-free boxboard called Lig-free Type I, which does not contain a polyester moisture barrier.

Lig-free boxes are currently available in a number of styles; the Drop Front Print Boxes, Negative Boxes, and Document Cases are best suited to photographic needs. Microfilm storage boxes are also available. Conservation Resources can custom-make almost any style or size of

box on special order. The boxes are moderate in price: the cost of a 11½x14½x3-inch Lig-free Type II drop-front box for 11x14-inch prints is about $6 in quantities of 20, and less for larger quantities. Lig-free Type I boxes of the same size cost about $5, and 2-inch-deep Lig-free corrugated fold-up boxes for 11x14-inch prints are about $3. Lig-free corrugated cardboard is made in two forms: one is alkaline-buffered throughout, while the other is made with one side (and the corrugated core) alkaline-buffered and the opposite side nonbuffered.

Also recommended are the Hollinger-type boxes supplied by Light Impressions Corporation under the names Drop Front, Flip-Top, and Flat Storage Boxes. They are made of TrueCore boxboard, a tan, alkaline-buffered, lignin- and alum-free, wood pulp boxboard which is claimed to contain less than 0.0008% reducible sulfur and to have been tested with the *ANSI IT9.2-1991* Photographic Activity Test. The boxboard does not have a polyester moisture barrier, and the boxes are somewhat less expensive than the previously described Conservation Resources Lig-free Type II boxes.

Solander Boxes

Many private collectors, museums, and galleries store their fine art photography collections in cloth-covered, wood-framed boxes (cases) with cloth-hinged tops and drop backs, commonly called "solander boxes,"[41] "museum cases," or "print cases." They are almost always black, usually covered with a slightly pebbled, semi-gloss, pyroxylin-impregnated book-binding fabric. The best known manufacturer is Spink & Gaborc, Inc. in Clifton, New Jersey (from its founding in 1911 until 1985, the firm was located in New York City). Similar boxes are also made by Light Impressions Corporation in Rochester, New York; Museum Box Company

John Lawrence, curator of the Historic New Orleans Collection, holds a drop-back Solander box. Boxes such as this one are used to store all of the museum's matted prints.

February 1987

May 1982

Fine art portfolios are presented in custom-made cases, most of which are of the clam-shell design. At Light Gallery in 1982, Carol Brower and Peter Wilsey (former Light Gallery associates) examine Mitch Epstein's 1981 portfolio of six overmatted Dye Transfer photographs. The portfolio cases were made by Lisa Callaway of North Hampton, Massachusetts. Located at 724 Fifth Avenue in New York City, Light Gallery was the world's preeminent contemporary photography gallery from 1971 until the early 1980's, when an abrupt downturn in the market for fine art photographs led to the gallery's closing.

in West Warwick, Rhode Island; Portfoliobox, Inc. in Providence, Rhode Island; Opus Binding Limited in Ottawa, Ontario (not related to Opus Framing, Ltd., another Canadian company); G. Ryder & Co. Ltd. in Milton Keynes, England; Atlantis Paper Company Limited in London, England; and a number of other firms.

Solander boxes have long been used by museums for storage of drawings, lithographs, and other works of art on paper; when these institutions began to acquire photographs, it seemed logical to store them in these boxes as well. Such boxes are fairly expensive (in 1992 a box for 16x20-inch prints cost about $80), attractive, durable, and offer excellent *physical* protection for photographic prints. The lipped lids form an effective seal against dust when the box is closed. The boxes are usually made with a cloth-hinged drop back, which facilitates access to the contents and minimizes the possibility of damage to prints and mounts during handling, and are equipped with two polished nickel-plated clasps and a label holder on the front. Handles are available by special order.

Boxes currently manufactured by Spink & Gaborc are framed with pine wood; the top and bottom are made of binders board, a type of heavy compressed cardboard for covering hardbound books. The exterior of the box is covered with a pyroxylin-impregnated fabric, the edges of which wrap around into the inside of the box. The interior is covered with a shiny, white, clay-coated paper glued to the frame and to the binders board which forms the top and bottom of the box. On request, alkaline-buffered paper can be substituted for the clay-coated paper. The boxes are assembled with glue.

Binders board is a thick, low-cost, single-ply cardboard made from waste paper such as newsprint, scraps of cardboard, etc. Binders board has a high groundwood and lignin content. It contains many impurities and is usually nonbuffered and acidic. Binders board should not be used in photographic storage containers and in particular should be avoided for storage of black-and-white prints. If, for reasons of economy, binders board must be used, the alkaline-buffered Acid-pHree binders board introduced in 1984 by the Davey Company is strongly recommended.[42] The cost of this more stable product is only marginally greater than ordinary acidic, nonbuffered binders board.

Pyroxylin is a plasticized cellulose nitrate plastic (having a lower nitrogen content than highly flammable cellulose nitrate film base) and is commonly used as a lacquer base for coatings on book covers. Pyroxylin and other cellulose nitrate-based plastics are not sufficiently stable for long-term applications; on aging, pyroxylin can evolve nitrogen oxides and other substances which are harmful to black-and-white silver images. William Lee *et al.* have cautioned against their use with black-and-white photographs.[43] Acrylic-impregnated book binding cloth, which is a satisfactory substitute for pyroxylin-impregnated fabric, is available from Industrial Coatings Group, Inc.[44]

On special order, Spink & Gaborc will manufacture boxes with 100% cotton fiber mount board in place of binders board and replace the pyroxylin-impregnated fabric with an acrylic-coated, starch-filled, or plain cloth material (unfortunately, the wood frame is retained); these special boxes are sold at a premium price.

This author is unaware of any tests that have been conducted to determine the long-term effects of storing photographs in Spink & Gaborc boxes. Nor does this author know of any damage to photographs that has been directly attributed to Spink & Gaborc boxes. They are used extensively at the Museum of Modern Art in New York City; George Eastman House in Rochester, New York; the Art Institute of Chicago, and most of the other major fine art photography collections in the United States; however, binders board, wood frames, and various other materials in these boxes are potentially very harmful to silver images. Although the boxes probably present no immediate hazard to photographs, they cannot be recommended for long-term storage of black-and-white photographs, especially in humid locations.

Silver images — particularly the images of albumen prints, silver-gelatin printing-out papers, and contemporary RC prints — can be extremely sensitive to peroxides and other contaminants which, over time, are likely to be evolved from many of the components in Solander boxes. Harmful substances could reach print images either by migration through boards and papers or in a gaseous form. This author believes that of all the materials in a Solander box which have the potential to harm silver images, the acidic, high-lignin-content binders board is the cause for greatest concern. Forming both the top and bottom of the box, the total surface area of the binders board is quite large, and the board is also in very close proximity to the topmost and bottommost photographs stored inside the box. Image deterioration of silver-gelatin microfilms which has been attributed to peroxides evolved from cardboard storage boxes indicates that *all* materials used in the vicinity of silver image black-and-white films and prints must be selected very carefully.[45]

An improved version of the basic box design — in which the wood frame is replaced with extruded aluminum or a suitable plastic such as polypropylene, and with the top and bottom made with either aluminum or alkaline-buffered and lignin-free board, covered with an acrylic-coated fabric, and assembled with long-lasting, nonreactive adhesives — would be a major advance in the photographic conservation field; the internal and external appearance of such an improved box could remain unchanged.

In 1985 Light Impressions Corporation announced that in 1986 it would replace the binders board used in all of their Solander museum cases with a better-quality, alkaline-buffered, lignin-free boxboard; unfortunately, the company abandoned the idea for "practical and economic reasons," and decided to continue using inexpensive, low-quality, high-lignin-content, acidic binders board. Light Impressions did, however, replace the pyroxylin-impregnated fabric covering on its boxes with an acrylic-coated fabric. At a premium price, Light Impressions can also supply custom-made boxes, using materials specified by the customer.

Portfolio Cases and Clamshell Boxes

Light Impressions Corporation; University Products, Inc., Century Division of Pohlig Bros. Inc., Museum Box Company, Portfoliobox, Inc., G. Ryder & Co. Ltd., and several other companies make a moderately priced box usually called a "portfolio case" or "clamshell box." Extensively used for storing photographs, these boxes are constructed of binders board covered with pyroxylin-impregnated fabric or other book-covering cloth, and lined with paper or synthetic materials such as DuPont Tyvek. They are available in a variety of colors, the most common being gray, black, and brown. The boxes are glued together, and the top, bottom, and drop back are attached with flexible cloth joints; there are no wood frames, and the boxes do not have metal latches. A variation of the design, with a slightly overhanging top and bottom, is known as a "lipped clamshell" box. Detailed instructions on how to make these boxes are contained in a publication from the Library of Congress entitled *Boxes for the Protection of Rare Books – Their Design and Construction.*[46]

There are currently no accelerated test data on the effects on photographs of the materials that go into the manufacture of these boxes (materials and adhesives vary among manufacturers). Other than the lack of wood frames, portfolio cases are made with materials and construction techniques similar to those found in Solander boxes. While they are probably satisfactory for storing color photographs and likely present no immediate hazard to black-and-white prints, they are not recommended for long-term storage of black-and-white photographs, especially in humid conditions.

In late 1986, as the company did with their museum cases, Light Impressions Corporation replaced the pyroxylin-impregnated fabric covering of their boxes with an acrylic-coated fabric. Announced plans to improve the quality of the board used in the manufacture of the boxes were abandoned, however, and at the time of this writing in 1992 the boxes continued to be made with a low-quality, high-lignin-content, acidic binders board.

Metal Print-Storage Boxes

In the late 1970's, a steel print box was manufactured by Saxe Archival Systems, a Canadian firm; the box was coated with a heat-cured dry powder finish.[47] Equipped with a hinged drop front and a telescoping lid that lifts off, it was an interesting attempt to make an improved box. Because of the heavy-gauge steel used to make the box, it is heavy and difficult to handle. It is also likely that rust would develop in humid environments should the finish become chipped or scratched. This author finds the Saxe box to be generally unsatisfactory.

Several photographers have had metal boxes custom-made for portfolios. In 1980 Lilio Raymond used a brushed aluminum box for a portfolio entitled *Six Photographs;* the edition was limited to 30 sets and was sold for $1,000 by the Marcuse Pfeifer Gallery in New York City. Joe Maloney had a spray-painted metal box made for his portfolio of ten Kodak Dye Transfer prints published and sold by QED Editions in New York City for $5,000 in 1982.

A print storage box made of aluminum, lined with 100% cotton fiber mount board, and "covered in cloth to make it aesthetically pleasing," was under development by a British firm called Goldfinger Ltd.; unfortunately, the company went out of business in 1985 and the box was never marketed. This approach to box design appears to be sound, however, and it is hoped that in the future some other manufacturer will produce a box of this type.

Photograph Albums

Paper products in photograph albums should meet the same requirements as mount board, interleaves, envelopes, and any other paper in direct contact with films and prints; additional information on paper quality can be found in Chapter 13.

Photograph albums have traditionally been fabricated from paper of very low quality; usually made with alum-rosin size, these acidic papers often contain significant amounts of lignin from groundwood, and have potentially harmful levels of sulfur. Combined with damaging adhesives, the paper in such albums has caused — or accelerated — the discoloration and fading of countless millions of photographs.

November 1986

Commercial blueprint files are excellent for storing prints (especially large unmatted prints) because they have wide, shallow drawers. Marthe Smith, former director of the Life Gallery of Photography in New York City, and Carol Brower look at Alfred Eisenstadt photographs. The gallery exhibits and sells photographs from the extensive Time Inc. Magazines Picture Collection (part of Time Warner Inc.).

More recently, photograph albums with plastic-covered "self-stick" or "magnetic" pages have become very popular for storing amateur snapshots. As a group, these albums have proven to have very poor aging characteristics and are unacceptable for storing any type of photograph. In a 1987 *New York Times* article about the hazards of poor-quality photo albums, Glenn Collins wrote:

> The worst type of album, conservators say, is the most common one: the so-called magnetic album. It has no magnets, but its cardboard pages grip photographs on a sticky adhesive coating covered by a layer of plastic that is peeled back to position the photos.
>
> In such albums, "the cheap-quality cardboard gives off peroxides that cause yellow staining in the whites of the prints in both black and white and color prints," Mr. [James] Reilly said.
>
> The plastic covering can be harmful not only because it completely seals the photograph in with cardboard, but because the plastic gives off gases that attack photographic images.
>
> Furthermore, Mr. [Douglas] Severson said, "the strips of adhesive material can be devastating to photographs, transferring themselves to the print." Ms. [Judith] Fortson explained that eventually a bond forms between the adhesive and the photograph, "so you cannot take out the photo without destroying it."
>
> This is by no means the only harmful type of album. Mr. Reilly said the black backing paper that was used in many older albums "is the pits — the paper gives off oxidant gases that attack photo images."[48]

Existing albums of poor-quality materials can best be preserved by storing in refrigerated conditions with low relative humidity (about 30%) and the lowest temperature possible (see Chapters 19 and 20).

Many albums contain valuable written material such as captions to the photographs, and this material should be photocopied if it is decided to remove prints from an album. Unmounting photographs, especially old prints attached with unknown adhesives, is a complex and hazardous procedure and should not be attempted unless adequate equipment and thoroughly experienced personnel are available. It is beyond the scope of this book to discuss unmounting, reprocessing, and restoration of old photographs.

3M FlashBacks Brand Photo Albums with Self-Stick Pages

Perceiving that a large market existed for a reasonably safe, easy-to-use photograph album with self-stick pages, in 1991 the 3M Company introduced a line of albums with self-stick pages under the FlashBacks name. These albums utilize a different and much longer-lasting "tacky" adhesive to hold photographs in place than other currently available self-stick albums. 3M cautions, however, that the adhesive, which is similar to that used in 3M's familiar removable yellow "Post-it" note pads, may leave a "slight residue" on the backs of prints.

This author has not tested these albums for the long-term effects they could have on photographs. FlashBacks albums should not be used in museum or archive applications. However, the albums appear to be made of reasonably good quality materials and the pages are made with long-lasting polypropylene cover sheets. For those who insist on using self-stick albums, FlashBacks albums are recommended as the best currently available albums of this type. They are clearly much safer for photographs than the common, low-cost, self-stick "magnetic-page" albums discussed previously.

Albums with Paper and Polyester Pages

Light Impressions Corporation, University Products, Inc., Century Division of Pohlig Bros. Inc., Photofile, Inc., and a few other suppliers now market "archival" photograph albums with paper pages and polyester-covered pages which, in general, are made with long-lasting and nonreactive materials. These albums, which appear to be suitable for histori-

cal societies, museums, and other long-term applications, are fairly expensive.

Low-cost albums of reasonable quality can be made by using a loose-leaf notebook filled with good-quality artists' drawing paper obtainable at any art supply store. A notebook with a cloth or paper cover is preferable to one made with the currently popular plasticized PVC covers. The artists' paper can be cut to the proper size and holes punched with a standard paper punch. Gummed hole reinforcements should then be applied to the holes. Pencil or India ink should be used to mark the pages. Prints may be attached with mounting corners (see Chapter 12), or with 3M No. 568 Positionable Mounting Adhesive, available from photographic supply stores.

Uncoated polyester notebook page protectors (made from DuPont Mylar D or ICI Melinex 516), available from Light Impressions Corporation and most office supply stores, offer excellent physical protection for album pages; because transparent notebook page protectors are made from a variety of plastics, be certain that those to be placed in photograph albums are fabricated from polyester.

Webway Family Archival Albums

Moderately priced, well-designed albums consisting of good-quality acid-free and lignin-free paper pages with ICI Melenix polyester-covered "Picture-Pockets" are supplied by Webway Incorporated of St. Cloud, Minnesota under the Webway Family Archival Album name. These albums, which can be easily expanded with low-cost Family Archival refill pages, are available in sizes for standard 3½x5-inch 3R format prints ($18.00) and 4x6-inch 4R format prints ($20.00). Page styles are available both with and without an ample writing space below each print for captions (probably better for most people are the pages with extra writing space, even though these pages accommodate fewer prints than the page style without writing space).

Webway Family Archival albums, which were introduced in 1989, are this author's primary recommendation for general home and amateur storage of both color and black-and-white photographs. For 8x10-inch prints, the Webway Portrait Album is available. Webway supplies other albums under the Classic, Prestige, and Vanguard names; some of these albums are sold with "Press-N-Stick" self-adhesive pages, which should be avoided.

Albums with Polypropylene and Low-Density Polyethylene Pages

C-Line Products, Inc., 20th Century Plastics, Inc., Light Impressions Corporation, and others sell surface-treated (coated) polypropylene notebook pages with sectioned pockets, similar to those made for slides, to hold a variety of common print sizes. Although surface-treated polypropylene pages are superior to PVC notebook pages, such as those sold by 20th Century Plastics, they are not recommended by this author for long-term storage of valuable photographs; polypropylene pages should be avoided in museum and archive applications. Likewise, polyethylene notebook pages made by Vue-All Incorporated, Print File, Inc., Clear File Inc., and other suppliers are not recommended. For further information, see Chapter 14.

November 1986

Print boxes are stored on steel shelves (coated with baked enamel) at the Museum of Modern Art in New York City. The shelves are open and no box rests on another; this provides ready access to the boxes and the prints. Here, Peter Galassi, now the director of the Department of Photography, removes a print box for study purposes. The photography collection is stored in an environmentally controlled room at 60°F (15.5°C) and 40% RH.

A variety of low-cost consumer albums with polypropylene-covered pages are available from the Holson Company of Wilton, Connecticut. Holson has advertised that its album pages have "No PVC Content." One Holson brochure issued in 1985 shows a faded color print that is claimed to have been stored for 5 years in a PVC album page. Also illustrated is an unfaded print of the same scene which has received "No PVC Exposure." On inquiry to the company, this author was informed that the "unfaded" print was not 5 years old like the "faded" print — it was actually a new print made from the original negative. The faded print stored in the polyvinyl chloride page appears to have suffered a near total loss of cyan dye and, judging from its appearance and the date it was supposed to have been made, this author believes that Agfacolor Paper Type 4 was probably used to make the print.

Agfacolor Paper Type 4 has extremely poor dark fading stability and in 5 years would be expected to fade in this manner, regardless of whether the print was stored in a PVC album page. The Holson Company could not identify

March 1981

Thomas Hill, Peter Krause (center), and other visitors look at large unmounted panoramic prints stored in blueprint files at the Humanities Research Center Photography Collection at the University of Texas in Austin.

the type of paper that was used to make the 5-year-old print.[49] The company did say, however, that the faded print had no backprinting — this precludes it from being an Ektacolor print because all Kodak color paper sold in the U.S. during that period was backprinted to identify it as a Kodak product. Most, if not all, Agfacolor Paper Type 4 imported into the U.S. was not backprinted (watermarked). The new, "unfaded" print was made on Kodak Ektacolor paper.

Regardless of whether a PVC page was the cause of the fading suffered by the print in the Holson brochure, Holson's concern about PVC is justified and the firm's polypropylene-page albums are to be preferred over albums supplied with PVC or poor-quality paper pages. In Holson's product literature, the company does not identify the brand or type of polypropylene in its albums.

Unless plastic-covered pages or plastic page protectors are used, photographs should be mounted on only one side of each album page; if prints are mounted on facing pages, they may catch and damage each other as the pages are turned. In addition, direct print-to-print contact will permit chemicals from poorly processed prints to migrate onto other prints. It is also important to prevent different types of prints (e.g., Kodacolor prints and Polaroid instant prints) from directly contacting each other in the album.

Albums should be kept in a cool, dry place away from strong light. This is especially important if the album contains color photographs. Albums containing lacquered Ektacolor and similar chromogenic color prints from professional wedding and portrait photographers should be opened several times a year during the first few years after the prints are made to allow lacquer solvent vapors to dissipate; Kodak reports that "Lacquered prints can . . . turn yellow in albums that are tightly sealed, particularly where peroxide forming solvents are present in the lacquer."[50] Prints obtained from drugstores, "one-hour" minilabs, and similar outlets are never lacquered.

Other Types of Albums

Hallmark Card Shops (operated by Hallmark Cards, Inc. of Kansas City, Missouri) sell several types of photograph albums, some of which are made with overlapping cellulose acetate pages with prints inserted back-to-back, two to a page. These albums appear to be satisfactory for amateur use.

Some albums supplied by the Polaroid Corporation for Polaroid 600 and SX-70 prints require that the prints be flexed during insertion into album page slots. These albums should be avoided because such bending may contribute to eventual cracking of the prints' internal image-receiving layer. Polaroid albums for peel-apart color and black-and-white prints that have pages made of plasticized polyvinyl chloride (PVC) are not recommended for long-term storage of photographs.

Cabinets and Shelves

Cabinets and shelves should be constructed of steel or aluminum coated with baked enamel, of chrome- or nickel-plated steel, of anodized aluminum, or of stainless steel.[51]

Wood is not recommended, but if it *must* be used, well-dried hardwoods such as maple or birch are preferred. For reasons to be discussed later, plywood and particle board in particular should be avoided. Structural foam plastics and laminated decorative plastics such as Formica should never be used.

ANSI standards concerned with the storage of photographs suggest both "baked-on nonplasticized synthetic resin lacquer" and "baked-on enamel"[52] as suitable finishes for steel cabinets, shelves, and other storage housings.[53] Lacquers containing cellulose nitrate (pyroxylin) should be avoided. Kodak has recommended against both acrylic lacquers and acrylic enamels.[54]

If steel equipment is to be repainted, this author suggests having this work done at a commercial spray-paint shop equipped with drying ovens to produce the proper finish. Some automobile paint shops can do this type of work. Finishes on wood will blister if baked at high temperatures; therefore, water-base latex paints, which do not require baking, are recommended for painting wood shelves and cabinets, as well as walls and other fixtures in galleries and storage areas. Alkyd oil-base paints have been shown to produce peroxides and other vapors which can rapidly discolor black-and-white images. Larry Feldman of Eastman Kodak has reported that unbaked alkyd oil-base enamel continued to evolve harmful fumes for many weeks after the paint was applied; latex paints, however, did not produce harmful fumes in the Kodak tests.[55]

Anodized aluminum is an excellent material for cabinets and shelves, though it is more expensive than baked-enamel-coated steel. Stainless steel is also excellent, but because it is very expensive it is not often chosen for making photographic storage equipment.

A wide range of cabinets, cabinets with shelves, and open shelves made of steel finished with baked enamel are available from office equipment dealers at moderate cost; most are well suited for long-term storage of photographs. Blueprint files, which have many large drawers of shallow depth, are excellent for storing large or odd-sized prints.

For large-volume storage applications, shelving which can be rolled together will save a significant amount of space; the shelves are rolled apart for access.[56] Shelves of this type are particularly helpful in cold storage facilities where space is at a premium.

Cabinets and closed shelves normally do not need ventilation if the prints stored in them are properly processed and the mount board, paper products, and boxes are of high quality. Closed cabinets greatly reduce problems with dust and minimize effects of air pollution. Unventilated cabinets also minimize fluctuations in relative humidity if the humidity in the storage area is not controlled.

If the photographs and associated paper products and boxes are of poor quality, however, there may be some advantage in providing ventilation to allow peroxides and other potentially harmful vapors to diffuse into the surrounding air. Cabinets for storing cellulose nitrate films at room temperature should be adequately ventilated — and if possible should be located in a separate building away from other collections. Ideally, nitrate films should be sealed in vapor-proof containers and stored in special, explosion-proof freezers at a temperature of 0°F (–18°C) or lower (see **Appendix 19.1** in Chapter 19).

Plywood, Particle Board, and Formica-covered Cabinets and Shelves Should Be Avoided

Margaret A. Leveque, a conservator at the Museum of Fine Arts in Boston, has reported a case in which metal objects in the museum collection corroded within a short period after they were put in new plywood display cases.[57] The source of the problem was identified as formaldehyde from the urea-formaldehyde adhesive that bonded the layers of plywood together; samples of the birch plywood in the cases contained about 7.8% free formaldehyde by weight. Attempts to seal the plywood with three coats of polyurethane varnish and covering the cut edges with strips of hardwood proved to be of little benefit. Ventilation of the display cases also did not solve the problem.

Leveque also reported that tests of the interior environment of veneered wood-particle-board storage cases installed in the newly built Sackler Museum at Harvard University indicated such high levels of formaldehyde that it was decided not to jeopardize museum objects by placing them in the cases; instead, the units were replaced with baked-enamel steel cases.

It has been shown that formaldehyde vapors also are capable of harming black-and-white photographs. In an important article published in 1972, Edith Weyde, a research chemist at Agfa-Gevaert in Leverkusen, West Germany, described a number of chemical processes which the silver images of black-and-white films and prints can undergo during the course of image deterioration:

> When silver coatings are exposed to oxidizing gases, soluble silver salts form in these coatings. . . . These salts are colorless and will remain that way for years if they are protected from intense light exposure and kept in pure air. The only effect of the oxidizing gases is to reduce the density of the images, which is easily overlooked. However, the colorless silver salts are very easily converted to brown, water-soluble compounds, if the air contains traces of certain impurities such as formaldehyde, acids, etc. For example, it is quite sufficient to open a bottle of formaldehyde in the same room to stain these colorless silver salts brown. Light will quickly convert these salts to silver.[58]

The initial reason for Weyde's research was the unexpectedly rapid deterioration of some of the films and prints in the Munich archives. Weyde was able to identify plastic file index cards made of phenylene-formaldehyde as the cause; the cards had been in use at the archives for 14 years, and the first signs of image discoloration had been noted after 5 years.

Formaldehyde solutions have been used as hardeners in black-and-white processing, and it is apparent that newly processed silver images are not adversely affected by short-term exposure to the substance. Older films and prints, on the other hand, are likely to contain at least trace amounts of silver salts due to exposure to oxidizing gases during the course of storage; as a result, the photographs may be subject to discoloration in the presence of formaldehyde. The hazard is probably the greatest for films and prints

which have been subjected to periods of storage under adverse conditions during their history.

This underscores this author's recommendation that museums and archives in particular should strictly prohibit wood, plywood, particle board, chipboard, Masonite, and formaldehyde-containing plastic laminates such as Formica in making boxes, cabinets, shelves, and display cases for storing their collections.

Notes and References

1. Glenn Collins, "Fading Memories: Albums Damage Photos," **The New York Times,** October 3, 1987, p. 16Y.
2. T. F. Parsons, G. G. Gray, and I. H. Crawford [Eastman Kodak Company], "To RC or Not to RC," **Journal of Applied Photographic Engineering,** Vol. 5, No. 2, Spring 1979, pp. 110–117. See also: Larry H. Feldman [Eastman Kodak Company], "Discoloration of Black-and-White Photographic Prints," **Journal of Applied Photographic Engineering,** Vol. 7, No. 1, February 1981, pp. 1–9. (The Feldman article does not directly address the image deterioration in framed and displayed black-and-white RC prints.) Kodak's most recent advice: **"Displaying Prints:** Prints on black-and-white, resin-coated [RC] papers that may be subjected to intense or extended illumination, exposed to oxidizing gases, or framed under glass or plastic should be treated with toners . . . to extend image life. Toned fiber-base papers continue to be recommended for those applications requiring long-term keeping under adverse storage or display conditions." (From information sheet: **Kodak Polycontrast Rapid II RC Paper,** KP73873f, Eastman Kodak Company, Rochester, New York, August 1981.)
3. W. E. Lee, F. J. Drago, and A. T. Ram, "New Procedures for Processing and Storage of Kodak Spectroscopic Plates, Type IIIa–J," **Journal of Imaging Technology,** Vol. 10, No. 1, February 1984, p. 28.
4. Light Impressions Corporation, **Light Impressions Mid-Summer 1991 Archival Supplies Catalog,** p. 2 (see **Suppliers** list below for Light Impressions' address).
5. See **ANSI PH1.48-1982, American National Standard for Photography (Film and Slides) – Black-and-White Photographic Paper Prints – Practice for Storage,** 1982, p. 6. American National Standards Institute, Inc., 11 West 42nd Street, New York, New York 10036; telephone: 212-642-4900; Fax: 212-398-0023.
6. Eastman Kodak Company, **Conservation of Photographs** (George T. Eaton, editor), Kodak Publication No. F-40, Eastman Kodak Company, Rochester, New York, March 1985, p. 108.
7. PermaColor Corporation, press release, June 1, 1982.
8. Norb J. DeKerchove, product research coordinator, Light Impressions Corporation, Rochester, New York.
9. Toshiaki Aono, Kotaro Nakamura, and Nobuo Furutachi [Fuji Photo Film Co., Ltd.], "The Effect of Oxygen Insulation on the Stability of Image Dyes of a Color Photographic Print and the Behavior of Alkylhydroquinones as Antioxidants," **Journal of Applied Photographic Engineering,** Vol. 8, No. 5, October 1982, pp. 227–231. See also: Kaoru Onodera, Toyoki Nishijima, Shun Takada, and Masao Sasaki [Konica Corporation], "The Effect of Oxygen Gas on the Light-Induced Fading of Dye Images and Staining of Color Photographic Prints," presented at the **Second SPSE International Conference on Photographic Papers,** sponsored by the Society of Photographic Scientists and Engineers, Vancouver, British Columbia, Canada, July 24, 1984.
10. Remon Hagen, "Further Improvements in the Permanence of Cibachrome Materials under Adverse Display Conditions," **Journal of Imaging Technology,** Vol. 12, No. 3, June 1986, pp. 160–162. One company offering rigid plastic encapsulation of Ilfochrome (Cibachrome) and other photographs is: Armourseal, VPB Industries, Albion Mill, Hollingsworth, Hyde, Cheshire SK14 8LS, England; telephone: 01-0475-65226. See also: Attila Kiraly, "The Kiraly Method of Embedding Cibachrome Display Prints for Archival Protection," **Proceedings of the International Symposium: The Stability and Conservation of Photographic Images: Chemical, Electronic and Mechanical,** Bangkok, Thailand, November 3–5, 1986, pp. 139–144. (Available from: SPSE, The Society for Imaging Science and Technology, 7003 Kilworth Lane, Springfield, Virginia 22151; telephone: 703-642-9090.)
11. Eastman Kodak Company, **Quality Enlarging with Kodak B/W Papers – Art, Technique, and Science,** Kodak Publication No. G-1, Eastman Kodak Company, Rochester, New York, May 1982, p. 119.
12. Laurence E. Keefe, Jr. and Dennis Inch, **The Life of a Photograph,** Focal Press (Butterworth Publishers), Boston, Massachusetts and London, England, 1990, p. 179. The venting recommendation was also included in the first edition of the book (p. 165), published in 1984.
13. Eastman Kodak Company, see Note No. 6, pp. 57–58. See also: Eastman Kodak Company, **Printmaking with Kodak Elite Fine-Art Paper,** Kodak Publication No. G-18, Eastman Kodak Company, Rochester, New York, November 1984.
14. Debbie Hess Norris, "The Proper Storage and Display of a Photographic Collection," **Picturescope,** Vol. 31, No. 1, Spring 1983, p. 10.
15. Laurence E. Keefe, Jr. and Dennis Inch, see Note No. 12, p. 182.
16. If economy dictates corrugated cardboard as backing for framed photographs, the best available product is probably Lig-free Corrugated Board, supplied by Conservation Resources International, Inc. (see **Suppliers** list at the end of this chapter).
17. American Society for Testing and Materials, **ASTM D 984–74, Standard Methods of Testing for Reducible Sulfur in Paper,** American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103; 1974. Related Standard: Technical Association of Pulp and Paper Industry [TAPPI] Standard Method T 406 Su 72.
18. T. J. Collings and F. J. Young, "Improvements in Some Tests and Techniques in Photograph Conservation," **Studies in Conservation,** Vol. 21, No. 2, May 1976, pp. 79–84.
19. Check with aluminum suppliers in your area (listed in the Yellow Pages of the telephone book). Some industrial suppliers will sell only to large-quantity purchasers. Small or large quantities, including cut-to-size pieces, may be purchased from Lawrence N. Frederick, Inc., 501 East Lake Street, Streamwood, Illinois 60107; telephone: 708-289-8300. This firm also sells anodized aluminum foil.
20. Michael F. Bruton, market supervisor, Fabricated Products Division, Monsanto Plastics and Resins Co., 800 N. Lindbergh Boulevard, St. Louis, Missouri 63166, letter to this author, December 1, 1982.
21. Advertisement in **Photographic Processing,** Vol. 18, No. 6, June 1983.
22. International Paper Company, **Gatorfoam Photo-Mount Use Instruction Sheet,** March 13, 1984, Gatorfoam Laminated Foam Panels, International Paper Company, Uniwood Division, Highway 90, P.O. Box 5380, Statesville, North Carolina 28677.
23. Advertisement in **Photographic Processing,** Vol. 18, No. 9, Sept. 1983.
24. Jay Wynne, technical manager, Gatorfoam Laminated Foam Panels, see Note No. 22, telephone discussion with this author, Oct. 24, 1984.
25. W. E. Lee **et al.,** see Note No. 3, p. 28.
26. Polaroid Corporation, **Storing, Handling, and Preserving Polaroid Photographs: A Guide,** Polaroid Corporation, Cambridge, Massachusetts, 1983, p. 33.
27. Coroplast, Inc., 700 Vadnais Street, Granby, Quebec J2J 1A7, Canada; telephone: 514-378-3995.
28. Framespace spacers are available from Frame Tek, 5120–5 Franklin Boulevard, Eugene, Oregon 97403; telephone: 503-726-5779 (toll-free outside of Oregon: 800-227-9933). Framespace spacers are made of KODAR PETG 6763 plastic, a product of Eastman Chemical Company. The plastic is claimed to contain no "plasticizers or additives which might exude."
29. Rohm and Haas Company, **Ultraviolet Filtering and Transmitting Formulations of Plexiglas Acrylic Plastic,** Plexiglas Design, Fabrication Data, PL–612d, 1979, pp. 2, 3, 5. Rohm and Haas Company, Independence Mall West, Philadelphia, Pennsylvania 19105; telephone: 215-592-3000. Plexiglas UF-3 should not be confused with Plexiglas II UVA which does not contain an ultraviolet absorber. UVA has about the same ultraviolet cutoff point as the standard grades of Plexiglas (which absorb somewhat more UV radiation than ordinary glass). The Plexiglas II series is made to much closer thickness tolerances, and is more expensive, than the standard grades such as Plexiglas G.

    Polycast UF-3 and UF-4 are manufactured by Polycast Technology Corporation, P.O. Box 141, Stamford, Connecticut 06904. DuPont Lucite SAR and Lucite SAR UF-3 are manufactured by the DuPont Company, Polymer Products Department, Lucite Sheet Products Group, Wilmington, Delaware 19898. To produce Lucite SAR UF-3 and SAR UF-4 abrasion-resistant sheet, DuPont reportedly applies its proprietary SAR coating to UF-3 and UF-4 acrylic sheet purchased from Polycast Technology Corporation. Licensing and purchasing agreements allow the Rohm and Haas UF-3 and UF-4 trademarks to be used by all three companies. Acrylite OP-2 and OP-3 are distributed by CYRO Industries, Inc., 100 Valley Road, P.O. Box 950, Mt. Arlington, New Jersey 07856; telephone: 201-770-3000.

    Plexiglas is supplied with protective paper or polyethylene cover sheets on both sides to prevent scratches during cutting and handling. Plexiglas may be cut with a table saw equipped with a fine hollow-ground plywood blade such as those sold by Sears Roebuck, Rockwell, and others. Production shops cutting large quantities of Plexiglas should use one of the fine-toothed, carbide-tipped blades especially designed for cutting acrylic sheet. These blades, which may cost more than $200 each, are available from several companies, including Forrest Manufacturing Company, Inc., 461 River Road, Clifton, New Jersey 07014; telephone: 201-473-5236. Coarse-toothed saw blades or blades with teeth which have been "set" should not be used because a rough cut and edge chipping will result.
30. Edith Weyde [Agfa-Gevaert AG], "A Simple Test to Identify Gases Which Destroy Silver Images," **Photographic Science and Engineering,** Vol. 16, No. 4, July–August 1972, pp. 283–286.
31. C. I. Pope, "Blemish Formation in Processed Microfilm II," **Journal of Research of the National Bureau of Standards – A. Physics and Chemistry,** Vol. 74A, No. 1, January–February 1970, pp. 31–36.
32. Eastman Kodak Company, **Preservation of Photographs,** Kodak Publication No. F-30, Eastman Kodak Company, Rochester, New York, August 1979, p. 30.

33. Polaroid Corporation, see Note. No. 26, p. 28.
34. Viratec Tru Vue, Inc., 1315 N. North Branch Street, Chicago, Illinois 60622; telephone: 312-943-4200; toll-free: 800-621-8339 (anti-reflection coated glass sold under the Tru Vue Museum Glass name). Denton Vacuum, Inc., 8 Springdale Road, Cherry Hill, New Jersey 08003; telephone: 609-424-1012 (anti-reflection coated glass sold under the Denglas name).
35. American National Standards Institute, Inc., **ANSI PH1.45-1981, American National Standard Practice for Storage of Processed Photographic Plates,** American National Standards Institute, Inc., 11 West 42nd Street, New York, New York 10036; telephone: 212-642-4900; Fax: 212-302-1286. (Note: This Standard eventually will be replaced with a revised version under the ANSI IT9 designation.)
36. American National Standards Institute, Inc., see Note No. 5, p. 6.
37. American National Standards Institute, Inc., see Note No. 5, p. 6.
38. James M. Reilly, **Care and Identification of 19th-Century Photographic Prints,** Kodak Publication No. G-2S, Eastman Kodak Company, Rochester, New York, 1986, p. 93.
39. The Tri-Test Spot Testing Kit for Unstable Papers was previously known as the Barrow Laboratory Paper Test Kit. The Barrow kit was developed by the now defunct W. J. Barrow Research Laboratory in Richmond, Virginia in the 1960's. See: W. J. Barrow Research Laboratory, **Permanence/Durability of the Book: VI, Spot Testing for Unstable Modern Book and Record Papers,** Richmond, Virginia, 1969 (a copy of this publication, with a new cover, is included as an instruction booklet with each Tri-Test kit). The test reagent for detecting groundwood yellows with age and should be replaced as necessary; refrigeration will greatly extend the life of the solutions. The bottle of test reagent for groundwood should be opened slowly, while holding over a sink. Eye goggles and rubber or plastic gloves should be worn. Gas pressure which may have built up inside the bottle over time can cause the solution to bubble over, perhaps with some force, upon opening. The Tri-Test kit is available for about $30 from Professional Picture Framers Association, Inc., 4305 Sarellen Road, Richmond, Virginia 23231; telephone: 804-226-0430. Also available from Light Impressions Corporation and Westfall Framing (see **Suppliers** list at the end of this chapter).
40. Eastman Kodak Company, see Note No. 6, p. 95.
41. "Solander box (Solander book-box portfolio). A more or less elaborate book or document box invented by Dr. Daniel Charles Solander, a botanist, during his tenure at the British Museum (1773–1782).

    ". . . When properly constructed the Solander box is very nearly dustproof and almost waterproof.

    ". . . The drop-back Solander is intended to house a book. For document storage, specifically to facilitate removal from the box, a drop-front box may actually be preferable, although in a strict sense it may be argued that such an arrangement is not really a Solander box. Aside from this, however, the drop-back box has a distinct advantage over the drop-front type in that the former imposes virtually no strain on the hinge of the box because it is in a right-angle position when closed and assumes a straight line position when opened."

    From **Bookbinding and the Conservation of Books,** Matt T. Roberts and Don Etherington, Library of Congress, Washington, D.C., 1982, p. 243.
42. Davey Acid-pHree binders board is available in six thicknesses, from 0.067 to 0.123 inch, from The Davey Company, 164 Laidlaw Avenue, P.O. Box 8128, Five Corners Station, Jersey City, New Jersey 07306; telephone: 201-653-0606.
43. W. F. Lee **et al.,** see Note No. 3, p. 28.
44. Acrylic-impregnated book cloth with surface physical characteristics similar to pyroxylin-impregnated fabric is manufactured under the Arrestox name (supplied in three thicknesses: A, B, and C) by Industrial Coatings Group, Inc., 220 Broad Street, Kingsport, Tennessee 37660; telephone: 615-247-2131 (toll-free: 800-251-7528). See: Ellen McCrady, "Pyroxylin vs. Aqueous (Acrylic) Coated Cloth," **The Abbey Newsletter,** Vol. 9, No. 3, May 1985, p. 3. Acrylic-impregnated book cloth also is available from: The Holliston Mills, Inc., P.O. Box 1568, Boca Raton, Florida 33429; telephone: 305-392-9934 (toll-free: 800-225-7122).
45. C. I. Pope, see Note No. 31.
46. Margaret R. Brown, comp., **Boxes for the Protection of Rare Books: Their Design and Construction,** Library of Congress, Washington, D.C., 1982.
47. Saxe steel boxes were manufactured by Saxe Archival Systems, P.O. Box 237, Victoria Station, Westmount, Quebec H3Z 2V5, Canada. The boxes were supplied in four standard sizes, 8x10 through 16x20 inches; they were coated with a dry, heat-cured, electrostatically applied polyester finish. A heavy, similarly finished steel plate was available to keep prints flat inside the boxes. For several years, Saxe boxes were distributed in the U.S. by Light Impressions Corporation, Rochester, New York.
48. Glenn Collins, see Note No. 1, p. 16Y.
49. Todd Holson, marketing manager, The Holson Company, telephone discussion with this author, October 1, 1985.
50. Eastman Kodak Company, **Post-Processing Treatment of Kodak Ektacolor Papers,** ("Reference Information From Kodak"), Kodak Publication No. E-176, Rochester, New York, July 1984, p. 5. See also Eastman Kodak Company, Note No. 6, "The Effect of Post-Processing Treatments on Color Image Stability," pp. 66–68.
51. American National Standards Institute, Inc., see Note No. 5, p. 6.
52. Modern finishes are often not clearly distinguished as being lacquers, enamels, or other types of coatings. Lacquers generally refer to thermoplastic materials dissolved in a solvent and capable of drying rapidly to harden films. Cellulose esters, including cellulose nitrate (nitrocellulose), are often used in lacquers; however, many other types of plastics, including vinyls and acrylics, are also used. The clear spray finishes for coating photographic prints are usually true lacquer products (see Chapter 4). These finishes remain soluble in appropriate solvents after drying. Another example of a true lacquer finish is fingernail paint, variously referred to as "polish," "lacquer," and "enamel."

    Enamel finishes generally refer to coatings which form a hard film by a curing process (either an oxidation or polymerization reaction) which takes place after most of the solvent has evaporated. Once hardened, these finishes are no longer soluble in common solvents. Baking at temperatures of 180–250°F (82–121°C), or higher, will produce very hard, solvent-free finishes with most alkyd and other oil-base enamels. Baked enamels of this type have traditionally been used to finish steel office equipment, home appliances, and automobiles. Baking ovens on production lines can quickly dry the enamels to a durable finish. The rising cost of energy required to heat ovens and the cost of solvent-recovery equipment for meeting air pollution regulations are causing some industries to change to two-component, catalyst-hardened finishes, which do not require heating and give off little vapor. This author has no data on the long-term effects of these two-component finishes on photographs. Another new type of finish is the heat-fused sprayable powder coating.
53. American National Standards Institute, Inc., see Note No. 5, p. 6.
54. Eastman Kodak Company, see Note No. 32, p. 30.
55. Larry H. Feldman [Eastman Kodak Company], "Discoloration of Black-and-White Photographic Prints," **Journal of Applied Photographic Engineering,** Vol. 7, No. 1, February 1981, pp. 1–9.
56. Spacesaver Corporation, 1450 Janesville Avenue, Ft. Atkinson, Wisconsin 53538; telephone: 414-563-6362.
57. Margaret A. Leveque, "The Problem of Formaldehyde – A Case Study," **Preprints,** of papers presented at the 14th annual meeting of the American Institute for Conservation of Historic and Artistic Works (AIC), Chicago, Illinois, May 21–25, 1986, pp. 56–65. See also: Pamela Hatchfield and Jane Carpenter, **Formaldehyde: How Great is the Danger to Museum Collections?,** Center for Conservation and Technical Studies, Harvard University Art Museum, Harvard University, 1987. (Available from: The Center for Conservation and Technical Studies, Harvard University Art Museums, 32 Quincy Street, Cambridge, Massachusetts 02138; telephone: 617-495-2392.)
58. Edith Weyde, see Note No. 30, p. 283.

Additional References

Ansel Adams, **The Print,** The New Ansel Adams Photography Series – Book 3, New York Graphic Society, Little, Brown and Company, Boston, Massachusetts, 1983.

W. J. Barrow, "Migration of Impurities in Paper," **Archivum,** Vol. 3, 1953.

Jared Bark, **Notes on Framing,** Bark Frameworks, Inc., 85 Grand Street, New York, New York, 1982.

Jared Bark, **More Notes on Framing,** Bark Frameworks, Inc., 85 Grand Street, New York, New York, 1985.

Helen D. Burgess and Carolyn G. Leckie, "Evaluation of Paper Products: With Special Reference to Use with Photographic Materials," **Topics in Photographic Preservation — Volume Four** (compiled by Robin E. Seigel), Photographic Materials Group of the American Institute for Conservation, 1991, pp. 96–105. Available from the American Institute for Conservation, Suite 340, 1400 16th Street, N.W., Washington, D.C. 20036; telephone: 202-232-6636.

Ctein, "Archival Framing," **Petersen's Photographic Magazine,** Vol. 8, No. 4, August 1979.

Francis W. Dolloff and Roy L. Perkinson, **How to Care for Works of Art on Paper,** third edition, Museum of Fine Arts, Boston, Massachusetts, 1979.

Klaus B. Hendriks, together with Brian Thurgood, Joe Iraci, Brian Lesser, and Greg Hill of the National Archives of Canada staff, **Fundamentals of Photographic Conservation: A Study Guide**, published by Lugus Publications in cooperation with the National Archives of Canada and the Canada Communication Group, 1991. Available from Lugus Productions Ltd., 48 Falcon Street, Toronto, Ontario, Canada M4S 2P5; telephone: 416-322-5113; Fax: 416-484-9512.

Gregory Hill, "The Conservation of a Photograph Album at the National Archives of Canada," **Journal of the American Institute for Conservation,** Vol. 30, No. 1, Spring 1991, pp. 75–88.

Douglas M. Kenyon, **Framing and Conservation of Works of Art on Paper,** Rising Paper Company, Housatonic, Massachusetts, 1981.

Eugene Ostroff, "Preservation of Photographs," **The Photographic Journal,** Vol. 107, No. 10, October 1967, pp. 309–314.

Beverly Solochek, "Framers Putting More Emphasis on Preservation of Art Works," **The New York Times,** January 29, 1981, pp. C1, C6.

David Vestal, **The Art of Black-and-White Enlarging,** Harper & Row, Publishers, Inc., New York, New York, 1984.

Suppliers

Welded Aluminum and other Pre-Assembled Frames

A.P.F., Inc.
320 Washington Street
Mt. Vernon, New York 10053
Telephone: 914-665-5400

A.P.F., Inc. (uptown showroom)
136 East 70th Street
New York, New York 10021
Telephone: 212-988-1090

A.P.F., Inc. (SoHo showroom)
568 Broadway
New York, New York 10012
Telephone: 212-925-5444

Aluminum Section Frames

ASF American Frame Corporation
1340 Tomahawk Drive
Maumee, Ohio 43537
Telephone: 419-893-5595
Toll-free: 800-537-0944 (outside Ohio)

Graphic Dimensions Ltd.
41–23 Haight Street
Flushing, New York 11355
Telephone: 212-463-3500
Toll-free: 800-221-0262 (outside New York)

Light Impressions Corporation
439 Monroe Avenue
Rochester, New York 14603-0940
Telephone: 716-271-8960
Toll-free: 800-828-9629

Nielsen & Bainbridge Division
Esselte Business Systems, Inc.
40 Eisenhower Drive
Paramus, New Jersey 07653
Telephone: 201-368-9191
Toll-free: 800-342-0124

Opus Framing Ltd.
1360 Johnston Street
Vancouver, British Columbia V6H 3S1
Canada
Telephone: 604-688-0388

Westfall Framing
P.O. Box 13524
Tallahassee, Florida 32317
Telephone: 904-878-3546
Toll-free: 800-874-3164

Boxes for Storing Prints and Films

Conservation Resources International, Inc.
8000-H Forbes Place
Springfield, Virginia 22151
Telephone: 703-321-7730
Toll-free: 800-634-6932 (outside Virginia)

The Hollinger Corporation
4410 Overview Drive
P.O. Box 8630
Fredericksburg, Virginia 22404
Telephone: 703-898-7300
Toll-free: 800-634-0491 (outside Virginia)

Light Impressions Corporation
439 Monroe Avenue
Rochester, New York 14603-0940
Telephone: 716-271-8960
Toll-free: 800-828-6216

Museum Box Company
1050 Tollgate Road
P.O. Box 1292
West Warwick, Rhode Island 02893
Telephone: 401-822-1560

Opus Binding Limited
356 Preston Street
Ottawa, Ontario K1S 4M7
Canada
Telephone: 613-236-8743

Pohlig Bros. Inc.
Century Division
2419 E. Franklin Street
P.O. Box 8069
Richmond, Virginia 23223
Telephone: 804-644-7824

Portfoliobox, Inc.
166 Valley Street
Building 3–402
Providence, Rhode Island 02909
Telephone: 401-272-9490

G. Ryder & Co., Ltd.
Denbigh Road, Bletchley
Milton Keynes, Buckinghamshire MK1 1DG
England
Telephone: 01-0908-75524

Spink & Gaborc, Inc.
11 Troast Court
Clifton, New Jersey 07011
Telephone: 201-478-4551

Suppliers

Boxes for Storing Prints and Films

Talas, Inc.
213 West 35th Street
New York, New York 10001-1996
Telephone: 212-736-7744

University Products, Inc.
517 Main Street
Holyoke, Massachusetts 01041-0101
Telephone: 413-532-9431
Toll-free: 800-628-1912 (outside Massachusetts)
Toll-free: 800-336-4847 (in Massachusetts)

High-Quality Photograph Albums

Light Impressions Corporation
439 Monroe Avenue
Rochester, New York 14607-3717
Telephone: 716-271-8960
Toll-free: 800-828-6216

Photofile, Inc.
2020 Lewis Avenue
Zion, Illinois 60099
Telephone: 708-872-7557
Toll-free: 800-356-2755

University Products, Inc.
517 Main Street
Holyoke, Massachusetts 01041-0101
Telephone: 413-532-9431
Toll-free: 800-628-1912 (outside Massachusetts)
Toll-free: 800-336-4847 (in Massachusetts)

Pohlig Bros. Inc.
Century Division
2419 E. Franklin Street
Richmond, Virginia 23223
Telephone: 804-644-7824

Good-Quality "Consumer" Photograph Albums

Webway Incorporated
2815 Clearwater Road
P.O. Box 767
St. Cloud, Minnesota 56302
Telephone: 612-251-3822
Toll-free: 800-328-2344

The Holson Company
111 Danbury Road
Wilton, Connecticut 06897
Telephone: 203-762-8661

The Best Available Self-Stick "Magnetic" Page Photograph Albums

3M Company (FlashBacks Photo Albums)
3M Consumer Stationery Division
P.O. Box 33594
St. Paul, Minnesota 55133
Telephone: 612-731-6676

DuPont Mylar D and ICI Melinex 516 (Polyester Sheet)

Archivart
Division of Heller & Usdan, Inc.
7 Caesar Place
Moonachie, New Jersey 07074
Telephone: 201-804-8986

The Hollinger Corporation
4410 Overview Drive
Fredericksburg, Virginia 22404
Telephone: 703-898-7300
Toll-free: 800-634-0491

Light Impressions Corporation
439 Monroe Avenue
Rochester, New York 14603-0940
Telephone: 716-271-8960
Toll-free: 800-828-6216

Spink & Gaborc, Inc.
11 Troast Court
Clifton, New Jersey 07011
Telephone: 201-478-4551

Talas Inc.
213 West 35th Street
New York, New York 10001-1996
Telephone: 212-736-7744

Transilwrap Company
2615 N. Paulina Street
Chicago, Illinois 60614
Telephone: 312-528-8000

University Products, Inc.
517 Main Street
Holyoke, Massachusetts 01041-0101
Telephone: 413-532-9431
Toll-free: 800-628-1912 (outside Massachusetts)
Toll-free: 800-336-4847 (in Massachusetts)

Westfall Framing
P.O. Box 13524
Tallahassee, Florida 32317
Telephone: 904-878-3546
Toll-free: 800-874-3164