Hewlett-Packard Designjet 130 – Print Permanence Ratings

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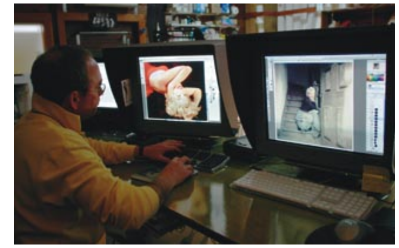
Joshua Greene, digital restoration and printing expert at "The Archives – A House of Restoration," located in Florence, Oregon, with an HP Designjet 130 printer and a portrait of Marilyn Monroe taken in 1957 by Milton Greene, Joshua's father. The now very faded Ektachrome original, made during Milton's last photography session with the actress, was digitally restored by Joshua. <www.archiveimages.com>

Description: The Hewlett-Packard Designjet 130 is a desktop 6-ink printer which uses the HP 84/85 high-stability, dye-based inkset with a high d-max and is designed for professional photography, and design and proofing applications. The HP130 was announced in February 2004, with the first units shipped in April 2004. The printer's 100-sheet paper cassette handles sizes up to 18 x 24 inches. A manual rear-feed paper path accommodates paper sizes up to 24 x 64 inches and a roll paper option supports roll sizes up to 24 inches wide (the roll paper option is standard with the network-equipped HP130nr). Papers in weights from 17 to 40 lbs. (150 gsm) can be used with the paper cassette; the printer's rear-feed paper path handles papers up to 80 lbs (300 gsm). Using an internal color sensor, the HP130 features a closed-loop color calibration system which automatically compensates for small variations in media, inks, and environmental conditions to provide consistent color reproduction. The closed-loop system also provides automatic Pantone® calibration. The printer was designed to be placed on a table top, occupying approximately 42 x 32 x 9-inches of space and weighs about 50 lbs. Optional accessories include the EFI Designer Edition 4.0 RIP for HP XL and an HP Software RIP; RIPS from other vendors are also supported. The base price of the HP 130 is $1,295; an optional floor stand/media bin is available for $295. The smaller HP Designjet 30, which handles paper sizes up to 11x17 inches and uses the same ink cartridges as the HP 130, sells for $699.



Greene working on complex digital restorations of faded Ektachrome transparencies.

The HP Designjet 130 makes use of six high-stability dye-based photo inks.

Display Permanence Ratings and Dark Storage Ratings (Years Before Noticeable Fading and/or Changes in Color Balance Occur)[1]

Paper, Canvas, or Film Media Printed with HP 84/85 Dye-Based Inkset	Displayed Prints Framed Under Glass[2]	Displayed Prints Framed With UV Filter[3]	Displayed Prints Not Framed (Bare-Bulb)[4]	Dark Storage Stability Rating at 73°F & 50% RH (incl. Paper Yellowing)[5]	Resistance to Ozone[6]	Resistance to High Humidity[7]	Resistance to Water[8]	Are UV Brighteners Present?[9]
HP Premium Plus Photo and Proofing Gloss	**82 years**	100 years	45 years	>200 years	now in test	now in test	low	very little
HP Premium Plus High Gloss Photo Paper	**82 years**	100 years	45 years	>200 years	now in test	now in test	low	very little
HP Premium Plus Soft Gloss Photo Paper	**82 years**	100 years	45 years	>200 years	now in test	now in test	low	very little
HP Premium Photo Paper, Gloss (2004)	**82 years**	100 years	45 years	>200 years	now in test	now in test	low	very little
HP Premium Photo Paper, Soft Gloss (2004)	**82 years**	100 years	45 years	>200 years	now in test	now in test	low	very little
HP Photo Matte Paper	to be tested	to be tested	to be tested	to be tested	to be tested	to be tested	–	–
More papers to be added.....								

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Notes on These Tests:

1) Display Permanence Ratings (DPR) are based on accelerated light stability tests conducted at 35 klux with glass-filtered cool white fluorescent illumination with the sample plane air temperature maintained at 24℃ and 60% relative humidity. Data were extrapolated to a display condition of 450 lux for 12 hours per day using the Wilhelm Imaging Research, Inc. "Visually-Weighted Endpoint Criteria Set v3.0." and represent the years of display for easily noticeable fading, changes in color balance, and/or staining to occur. (See: Henry Wilhelm, "How Long Will They Last? An Overview of the Light-Fading Stability of Inkjet Prints and Traditional Color Photographs," *IS&T's 12th International Symposium on Photofinishing Technologies,* sponsored by the Society for Imaging Science and Technology, Orlando, Florida, February 2002: *<http://www.wilhelm-research.com/articles_ist_02_2002.html>.* See also: Henry Wilhelm, "How Long Will They Last? – Part II An Overview of the Permanence of Digitally-Printed Photographs and Applicable Print Permanence Test Methods," *IS&T's 13th International Symposium on Photofinishing Technology,* sponsored by the Society for Imaging Science and Technology, Las Vegas, Nevada, February 2004: *<WIR_ISTpaper_2004_02_HW.pdf>.)* High-intensity light fading reciprocity failures in these tests are assumed to be zero. Illumination conditions in homes, offices, and galleries do vary, however, and color images will last longer when displayed under lower light levels; likewise, the life of prints will be shortened when displayed under illumination that is more intense than 450 lux. Ink and paper combinations that have not reached a fading or color balance failure point after the equivalent of 100 years of display are given a rating of "more than 100 years" until such time as meaningful dark stability data are available (see discussion in No. 5 below).

2) In typical indoor situations, the "Displayed Prints Framed Under Glass" test condition is considered the single most important of the three display conditions listed. All prints intended for long-term display should be framed under glass or plastic to protect them from staining, image discoloration, and other deterioration caused by prolonged exposure to cigarette smoke, cooking fumes, insect residues, and other airborne contaminants; this precaution applies to traditional black-and-white and color photographs as well as inkjet and other types of digital prints.

3) Displayed prints framed with ultraviolet filtering glass or ultraviolet filtering plastic sheet generally last longer than those framed under ordinary glass. How much longer depends upon the specific print material and the spectral composition of the illuminate, with some ink/paper combinations benefitting a great deal more than others. Some products may even show reduced life when framed under a UV filter because one of the image dyes or pigments is disproportionately protected from fading caused by UV radiation and this can result in more rapid changes in color balance than occur with the glass-filtered and/or the bare-bulb illumination conditions. For example, if a UV filter protects the cyan and magenta inks much more than it protects the yellow ink in a particular ink/media combination, the color balance of the image may shift toward blue more rapidly than it does when a glass filter is used (in which case the fading rates of the cyan, magenta, and yellow dyes or pigments are more balanced in the neutral scale). Keep in mind, however, that the major cause of fading with most digital and traditional color prints in indoor display conditions is visible light and although a UV filter may slow fading, it will not stop it. For the display permanence data reported here, Acrylite OP-3 acrylic sheet, a "museum quality" UV filter supplied by Cyro Industries, was used.

4) Illumination from bare-bulb fluorescent lamps (with no glass or plastic sheet between the lamps and prints) contains significant UV emissions at 313nm and 365nm which, with most print materials, increases the rate of fading compared with fluorescent illumination filtered by ordinary glass (which absorbs UV radiation with wavelengths below about 330nm). Some print materials are affected greatly by UV radiation in the 313–365nm region, and others very little. "Gas fading" is another potential problem when prints are displayed unframed, such as when they are attached to kitchen refrigerator doors with magnets, pinned to office walls, or displayed inside of fluorescent illuminated glass display cases in schools, stores, and offices. Field experience has shown that, as a class of media, microporous "instant dry" papers used with dye-based inkjet inks can be very vulnerable to gas fading when displayed unframed and/or stored exposed to the open atmosphere where even very low levels of ozone and certain other air pollutants are present. In some locations, displayed unframed prints made with microporous papers and dye-based inks have suffered from extremely rapid image deterioration. This type of premature ink fading is not caused by exposure to light. Polluted outdoor air is the source of most ozone found indoors in homes, offices and public buildings. Ozone can also be generated indoors by electrical equipment such as electrostatic air filters ("electronic dust precipitators") that may be part of heating and air conditioning systems in homes, office buildings, restaurants, and other public buildings to remove dust, tobacco smoke, etc. Electrostatic air filtration units are also supplied as small "tabletop" devices. Potentially harmful pollutants may be found in combustion products from gas stoves; in addition, microscopic droplets of cooking oil and grease in cooking fumes can damage unframed prints. Because of the wide range of environmental conditions in which prints may be displayed or stored, Display Permanence

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Notes on These Tests (continued from previous page):

Ratings for the bare-bulb illumination condition will not be listed for paper/ink combinations of known susceptibility to gas fading. For all of the reasons cited above, prints made with microporous papers and dye-based inks should always be displayed framed under glass or plastic.

5) Prints stored in the dark may suffer slow deterioration that is manifested in yellowing of the print paper, image fading, changes in color balance, and physical embrittlement, cracking, and/or delamination of the image layer. These types of deterioration may affect the paper support, the image layer, or both. Each type of print material (ink/paper combination) has its own intrinsic dark storage stability characteristics; some are far more stable than others. Rates of deterioration are influenced by temperature and relative humidity; high temperatures and/or high relative humidity exacerbate the problems. Long-term dark storage stability is determined using Arrhenius accelerated dark storage stability tests that employ a series of elevated temperatures (e.g., 50°C, 57°C, 64°C, 71°C, and 78°C) at a constant relative humidity of 50% RH to permit extrapolation to ambient room temperatures (or other conditions such those found in sub-zero, humidity-controlled cold storage preservation facilities). Because many types of inkjet inks, especially those employing pigments instead of dyes, are exceedingly stable when stored in the dark, the eventual life of prints made with these inks may be limited by the instability of the paper support, and not by the inks themselves. Due to this concern, as a matter of policy, Wilhelm Imaging Research does not provide a Display Permanence Rating of greater than 100 years for any inkjet or other photographic print material unless it has also been evaluated with Arrhenius dark storage tests and the data indicate that the print can indeed last longer than 100 years without noticeable deterioration when stored at 73°F (23°C) and 50% RH. Arrhenius dark storage data are also necessary to assess the physical and image stability of a print material when it is stored in an album, portfolio box, or other dark place. The Arrhenius data given here are only applicable when prints are protected from the open atmosphere; that is, they are stored in closed boxes, placed in albums within protective plastic sleeves, or framed under glass or high-quality acrylic sheet. If prints are stored, displayed without glass or plastic, or otherwise exposed to the open atmosphere, low-level air pollutants may cause significant paper yellowing within a relatively short period of time. Note that these Arrhenius dark storage data are for storage at 50% RH; depending on the specific type of paper and ink, storage at higher relative humidities (e.g., 70% RH) could produce significantly higher rates of paper yellowing and/or other types of physical deterioration.

6) Tests for resistance to ozone are conducted using an accelerated ozone exposure test (conducted at 23°C and 60% RH) and the reporting method outlined in: Kazuhiko Kitamura, Yasuhiro Oki, Hidemasa Kanada, and Hiroko Hayashi (Seiko Epson), "A Study of Fading Property Indoors Without Glass Frame from an Ozone Accelerated Test," *Final Program and Proceedings – IS&T's NIP19: International Conference on Digital Printing Technologies,* sponsored by the Society for Imaging Science and Technology, New Orleans, Louisiana, September 28 – October 3, 2003, pp. 415–419.

7) Changes in image color and density, and/or image diffusion ("image bleeding"), that may take place over time when prints are stored and/or displayed in conditions of high relative humidity are evaluated using a humidity-fastness test maintained at 80°F (27°C) and 80% RH. Depending on the particular ink/media combination, slow humidity-induced changes may occur at much lower humidities – even at 50–60% RH. Test methods for resistance to high humidity and related test methods for evaluating "short-term color drift" in inkjet prints have been developed over the past 6 years by Mark McCormick-Goodhart and Henry Wilhelm at Wilhelm Imaging Research, Inc. See, for example, Henry Wilhelm and Mark McCormick-Goodhart, "An Overview of the Permanence of Inkjet Prints Compared with Traditional Color Prints," *Final Program and Proceedings – IS&T's Eleventh International Symposium on Photofinishing Technologies,* sponsored by the Society for Imaging Science and Technology, Las Vegas, Nevada, January 30 – February 1, 2000, pp. 34–39. See also: Mark McCormick-Goodhart and Henry Wilhelm, "Humidity-Induced Color Changes and Ink Migration Effects in Inkjet Photographs in Real-World Environmental Conditions," *Final Program and Proceedings – IS&T's NIP16: International Conference on Digital Printing Technologies,* sponsored by the Society for Imaging Science and Technologies, Vancouver, B.C., Canada, October 15–20, 2000, pp. 74–77. See also: Mark McCormick-Goodhart and Henry Wilhelm, "The Influence of Relative Humidity on Short-Term Color Drift in Inkjet Prints," *Final Program and Proceedings – IS&T's NIP17: International Conference on Digital Printing Technologies,* sponsored by the Society for Imaging Science and Technology, Ft. Lauderdale, Florida, September 30 – October 5, 2001, pp. 179–185. See also: Mark McCormick-Goodhart and Henry Wilhelm, "The Correlation of Line Quality Degradation With Color Changes in Inkjet Prints Exposed to High Relative Humidity," *Final Program and Proceedings – IS&T's NIP19: International Conference on Digital Printing Technologies,* sponsored by the Society for Imaging Science and Technology, New Orleans, Louisiana, September 28 – October 3, 2003, pp. 420–425.

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Notes on These Tests (continued from previous page):

8) Data from waterfastness tests are reported in terms of three subjective classes: “high,” “moderate,” and “low.” Both “water drip” tests and “standing water droplets/gentle wipe” tests are employed.

9) Fluorescent brighteners (also called “UV brighteners,” “optical brighteners,” or “optical brightening agents” [OBA’s]) are white or colorless compounds added to most inkjet and other papers to make them appear whiter and “brighter” than they really are. Fluorescent brighteners absorb ultraviolet (UV) radiation, causing the brighteners to fluoresce (emit light) in the visible region, especially in the blue and green portions of the spectrum. Fluorescent brighteners can lose activity – partially or completely – as a result of exposure to light. Brighteners may also lose activity when subjected to high temperatures in accelerated thermal aging tests and, it may be assumed, in long-term storage in albums or other dark places under normal room temperature conditions. With loss of brightener activity, papers will appear to have yellowed and to be “less bright” and “less white.” In recent years, traditional chromogenic (“silver-halide”) color photographic papers have been made with UV-absorbing interlayers and overcoats and this prevents brighteners that might be present in the base paper from being activated by UV radiation. It is the relative UV component in the viewing illumination that determines the perceived “brightening effect” produced by fluorescent brighteners. If the illumination contains no UV radiation (for example, if a UV filter is used in framing a print), fluorescent brighteners are not activated and, comparatively speaking, the paper appears to be somewhat yellowed – and not as “white.” This spectral dependency of fluorescent brighteners makes papers containing such brighteners look different depending on the illumination conditions. For example, prints displayed near windows are illuminated with direct or indirect daylight, which contains a relatively high UV component, and if an inkjet paper contains brighteners, this causes the brighteners to strongly fluoresce. When the same print is displayed under incandescent tungsten illumination, which has a low UV component, the brighteners have little effect. Another potential drawback of brighteners is that brightener degradation products may themselves be a source of yellowish stain. These problems can be avoided by not adding fluorescent brighteners to inkjet photographic papers during manufacture. When long-term image permanence is an important consideration – or may eventually become important – papers with fluorescent brighteners should be avoided.