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Standard Guide for Printing Method Effects on Facial Comparison

Facial & Iris Identification Subcommittee
Digital/Multimedia Scientific Area Committee
Organization of Scientific Area Committees (OSAC) for Forensic Science



OSAC Proposed Standard

OSAC 2021-N-0025
Standard Guide for Printing Method Effects on Facial Comparisons

Prepared by
Facial Identification Subcommittee
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2.0	May 2, 2023	--	Added to the OSAC Registry and publicly announced.
2.1	October 4, 2024	All	Format and font updates only. No content changes made.

Standard Guide for Printing Method Effects on Facial Comparisons

1. Scope

1.1 This technical guideline provides a basic overview of various printing processes as well as their characteristics and potential impacts on a facial comparison.

1.2 The intended audience of this guideline is anyone who contributes to a facial image comparison.

1.3 The values stated in Standard International (SI) units are to be regarded as standard. The values given in parentheses are mathematical conversions to non-SI units that are provided for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM* Standards:

2.1.1 E2916 Terminology for Digital and Multimedia Evidence Examination.

3. Terminology

3.1 *Definitions:*

3.1.1 Printed Image: A printed image is the production of a digital image on a substrate by a direct or indirect printing process.

3.1.2 Dots per inch (DPI): In printing, DPI refers to the resolution setting of the printer and resolution capture for printed media. For example, a 1200 DPI resolution printer will deposit a much higher density of ink per inch than a 300 DPI printer. Use of DPI as a resolution term when scanning printed media will enable the use of post-scanning descreen software enhancement to more accurately reproduce the original artwork or image.

3.1.3 Lines per inch (LPI). A term in resolution setting in scanner software used for scanning original artwork for printing.

3.1.4 Pixels per inch (PPI): Measurements of the pixel density of an electronic image device, such as a computer monitor or camera. For example, a 1200 PPI image will produce a higher quality image than a 300 PPI image. Use of PPI as a resolution term is generally used with digitally capture images (i.e., photography).

3.1.5 Samples per inch (SPI): A generic term that can include of DPI, LPI, and PPI. SPI is the measurement of the resolution, in particular the number of individual samples that are taken in the space of one linear inch. Scanner software may not allow for the use of SPI during image capture.

3.1.6 Substrate: A substrate in printing terms is a form of media on which a printed image is produced. A substrate, as referred to in this guideline includes gloss or matte paper, plastic, sensitized material, or polycarbonate.

4. Summary of Practice

4.1 On occasion, a facial examiner will receive an image presented on a physically printed document. Printing processes will introduce artifacts or result in the loss of facial details. Consequently, an attempt to retrieve the original source image should be completed.

4.2 If the original source image cannot be retrieved, the facial examiner should have a basic understanding of common image printing processes. This will assist in identifying the potential printing effects and associated limitations that may affect the suitability to conduct a morphological facial image comparison.

4.3 A comprehensive report by the forensic scientist should report the limitations and uncertainty associated with measurements, and the inferences that could be drawn from them. This report might include a range of possible values for an estimated quantity, a separate statement regarding errors and uncertainties associated with the analysis of the evidence and resulting opinions, or empirical performance data associated with a chosen statistical model. If the forensic science practitioner has no information on sources of error in measurements and inferences, or has no validation data, the ASA recommends that this fact be stated. Ref Appendix for further information

5. Overview of Printing Processes

5.1 There are six printing processes that are commonly used to produce a printed facial image. Within this guideline, the printing methodology for each of these processes will be discussed in simple terms:

- Conventional and Digital Photographic
- Laser Toner
- Inkjet
- Thermal Transfer
- Dye Sublimation
- Laser Engraving

5.2 Potential Effects of a Printed Facial Image

5.2.1 The type of printer used to produce a facial image can result in a range of printing effects for consideration during a Facial Image examination. To demonstrate the differences in

the printed output of the six printing processes, a comparative view of the printing processes appears below. For each of the six printing processes, the high-resolution image scans (1200 DPI) of the eye area from a printed facial image are provided below to demonstrate the characteristics of each printing process and the potential effects of that process.

See **Appendix - Image Resolution in this Guideline** for details on the images shown in this document.

		
Photographic	**Laser Toner**	**Dye Sublimation**
		

Inkjet	Thermal Transfer	Laser Engraving

FIG. 1 (Comparative view of each print process (high resolution image scan at 1200 DPI

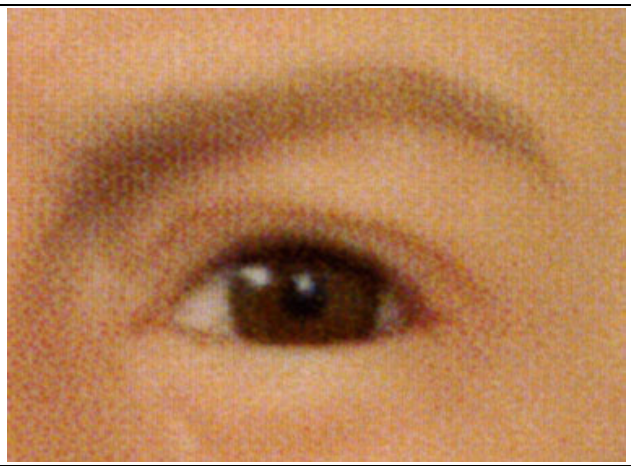
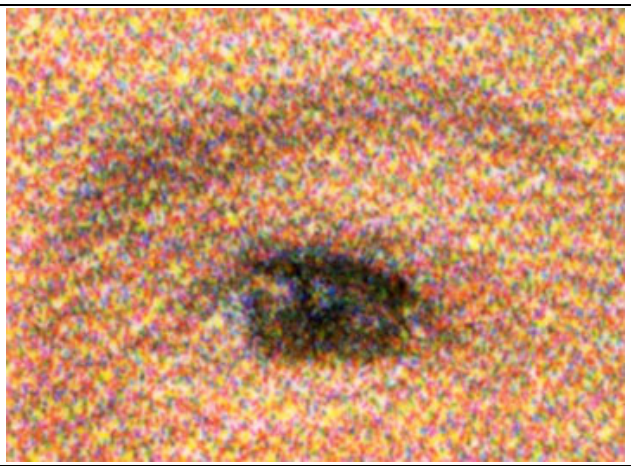
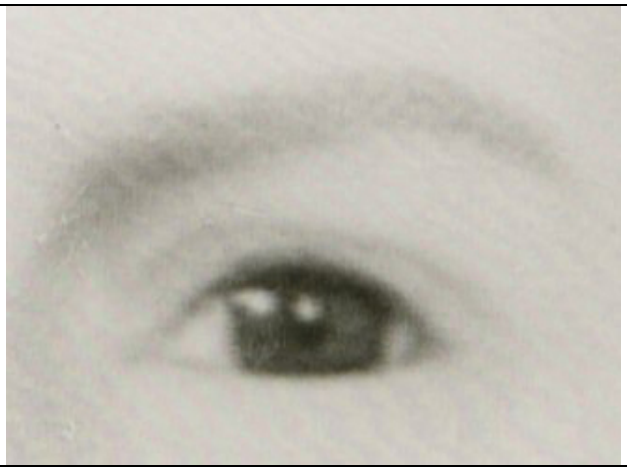
	
Photographic	**Laser Toner**
	
Inkjet	**Thermal Transfer**
	
Dye Sublimation	**Laser Engraving**

FIG. 2 Comparative view of the eye area for each print process (high resolution image scan at 1200 DPI)

6. Printing Definitions

6.1 **Conventional and Digital Photographic**

6.1.1 Photographic prints are derived from either an image captured onto a light-sensitive film or onto a digital light detector such as a charge-coupled device or a CMOS image sensor.

6.1.2 For conventional processes for color film, there are three light sensitive layers. The layers respond to exposure of Red, Green, and Blue light (RGB) to generate dyes that result in Cyan, Magenta, and Yellow (CMY) which are superimposed to form the final color in the finished print.

6.1.3 Modern photographic prints from a digitally captured image may use an Inkjet printer (with a photographic substrate) or more commonly Dye Sublimation for printing.

6.1.4 The outcome of this process is that the printed image can display the following characteristics:

6.1.4.1 Only K (black) and white (basic substrate color) for monochrome images, or C (cyan), M (magenta), Y (yellow) if a three-color process has been used. In a three-color process K (black) may also be present but that is dependent on the combination of film and substrate used.

6.1.4.2 Can be printed on a range of papers from uncoated to resin coated paper and the appearance of the image may vary depending on whether the substrate has a matte or gloss finish.

6.1.4.3 The colors blend into each other producing continuous tonal images, often with no clear edge transition.



FIG. 3 Example of a Conventional and Digital Photographic print

(Full facial image printed at 300 DPI and scanned at 1200 DPI for this guideline)

6.2 **Laser Toner**

6.2.1 Laser Toner printers are a type of non-impact printer that receive a digital image for printing followed by a laser transfer onto a photosensitive drum. Simultaneously, each color

toner is electrostatically charged to transfer onto the substrate and will combine with the positively charged areas of the drum to form the image. The negatively charged areas of the drum will repel the toner.

6.2.2 To transfer the image from the drum to a substrate, an electrostatic charge is used, and the plastic particles of the toner are fused using heat to ensure adherence to the substrate surface.

6.2.3 The outcome of this process is that the printed image can display the following characteristics:

6.2.3.1 K (black) and white (basic substrate color) or different color toners i.e. C (cyan), M (magenta), Y (yellow), K (black).

6.2.3.2 Each color can be applied at different angles resulting in a pattern, known as a “rosette” pattern of dots.

6.2.3.3 Excess toner that results in visible toner dots surrounding the image area and also appearing in non-image areas of the substrate.

6.2.3.4 Under magnification, the toner appears to sit ‘on top’ of the substrate (as opposed to being absorbed into the substrate) and therefore can be scratched off.

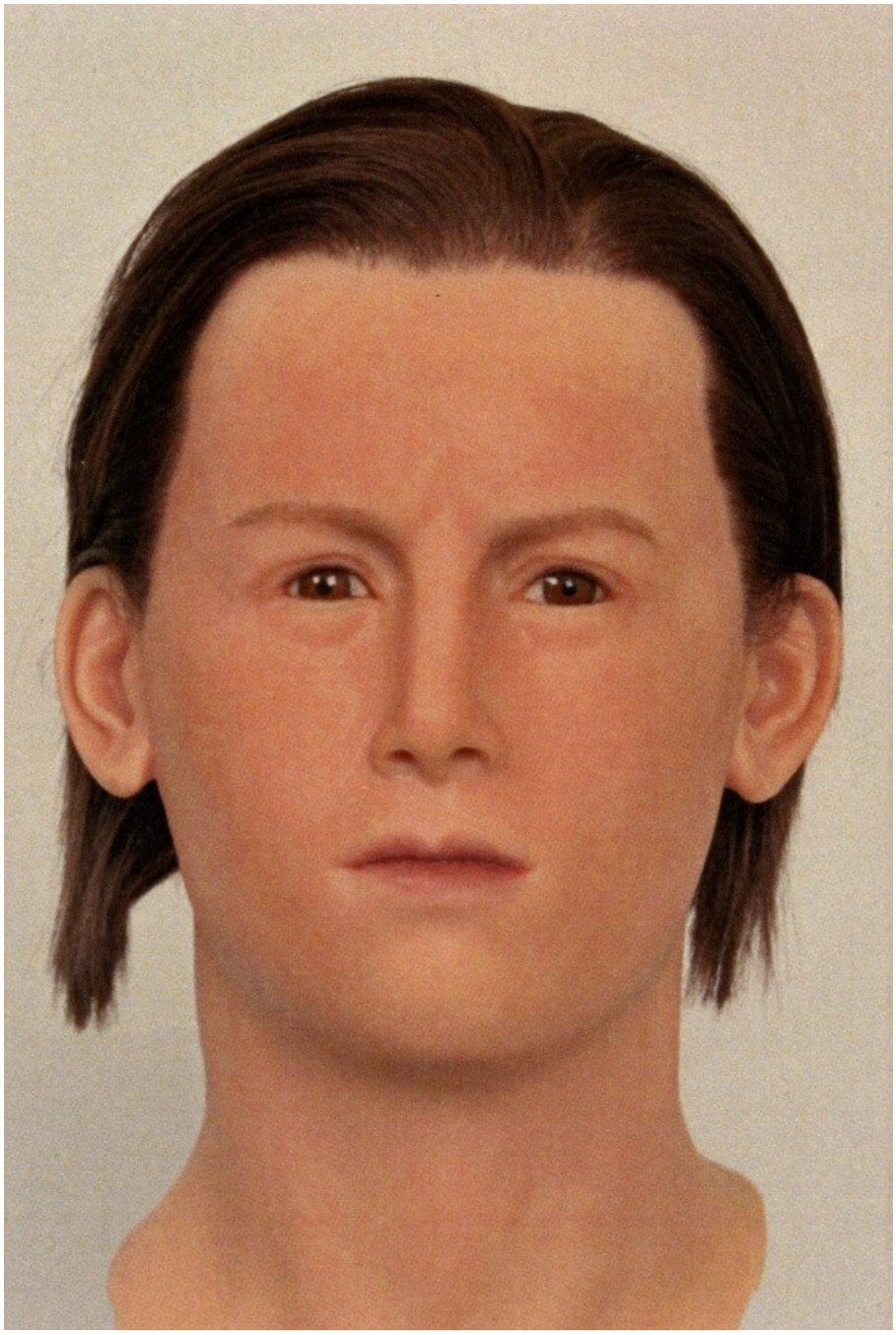


FIG. 4 Example of a Laser Toner print

(Full facial image printed at 300 DPI and scanned at 1200 DPI for this guideline)

6.3 **Inkjet**

6.3.1 Inkjet, which is also known as bubble jet, is a printing process in which ink droplets are propelled from a small aperture onto the substrate. Inkjet printers use either on-demand (low pressure) or continuous (high pressure) ink propulsion from apertures to form an image on the substrate.

6.3.2 The ink in this printer is electrostatically charged and propelled onto the substrate in a controlled formation based on the image dependent signals.

6.3.3 The outcome of this process is that the printed image can display the following characteristics:

6.3.3.1 K (black) and white (basic substrate color) or a four-color ink process i.e. C (cyan), M (magenta), Y (yellow), K (black).

6.3.3.2 Individual color droplets of ink are visible.

6.3.3.3 Excess ink resulting in dots visible around the printed image area (however they do not usually appear in non-image areas as in laser toner printing).

6.3.3.4 Under magnification, the ink has a flat surface. For paper substrates, the ink bleeds into the paper fibers.

6.3.3.5 Irregularly shaped dots in an irregular pattern (i.e. splash like jagged edges can sometimes be seen) and will not have a well-defined edge.

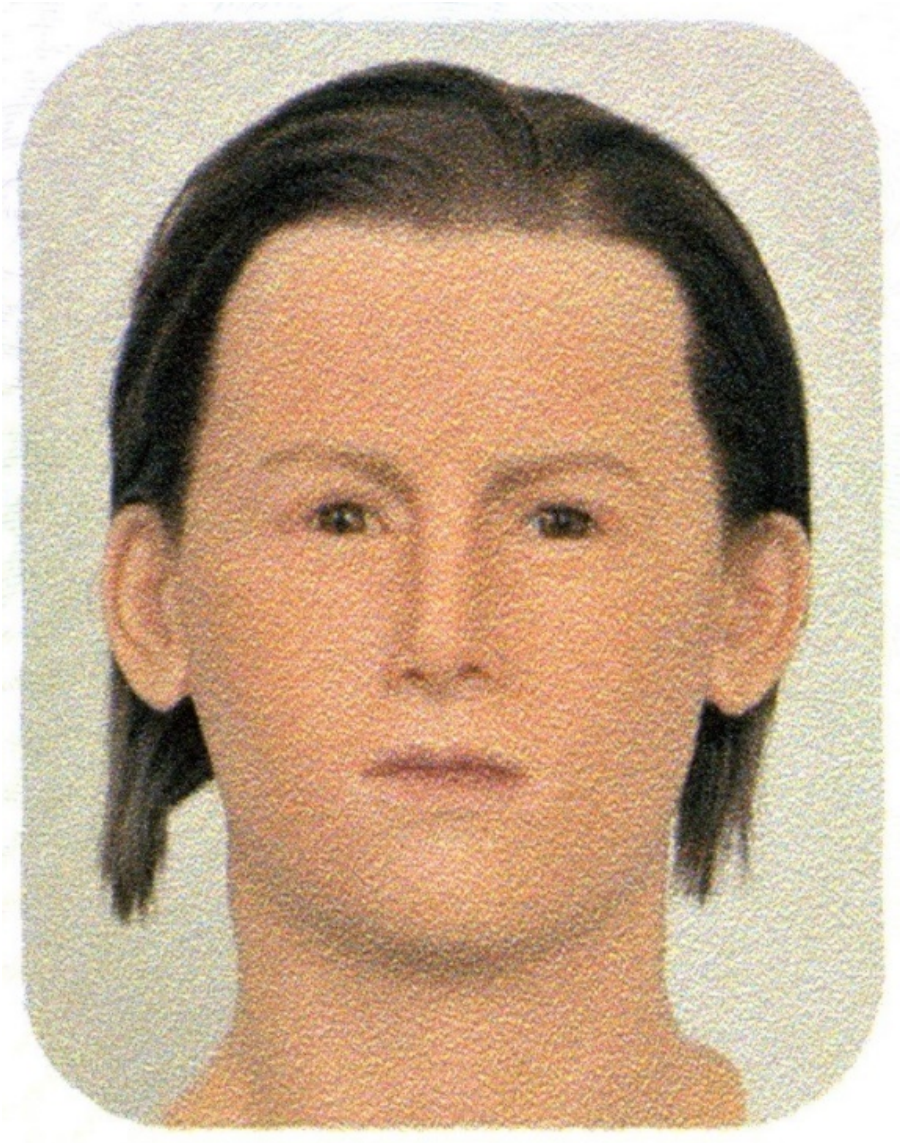


FIG. 5 Example of an Inkjet print

(Full facial image printed at 150 DPI and scanned at 1200 DPI for this guideline)

6.4 **Thermal Transfer**

6.4.1 Thermal Transfer printers are devices that use a combination of heated elements in a print head and a thermal reactive ribbon. The ribbon is a polyester base with wax, resin, or a combination of both wax and resin, and is generally referred to as containing ink.

6.4.2 The heating elements within the print head of this device are electronically controlled to contact the non-ink side of the ribbon, depending on image dependent signals. When and where required, the elements are heated and they melt the “ink” on the underside of the ribbon for transfer onto the substrate.

6.4.3 The outcome of this process is that the printed image can display the following characteristics:

6.4.3.1 K (black) and white (basic substrate color) or using a four-color process i.e. C (cyan), M (magenta), Y (yellow), K (black).

6.4.3.2 Under magnification, the “ink” has a flat surface. For paper substrates, the “ink” can bleed into the paper fibers.

6.4.3.3 Images have a dot like appearance.

6.4.3.4 A stepped effect to the edges of image.

6.4.3.5 There may be an overlap of the color frames.



FIG. 6 Example of a Thermal Transfer print

(Full facial image printed at 300 DPI and scanned at 1200 DPI for this guideline)

6.5 **Dye Sublimation**

6.5.1 Dye Sublimation printers are commonly used for continuous tonal ranges within a printed image. The term “sublimation” refers to the progression of a solid to a gaseous state without transitioning through the liquid phase. In this process, the printing color dyes are heated until they vaporize and reach the gaseous state, where the dye diffuses into the substrate and solidifies.

6.5.2 This type of printing process transfers colored dyes from a plastic ribbon onto specialized substrates. The main differences to other print processes discussed in this guideline are that the vaporized color dyes penetrate the surface of the substrate. The penetration into the substrate results in a gentle continuous gradation of tones at the edge of each pixel, instead of the obvious color changes seen in other printing processes.

6.5.3 The outcome of this process is that the printed image can display the following characteristics:

6.5.3.1 K (black) and white (basic substrate color) or using a four-color process i.e. C (cyan), M (magenta), Y (yellow), K (black).

6.5.3.2 Colors blend into each other producing continuous tonal images.

6.5.3.3 Used only on coated paper, plastic, or polycarbonate substrates.

6.5.3.4 Glossy appearance to the image.

6.5.3.5 Under magnification, the dye has a flat surface.



FIG. 7 Example of Dye Sublimation print

(Full facial image printed at 300 DPI and scanned at 1200 DPI for this guideline)

6.6 **Laser Engraving**

6.6.1 Laser Engraving is generally only used with polycarbonate or plastic substrates that predominately feature in identity documents, such as passports and identity cards. This process creates unique features and characteristics that are not present in other printing processes.

6.6.2 The composition of the polycarbonate or plastic substrate is multi-layered and the laser engraving enables various depths of carbonization in any of these layers. The depth of the engraving is dependent on the amount of energy used, and can result in raised print, flat print, or a combination of both raised and flat print.

6.6.3 The outcome of this process is that the printed image can display the following characteristics:

6.6.3.1 Raised print, flat print, or a combination of both.

6.6.3.2 Under magnification, there is a very fine dot like appearance and a grid pattern may be visible.

6.6.3.3 Currently the process is only used to produce monochrome prints and not color images for identity documents.

6.6.3.4 Can produce a moiré (e.g. having a rippled, lustrous finish) affect depending on the type of substrate.

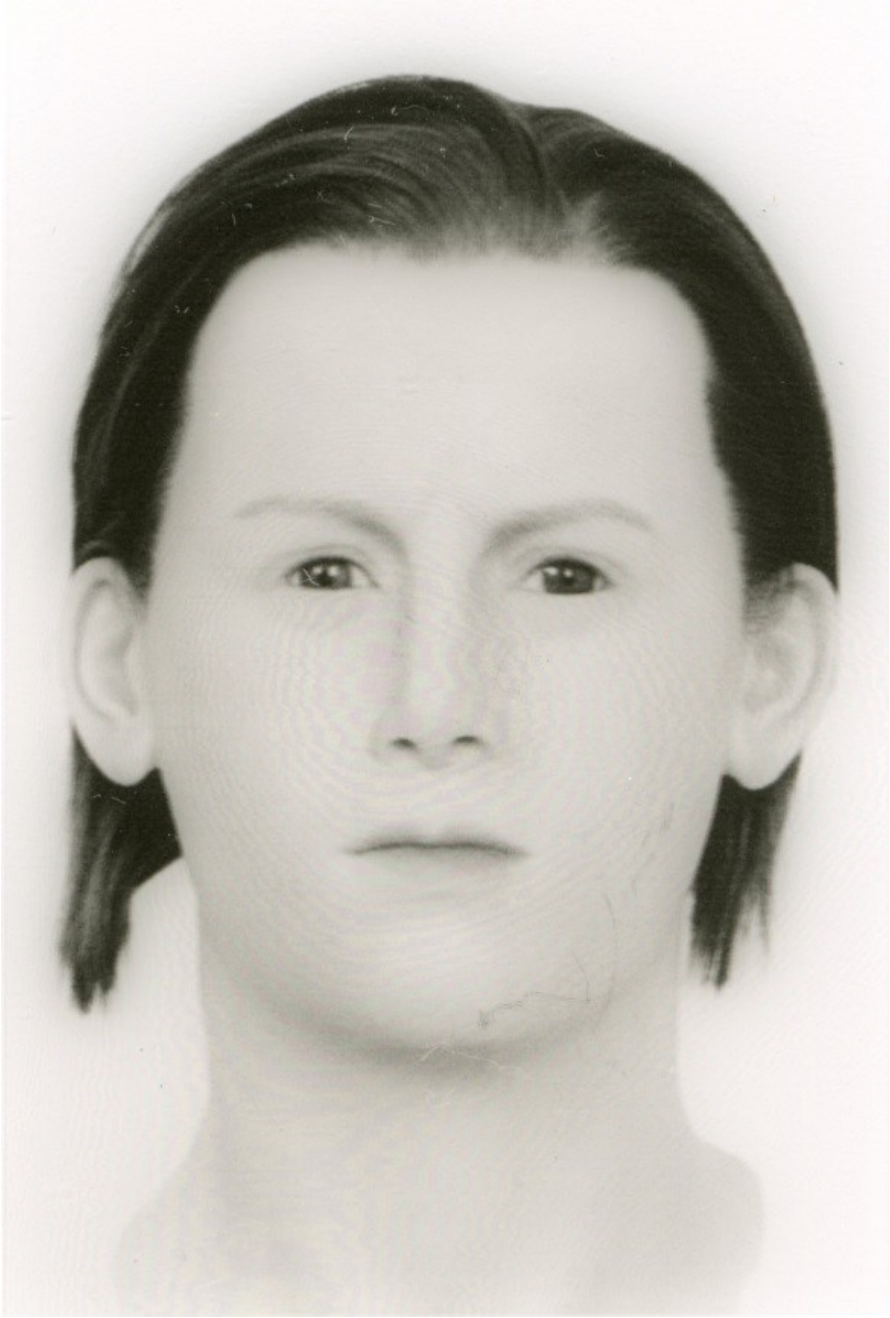


FIG. 8 Example of a Laser Engraved print

(Full facial image printed at 380 DPI and scanned at 1200 DPI for this guideline)

7. Recommendations

In the image analysis phase (which is done before the actual comparison is started), it is best practice for the facial examiner to determine whether the image referred for facial comparison is a digital live capture image or a capture of a printed facial image. The reference images for the common printing processes in this document demonstrate that magnification of the printed image may not assist in a detailed morphological comparison of the facial component features.

The determination that the image is from a printed product will assist in identifying potential limitations that may affect the suitability of the image or the ability of the facial examiner to conduct a full morphological image comparison. The effects of the printing processes outlined in this guideline and the resolution of the captured image may limit the facial examiner to a holistic image comparison.

Of the six common printing processes described in this guideline:

- Conventional and Digital Photographic Print and Dye Sublimation printing processes are more likely to provide an image suitable for a detailed facial morphological comparison.
- The Laser Engraving printing process will be the least likely to provide an image suitable for a detailed facial morphological comparison.

Appendix

Image Resolution in this Guideline

All images provided within this document are to illustrate the basic concepts of printing processes. To demonstrate each of the printing processes covered in this guideline, the following two types of images contained within the guideline have been scanned at a high-resolution of 1200 DPI:

- A full facial image.
- A magnified view of the eye area to illustrate a close-up view of the characteristics and effects of each printing process.

The original image capture resolution for the full facial image was 300 PPI and has not been changed except for automated image processing during personalization of sample images to demonstrate each of the printing processes.

The resolution or PPI settings of the facial image for printing can dictate the quality of the image output. Photographic prints are usually at 300 DPI. For identity documents, the print resolution for a facial image can vary from 96 DPI up to 1200 DPI.

Facial images in identity documents typically have a print size of 35-40 mm wide and 45-50

mm high. Consequently, these dimensions have been used to produce the printed facial images in this guide.

Ref 4.3. https://www.amstat.org/asa/files/pdfs/POL-ForensicScience.pdf