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Laser and Fiber Optic Photographic Analysis of Single-Edge Paper Striations

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ABSTRACT: The Secret Service has recently developed a technique of utilizing time-lapse photography in conjunction with fiber optic and helium-neon light sources in recording the striae appearing along the edges of single counterfeit notes. It appears that thus far, the fiber optic system of photographically recording striae criteria is superior to the laser systems. Future research is designed to improve the resolution of the laser process together with attempting to store and retrieve automatically the striae identifying criteria from appropriate computer hardware.

KEYWORDS: questioned documents, photography, striations

As the Secret Service is the primary law enforcement agency responsible for the detection and suppression of counterfeit currency, it has been a continuing objective of the Forensic Services Division to capture photographically those evidential striae produced by both manual and hydraulic paper cutting blades along the edges of counterfeit notes.

A review of the forensic science literature disclosed some impressive earlier research results obtained by Osborn and Purtell in photographically recording paper edge striae caused by defective cutting blades [*1,2*]. Excellent preliminary results with time-lapse photography were further reported by Postal Inspector Joseph Wichman [*3*]. As a result, the Secret Service initiated a two-year research effort to attempt to develop a reliable and reproduceable method of using time-lapse photography to record evidence striae.

It was noted however in earlier research attempts that two reoccurring problems plagued the successful resolution of this forensic science objective, namely:

(1) the difficulty in moving the sheet of paper with sufficient precision to avoid causing slight variations in velocity which were photographically recorded as horizontal bands of varying light intensity and

(2) vibrations of the camera (or evidence paper edge) contributing to a vertical wavering effect or fuzzy image on the final negative.

Potentially valuable suggestions for overcoming these objective influences (as provided by Wichmann) included designing a clamp to rigidly hold the paper edge and to install an electric motor onto a movable platform holding the questioned paper edge so as to insure constant rate of speed control during the time-lapse photographic process. Acting on these and other suggestions, Mr. John Syphrit of the Secret Service Visual Information Branch was requested to

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develop both the appropriate apparatus modifications and to employ both laser and fiber optic light illumination techniques in resolving these troublesome areas.

The preliminary results of this combined research effort have proven to be extremely encouraging as demonstrated in the following photographs. It should be emphasized that each of the following counterfeit note edges in the figures exposed to both laser and fiber optic light illumination were cut by the same hydraulic or manual paper cutting blade and therefore theoretically should possess the same striae detail, both in relative position and depth perspectives (that is, shading effects).

Figure 1 is the overall perspective photo of conventional black-and-white time-lapse photographic process. Specific equipment/film type/exposure settings includes the following data:

camera—conventional 35-mm SLR camera with a 55-mm Nikkor Micro lens;
film—high speed ASA 160 Ektachrome slide film with tungsten based emulsion;
exposure settings—F/3.5;
time exposure—39 s with shutter open;
light source—conventional fiber optic (EhrenReich Fiber Optic); and
platform mount—motorized photographic scanning device manufactured by Weiser/Robodyne Corp. of Silver Spring, MD.

Figure 2 is the Fiber optic light setup in relation to the motorized platform mount. Note the inclusion of an opaque barrier light filter to reduce the scattering effects of the light source beam and hence concentrate the illuminating effects.

Figure 3 depicts the suspect counterfeit note edge resting between two steel plates with a movable piece of white cardboard on plate edge to assist in varying and controlling the reflective artifacts of the fiber optic light source. Note that the edge extends approximately 6.35 mm (1/4 in.) beyond steel plate edge.

Figure 4 depicts the narrow slit opening for concentration of the illuminating light source beam.

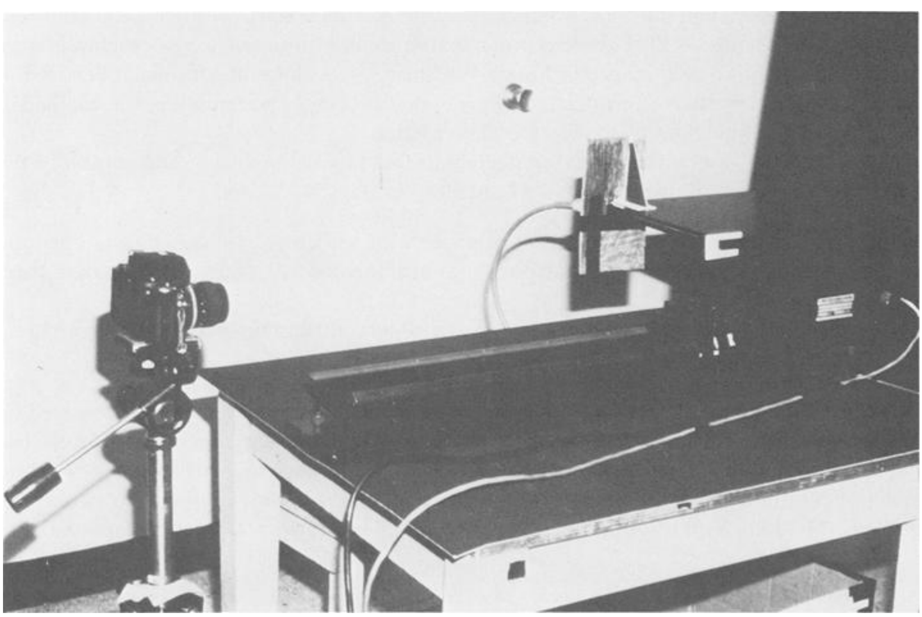

FIG. 1—*Overall perspective photo of conventional black-and-white time-lapse photographic process.*

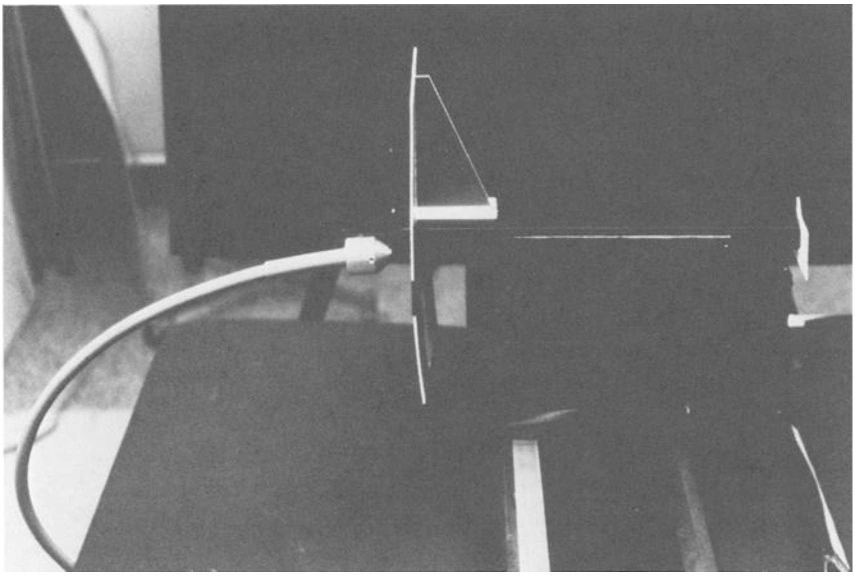

FIG. 2—*Fiber optic light setup in relation to the motorized platform mount. Note the inclusion of an opaque barrier light filter.*

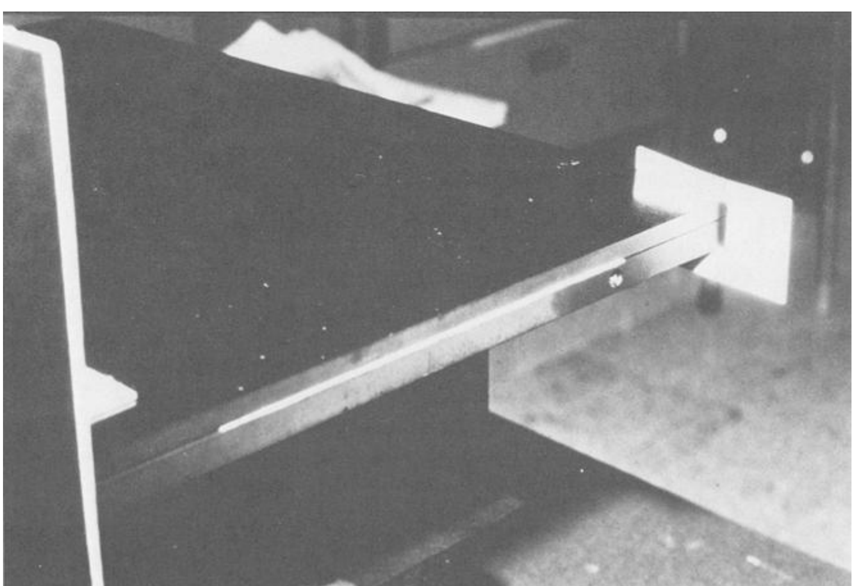

FIG. 3—*The suspect counterfeit note edge resting between two steel plates.*

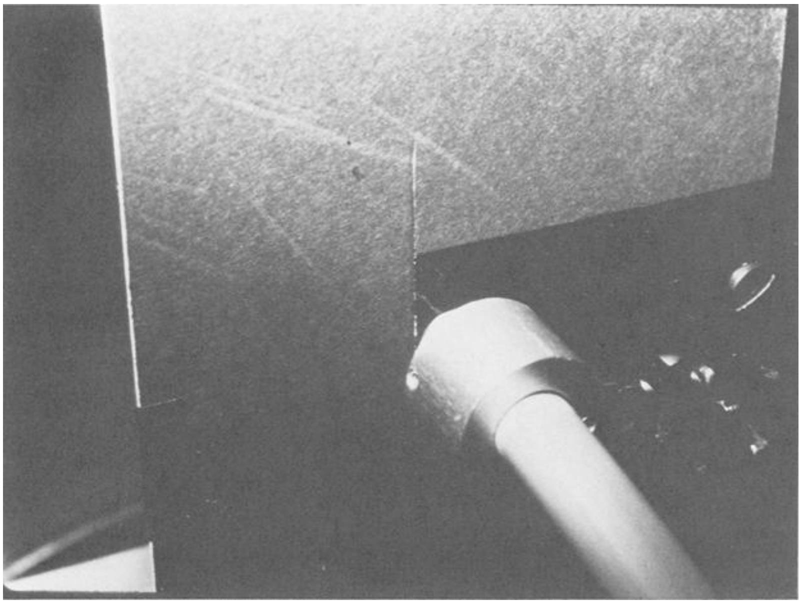

FIG. 4—*The narrow slit opening for concentration of the illuminating light source beam.*

Figure 5 is a conventional side-lighted photo of two *different, unwrinkled, nonninhydrin processed* counterfeit note edges revealing striae agreement.

Figure 6 is a photo of two *different, unwrinkled, ninhydrin processed* counterfeit note edges revealing striae agreement.

Figure 7 is a photo of two *different, wrinkled, ninhydrin processed* notes revealing striae agreement.

Laser Light Illumination

Figure 8 is an overall perspective photo of equipment used in laser illuminating time-lapse photography. Specific equipment modifications, film type, and exposure settings are set forth below:

camera—conventional 35-mm SLR camera with 85-mm Nikkor F/2 lens;

film type—ASA 160 Ektachrome (tungsten based emulsion);

exposure settings—F/4;

time exposure—10 s with shutter open;

light source—10-MW (maximum output) Helium-Neon Laser Light Source manufactured by Hughes, Inc.;

platform mount—same as described earlier in fiber optic setup. Note that rather than note moving during 39-s time span as steel plates descend, this technique requires tripod mounted camera to descend during 10-s time span at constant rate of speed.

Figure 9 depicts a tripod mounted laser light source in relation to steel plates compressing note edges.

Figure 10 depicts counterfeit note edge *flush* with steel plates. Note that as laser light source beam focus more critical than conventional fiber optic light beam, it is *essential that note edge be flush with plate edge.*

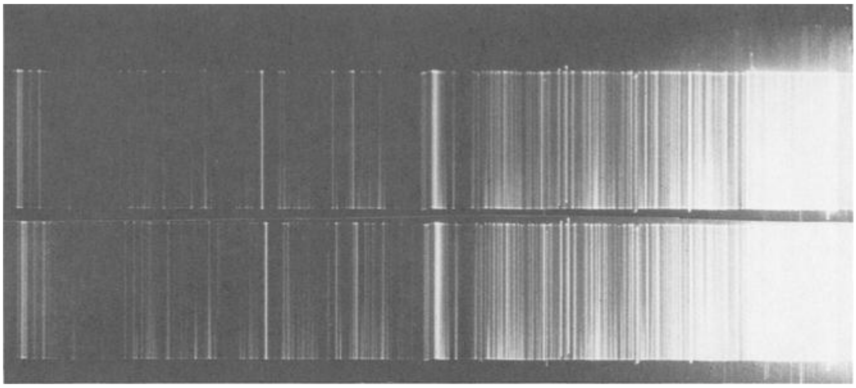

FIG. 5—*Conventional side-lighted photo of two different, unwrinkled, nonninhydrin processed counterfeit note edges revealing striae agreement.*

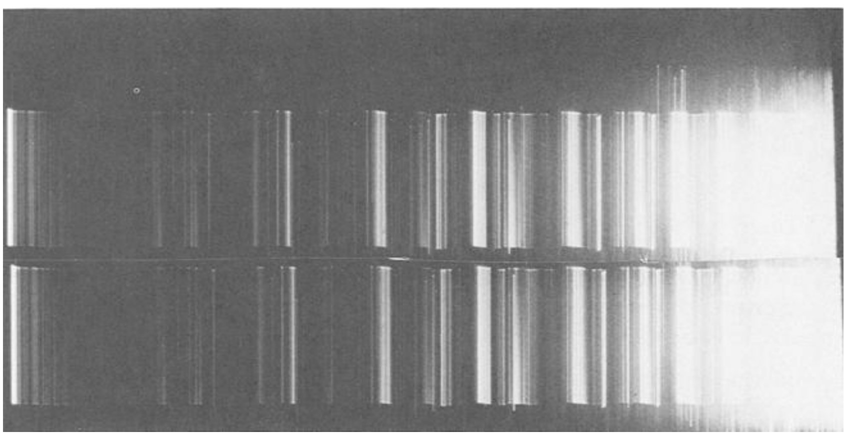

FIG. 6—*Two different, unwrinkled, ninhydrin processed counterfeit note edges revealing striae agreement.*

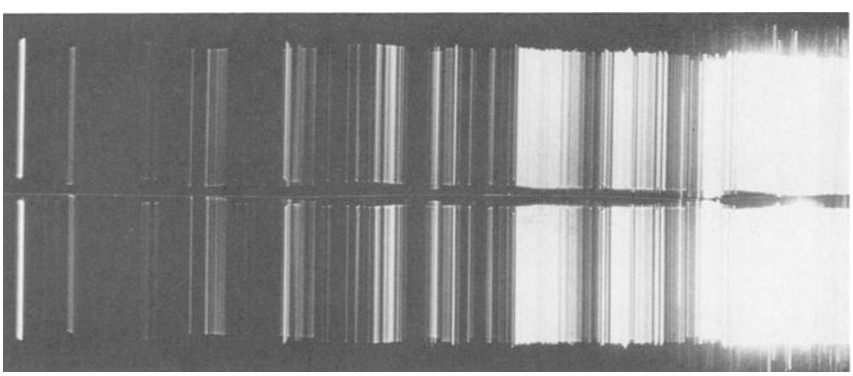

FIG. 7—*Two different, wrinkled, ninhydrin processed notes revealing striae agreement.*

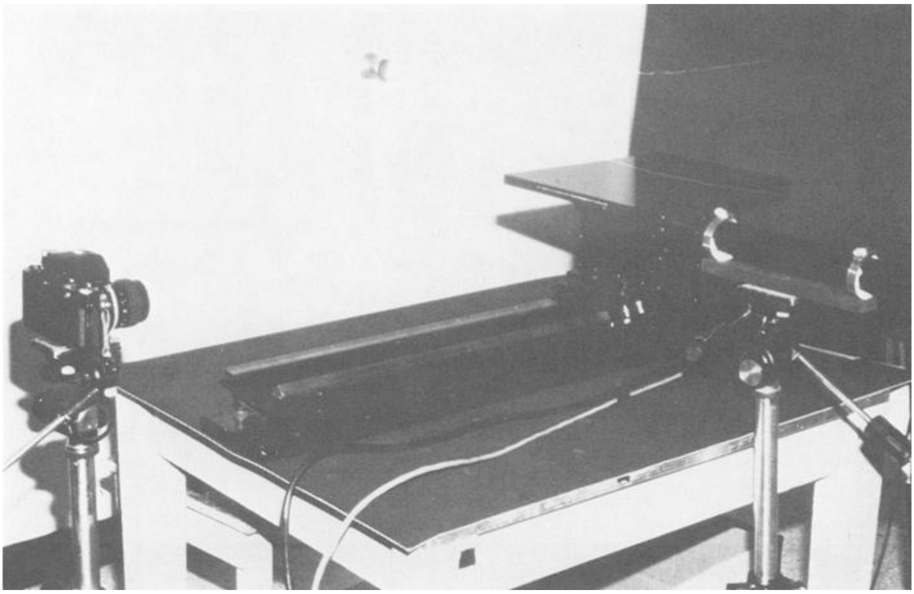

FIG. 8—*Overall perspective of equipment used in laser illuminating time-lapse photography.*

Figure 11 is a laser illuminated photo of three *different, unwrinkled, ninhydrin processed* counterfeit note edges revealing striae agreement.

Figure 12 is a laser illuminated photo of striae present along edges of two *different, wrinkled, nonninhydrin processed* counterfeit notes.

Future experiments by the Secret Service forensic photographers to enhance the laser and fiber optic light photographic techniques should include:

1. Adding a micrometer controlled laser light source armature attached to the motorized scanning device. This adaptation should reduce the differing length of image anomalies caused during the laser photographic processes when the camera was *manually* retracted on its tripod at a nonlinear rate of speed.

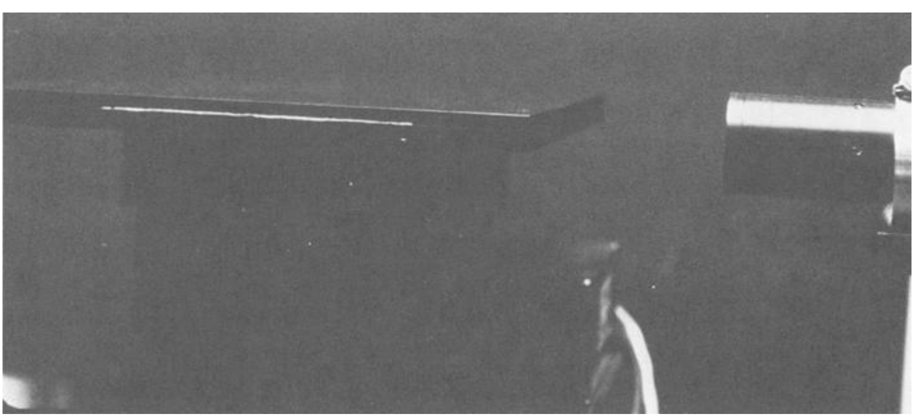

FIG. 9—*Tripod mounted laser light source in relation to steel plates compressing note edges.*

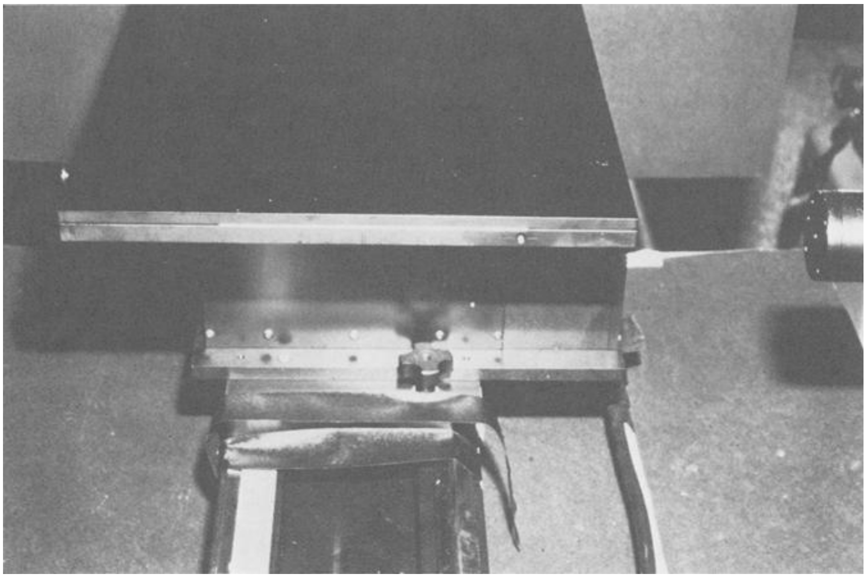

FIG. 10—*Counterfeit note edge flush with steel plates.*

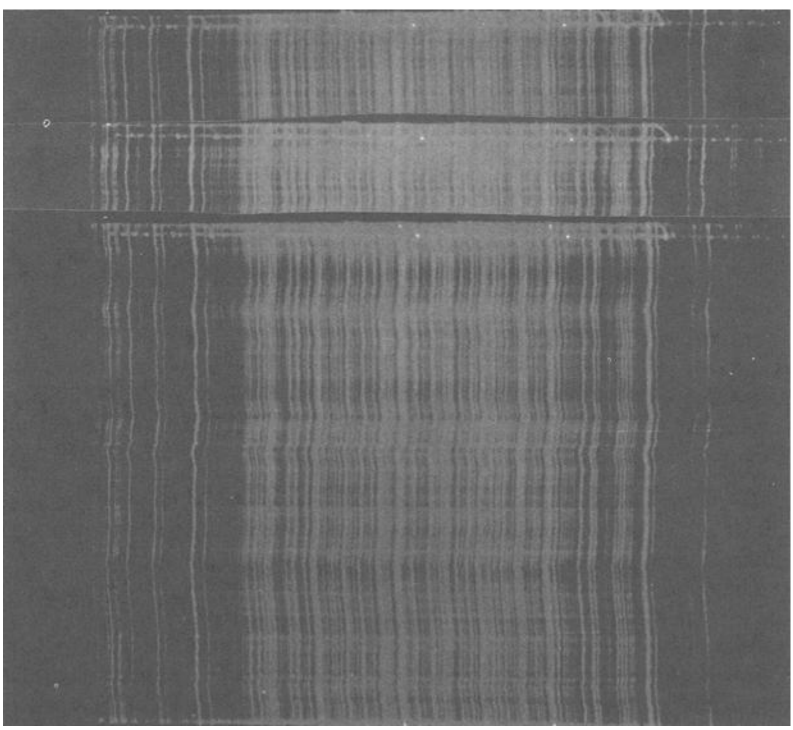

FIG. 11—*Laser illuminated photo of three different, unwrinkled, ninhydrin processed counterfeit note edges revealing striae agreement.*

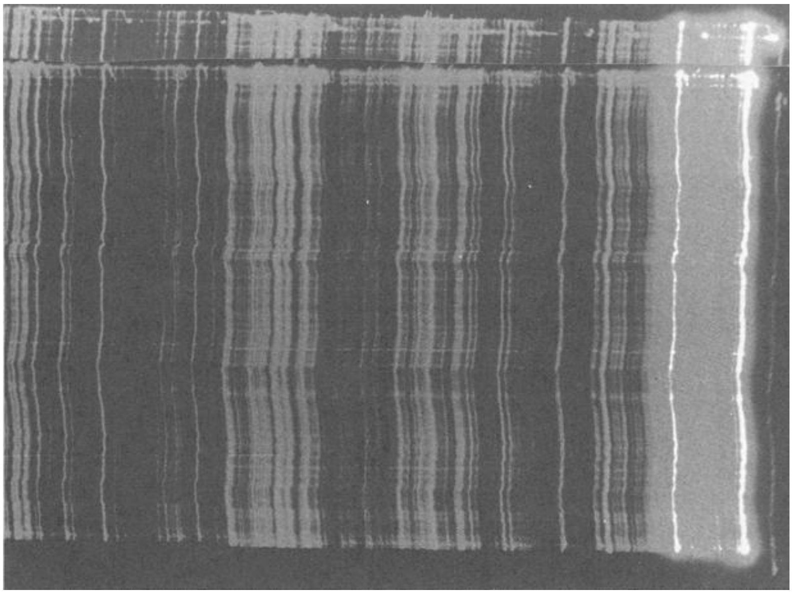

FIG. 12—*Laser illuminated photo of striae present along edges of two different, wrinkled, nonninhydrin processed counterfeit notes.*

2. Photography of the note edge striae with an appropriate type of Tech Pan film mounted on an 203- by 254-mm (8- by 10-in.) format camera for crisper resolution and detail enlargement.
3. Extension of the scanning device camera mount and the addition of suitable swivel mounts to enable both vertical and horizontal rotation of the camera.
4. Marking the camera viewfinder with an appropriate alignment grid so as to improve precision focusing.
5. Utilization of different polarizing screen filters so as to improve the "combing" effects of the laser light reflectance emanating from the note edge.
6. Permanent installation of all of the single-edge photographic equipment into a dark room thus eliminating the present ambient light problems which have produced extraneous lighting highlights on the note edges.
7. Coating of the note edges with an appropriate infrared reflecting dye which, when exposed to laser illumination and photographed on infrared sensitive film, should provide direct infrared absorption values to be recorded versus those reflective values presently being photographed.

Further scientifically controlled experiments will necessarily be required before photographic recordings of single-edge striae would be available for court consideration. Although the preliminary efforts have been encouraging, much more work is required.

Recent published experimental data provided by Deinet of the W. German Bundiskriminalamt has examined striated data with the use of a computer. Specifically, his research office was able to digitize image data on 40 grinding striation marks which were fed into a microcomputer and the position values of the lines were determined semiautomatically. The West German effort discusses in detail how they were able to magnify the striae with a light microscope, photograph the images, mount the resultant negatives on a computer controlled scanning table, scan the data line by line with a microscope photometer, and, finally, to feed the data into a computer for storage and retrieval purposes [*4*].

Software programs have been developed for the acquisition, reduction, and comparison of data on striae and, as suggested by Deinet, it now should be possible to eliminate the image-processing part of the program system. As reflected in his article, ". . . striated position values that have been measured manually on a photograph or under a microscope can be fed into a computer via a terminal" [4].

It is anticipated that eventually the Secret Service will be able to not only photograph evidence striae on single counterfeit note edges but also along the edges of any malleable material into which evidence markings are impressed (that is, cut offset printing plates, counterfeit or altered/mutilated Treasury obligations, and cut or mutilated credit cards). This striae data could then be automatically stored, compared, and retrieved with use of the appropriate computer hardware. These computer and time-lapse photographic technique adaptations should eventually provide both the Secret Service and other law enforcement agencies with the ability to automatically record, store, retrieve, and compare previously unrelated striae data and thus forensically associate that data with known criminal operations which involve usage of cutting blades in the perpetration of the offense.

References

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