Reflectance Spectroscopy of Colored Overprints

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ABSTRACT. This paper describes a new methodology for analyzing overprinted stamps. This methodology is based on two procedures. The first performs precise measurements of the dimensions of overprints and a statistical analysis of the minor variations present among them. The second performs a colorimetric analysis of the ink used for printing the overprints. The goal is to determine if these methods can differentiate between overprints made by different printers and if they can allow rapid identification of counterfeit overprints. A set of overprinted stamps from post–World War I Hungary was selected for testing samples. These stamps had many varieties, were produced by two different print shops, and were often counterfeited. After describing the different scientific testing performed, this paper outlines general procedures that may be used by other researchers.

INTRODUCTION

One of the difficult tasks in philately is the scientific analysis of overprints on stamps. This observation led Souren (1939:18) to write, in reference to his expertizing organization, "However, no opinion will be advanced on surcharged stamps except as to the condition of the basic stamp. It will necessitate years of preliminary research before scientific proof of the true nature of overprints can be determined satisfactorily."

More than 70 years later, the need for methods that allow overprint identification remains extremely high. Two particularly important areas are the ability to precisely measure all overprint dimensions and the ability to determine, in a quantitative manner, the color of the ink used for the overprint. Identification of color is important in making the distinction between different printings of a given stamp design and between genuine and counterfeit printings. It can make the difference between a stamp of little value and one of great rarity.

Cost-Effective Equipment

Developments in analytical instrumentation using various forms of electromagnetic radiation permit new methods of examination and analysis of the colors and compositions of the inks of stamps. These techniques have recently been evaluated for, and used in, philatelic applications (Lera, 2012; Lera et al., this volume).

Visual color identification is subjective. It is dependent upon the age and the sex of the observer and upon the conditions of observation (Herendeen et al., 2011:106). The spectrum of the light reflected from the surface of one stamp can be compared with the spectrum of the light reflected from a second stamp to determine if the colors of the two

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stamps are the same or different (White, 1979), but this comparison does not necessarily describe the colors of the stamps as seen by the eye.

More important, the cost of analytical instruments has dropped dramatically over the last 10–20 years, allowing the proliferation of such devices and increased access to them for philatelists. This is greatly facilitated by the facilities at the Smithsonian National Postal Museum (NPM).

The VSC 6000

One of the analytical instruments available at the NPM is the Foster + Freeman, Ltd. Video Spectral Comparator (VSC 6000). This spectrophotometric device allows the quantitative measurement of color, which allows the correlation of reflectance spectra with accepted color systems (Foster + Freeman, Ltd., 2011).

The most widely accepted color systems are those established by the Commission Internationale de l'Éclairage (CIE).[1] The proprietary software of the VSC 6000 system uses measured reflectance data to compute colorimetry parameters defined by the CIE system.

The human eye has three types of cones, which receive short (blue), medium (green), or long (red) wavelengths of light. Humans perceive color because these cones are stimulated by light energy. The colorimetry parameters are called the tristimulus values, X, Y, and Z. These correspond to the human visual responses to blue, green, and red components of light. A simple calculation transforms the tristimulus into the 1976 CIE chromaticity coordinates, u',v' (Berns, 2000).

The chromaticity coordinates are a measure of visible color. If the chromaticity values for two different objects are close together, using a simple distance metric, the colors of the two objects will appear either very close or identical to the eye.

The study of the 1919–1920 postage-due stamps of Slovenia by Herendeen et al. (2011) has demonstrated the utility of the VSC 6000 not only for the measurement of color of stamps but also for actual color identification through the use of chromaticity plots. Others have also used the VSC 6000 to study color varieties of stamps themselves (DeBlois and Harris, 2011).

THE SZEGED OVERPRINTS

In the spring of 1919, Admiral Miklós Horthy organized a counterrevolutionary nationalist government at Szeged, a city in southeastern Hungary. This was in opposition to Béla Kun's Communist government that was in control in Budapest. As is often the case during wartime conditions, the available stamp supplies were confiscated by the group in power. The available stamps in the Szeged post office were overprinted "MAGYAR NEMZETI KORMÁNYI, Szeged, 1919" (Hungarian National Government). A total of 49 different stamps were issued (Scott numbers 1–35, B1-4, E1, J1-8, and P1) (Scott, 1998).[2] The stamps were all issued on 28 June 1919.

The stamps overprinted for use in Szeged are referenced by their design or their postal use. While there were seven of these, only the three actually used are shown in Figure 1. They are called Harvesters (Figure 1a), Parliament (Figure 1b), and postage-due stamps (Figure 1c).

The format of the overprint, used for all of the stamps, is shown in Figure 1d. Although these stamps are listed in most catalogues with the so-called Occupation issues, that is, those stamps created by occupying military forces, they were issued by a valid Hungarian authority (Ettre, 1972a:5–6; Miles, 1993:193–196). After the Horthy regime became the de facto government of Hungary, these stamps were recognized as legitimate issues of the Hungarian government (Ettre, 1972a:5–6).

The Print Shops

The production of the Szeged overprints was carried out by two different print shops (Ettre, 1972a; Brainard, 2006). Unfortunately, details of these shops have been lost to time. Since the colors of the Hungarian flag are red, white, and green, the nationalist government in Szeged decided to use red and green as the colors of the overprints. The majority of the stamps received red overprints, but stamps on which a red overprint would not show well received green overprints. The green overprint has been extensively analyzed by the author in an earlier paper (Caswell, 2012).

a. Harvesters b. Parliament c. Postage Due d. Overprint

FIGURE 1. (a, b, and c) The basic stamps used for Szeged overprints and (d) the overprint setting.

FIGURE 2. The difference in colors between (left) Print Shop 1 and (right) Print Shop 2.

As seen in Figure 2, the red overprints from the two print shops are visibly different: vermilion from Print Shop 1 and carmine from Print Shop 2. There is no visual difference between the green overprints of the two print shops. Print Shop 1 overprints of both colors can be distinguished from other overprints by the force of their application, which resulted in ink splash, that is, thickening of the ink at the edge of each letter, on the front of the stamp, and reverse embossing on the back. Print Shop 2 overprints have no distinctive features other than color.

About half of the stamps received overprints in each print shop. As will be seen, this study developed a method for attributing stamps to the two print shops.

Counterfeits

Like all of the "Occupation" overprints, those of Szeged have been extensively counterfeited. The notorious Budapest stamp dealer and counterfeiter Géza Tarján produced excellent counterfeits late in 1919, apparently using the original plates (Fälschungen, 1936). Additional counterfeits originated from Prague in 1926 (Die Fälschungenplage, 1926), and there may well be counterfeits from other sources (Tyler, 1991).

For interested readers, Brainard (2006) has provided descriptions of a number of the counterfeits. Many of the counterfeits are easily recognized by bad fonts, characters, and colors. A simple example is shown in Figure 3.

Part of the research documented herein presents methods for determining how the more subtle counterfeits may be identified by precise measurements or colorimetry.

SELECTION OF TESTING SAMPLES

A preliminary examination of all of the available Szeged stamps was made in order to determine which ones were suitable for reflectance spectral measurement. Stamps with overprints that showed ink splash and embossing on the reverse were assumed to have genuine Print Shop 1 overprints. All overprints with a shifted date were assumed to be counterfeit (Caswell, 2012:37).

It was observed that in order to perform any spectrographic analyses on the overprints, a portion of the overprint must be over an unprinted portion of the stamp and the spot size must be small enough that only that portion is illuminated. If this is not the case, there may be interference by the reflectance of the underlying ink.

Most of the basic stamps with the Harvesters and the Parliament designs and the postage-due stamps have significant unprinted areas beneath parts of the overprints. Thus, with the exception of the problem described next, all of these stamps were included as samples for testing.

Under a ×10 hand lens, some candidate sample stamps were discovered to have tiny, uninked spots within the letters of the overprint. Such overprints were eliminated as samples.

FIGURE 3. The poorly executed forgery on the right has a wildly different ink color than the genuine stamp on the left.

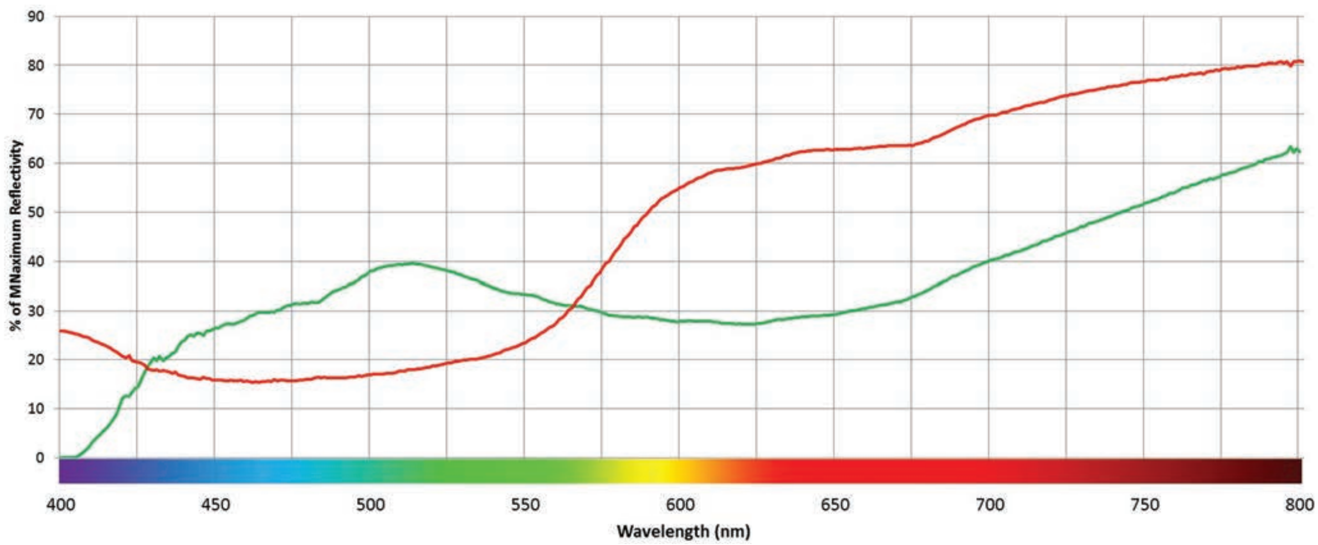

FIGURE 4. Reflectance curves from the VSC 6000 for typical red and green overprints.

TEST PROCEDURES

Each of the selected test samples was analyzed using the VSC 6000. During testing each stamp was illuminated with a 100-watt filtered incandescent spotlight. For precise measurements, the stamps were magnified by a factor of four. VSC tools for measuring and labeling the stamps were then used.

For colorimetry analysis, the reflected light was measured under ×18 magnification from a small portion of the stamp overprint having an area of 0.03 mm^2. The VSC measures reflectance as the percent of the light reflected by the sample compared to the light reflected from a standard white magnesium carbonate tile. The reflectance spectrum of each overprint was measured at a minimum of two points. The measurements were usually by different operators. The resulting spectra were averaged for each stamp. Figure 4 shows typical reflectance spectra for stamps with red and green overprints. The color of the curves in the figure matches the overprint color. The plot shows data for the wavelength range of human vision, 400–800 nanometers (nm).

RESULTS

This section presents the results of the precise measurements and colorimetric analysis of the overprints of the selected samples.

Precise Measurement

Dimensions of stamps and overprints can be measured accurately with the VSC 6000. This capability was used to measure the dimensions of the overprints of all stamps in this investigation under ×4.02 magnification. Table 1 gives a summary of the overprint measurements of the sample stamps.

TABLE 1. Precise overprint measurements of overprints by stamp design.

Stamp design	Mean horizontal distance (mm)	Standard deviation	Mean vertical distance (mm)	Standard deviation
Harvesters	14.28	±0.19	9.31	±0.19
Parliament, genuine overprint	15.67	±0.21	4.86	±0.12
Parliament, counterfeit overprint	14.29	±0.11	9.29	±0.09
Postage due, genuine overprint	16.05	±0.06	9.66	±0.03
Postage due, counterfeit overprint	14.72	±0.14	9.71	±0.06

FIGURE 5. Location of horizontal and vertical overprint measurements.

The table gives two measurements for the different stamp designs and the standard deviations of the measurements of different stamps with the same characteristics. The first are the mean horizontal distances from the foot of the "Y" of MAGYAR to the foot of the "R" of KORMÁNY (A in Figure 5). The second is the vertical distances from the foot of the first "E" of NEMZETI to the top of the "S" of Szeged (B in Figure 5).

Several conclusions may be drawn from these data:

- The measurements for the Harvesters design cannot be differentiated by overprint measurement of the sample stamps.
- The vertical distance of the counterfeit overprints on Parliament design stamps is almost double the distance of the genuine Parliament overprints.
- Comparison of the Parliament overprints with the Harvesters overprints leads to the conclusion the Harvesters setting for the overprint was used in counterfeiting the Parliament overprints.
- The horizontal distance of counterfeit overprints on the postage dues is significantly smaller than the genuine overprints. The settings the counterfeiter used were not a good match with the correct distances.

Colorimetric Analysis

Preliminary measurements with the VSC 6000 showed that reflectance spectra from parts of an overprint that overlay a printed portion of a stamp were ambiguous. Apparently, reflectance from the ink of the underlying design combined with the reflectance of the ink of the overprint, resulting in subtractive mixing. Useful spectra were obtainable only from parts of an overprint that lay on an unprinted part of the stamp. Thus, measurement was limited to overprinted stamps with significant unprinted areas, namely, the Harvesters, the Parliaments, and the postage-due stamps. Collecting data from overprints on other stamps would have been very difficult.

Colorimetric analyses were performed for all of the red overprint samples. Their reflectance spectra were then analyzed to determine whether CIE color models could be useful in identifying stamps from the two print shops and in differentiating between genuine and counterfeit overprints. This was not the case with the green overprints (Caswell, 2012), where the color match was so close that it is highly probable that the same ink was used.

As noted previously, it is possible to use chromaticity plots (u', v') to group samples into families of perceived colors. It has been demonstrated (Herendeen et al., 2011:108) that each group can then be enclosed in a convex hull to make the different colors easier to visualize. For the purposes of this paper, this hull is used to clearly differentiate between the three shades of the overprint.

Figure 6 presents the chromaticity plot for the carmine, vermilion, and rose-carmine overprints. It also shows the convex hulls that enclose the group of samples that have each of these colors. The carmine convex hull contains the points for both genuine Print Shop 2 overprints and counterfeit overprints. The convex hull for the vermilion overprints contains genuine Print Shop 1 overprints. The lack of overlap of these convex hulls is in agreement with the observation that the colors of these overprints are visually different. The unusually shaped rose-carmine convex hull is disjoint from the other two, which is consistent with its different color. Szeged overprints of the rose-carmine color have not previously been described in the philatelic literature.

Figure 7 compares the convex hull of genuine Print Shop 1 overprints (Hull A) with the convex hulls of other varieties. The convex hull of the carmine overprints, shown in Figure 6,

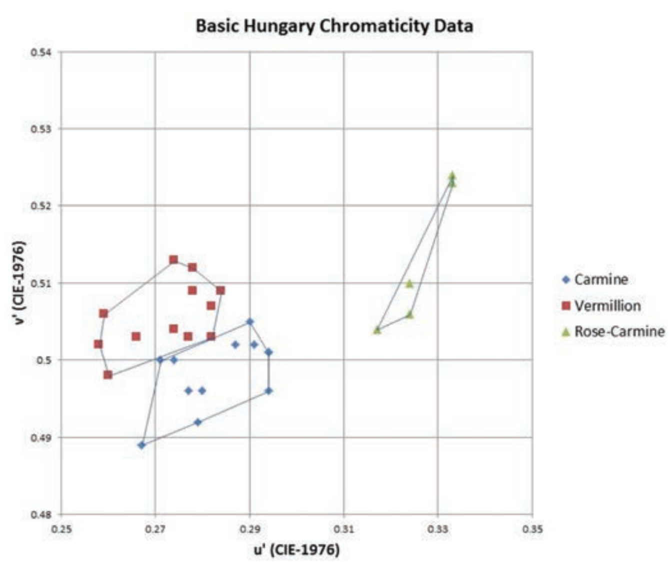

FIGURE 6. Convex hulls for the red-colored overprints.

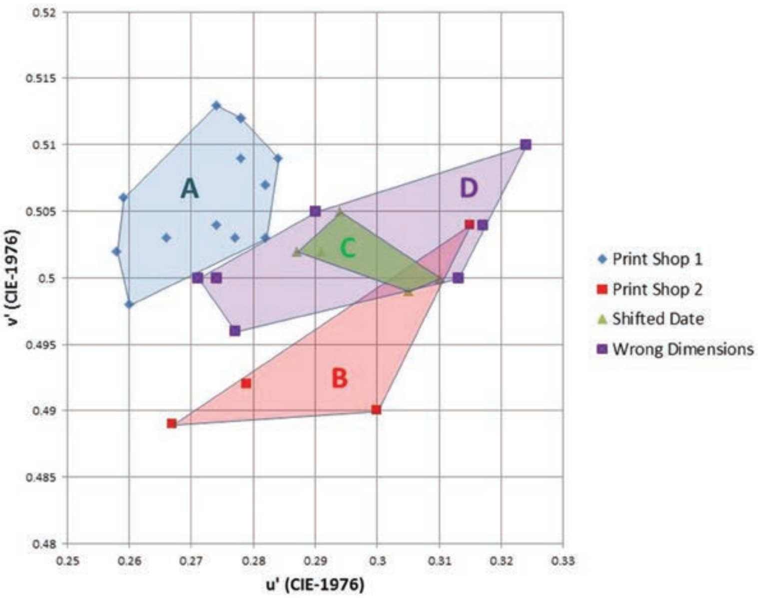

FIGURE 7. Identifying print shops by carmine colors.

is partitioned into three convex hulls, showing the distribution of points for

- genuine Print Shop 2 overprints (Hull B),
- shifted date overprints (Hull C), and
- wrong dimension overprints (Hull D).

The small overlap of Print Shop 2, shifted date, and wrong dimension overprints is due to the similarity in color of these overprints. The Print Shop 2 overprints are significantly distant from the Print Shop 1 overprints, again indicating a clear difference in color. The observation that the convex hull of the wrong dimension overprints (Hull D) lies outside the convex hull of genuine Print Shop 1 overprints (Hull A) and has only slight overlap with the hull of Print Shop 2 (Hull B) is in agreement with Brainard's new conclusion that the wrong dimension overprints are counterfeit,[3] rather than a genuine variety, as stated by Ettre (1972a). The convex hull of the shifted date overprints lies within the convex hull of the wrong dimension overprints because these overprints are the same color. They are therefore two varieties of counterfeits in agreement with the literature, Brainard states.

CONCLUSIONS

This study has demonstrated a useful methodology for analysis of colored overprints. The VSC 6000, through use of its capabilities to make precise measurements of stamps and to perform colorimetric analyses, has been shown to be a powerful tool for studying overprints.

The finding that the convex hulls for the overprints with the wrong dimensions lie outside of the convex hulls for genuine overprints was very important. It showed there was a significant color difference, thus confirming Brainard's (2011) conclusion that the wrong dimension overprints are counterfeit.[4] This corrected an earlier assumption (Ettre, 1972b) that they are genuine varieties. Both wrong dimension overprints and shifted date overprints fail to match the convex hull color characteristics of either the Print Shop A or Print Shop B overprints. These data are in agreement with Brainard's conclusions that they are two varieties of counterfeits.

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NOTES

1. CIE, the Commission Internationale de l'Éclairage (International Commission on Illumination), formed in 1913, is the international organization that develops standards for everything having to do with light and color. They have had a number of color standards through the decades used for color matching. For more information, visit their Web site at http://www.cie.co.at/main/ (accessed 6 September 2012).

2. Scott numbers (Scott Publishing Co., 1988) are given for reference, but specialized European catalogues may list more varieties.

3. C. E. Brainard, email message to author, 31 May 2011.

4. Brainard, email message.

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