Proposal for

A Colorimetric Analysis Methodology for Philatelic Studies

Prepared for

The Smithsonian National Postal Museum

Prepared by

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1. Executive Summary

Many philatelists of the “baby boom” generation began the hobby as collectors of U.S. stamps. Beyond blue, red, and green, colors were not a major consideration. In many cases, the first notion of a shade began when we heard of the exotic “pigeon blood pink” variety of the 1858 3c stamp (Scott 64a). Cool, we thought. Then we wondered, what on earth does pigeon blood pink look like? Who made up such an esoteric name? How would we ever know if our common 3c might be the “one?” These are excellent questions. What is needed is an affordable analytical method for verifying shades of stamps that eliminates the need for large reference collections and “experts.”

Prior to the last decade, the ability to perform objective, accurate, nondestructive and affordable spectrographic analyses of stamps has not been possible. However, the rapid development and improvement in computer, video, software, optical and laser technologies has resulted in new generations of hardware that will become indispensible to philatelists. One such device is the Video Spectral Comparator, VSC6000, at the Smithsonian National Postal Museum.

This proposed research project, entitled ***A Colorimetric Analysis Methodology for Philatelic Studies***, intends to develop a transferable technology that will be useful to the entire philatelic community for defining colors not by impossible-to-interpret names, but by accurate chromaticity metrics. It is hoped that a derivative technology can be developed that allows much more inexpensive scanning technologies to be used for the same purpose.

As will be seen, this proposed study intends to open new vistas for philatelic color analysis that allow shades to be identified without having a reference collection of comparator copies. If this can be done using inexpensive scanning hardware it will represent a truly significant forensic tool in the future. Such a possibility should certainly be deserving of the support of the SNPM.

2. Technical Approach and Statement of Work

2.1 Questions to be Addressed

The purpose of this study is to develop a new methodology that will address, and answer, a number of fundamental and open questions that have potentially broad applicability across many areas of philately. Specific questions that will be considered include:

1. Do stamp issues really have as many color shades as philatelists often claim?
2. Can shades be defined by precise, analytical metrics rather than the haphazard naming of arcane shades that have no meaning outside of the context of the entire universe of a stamp issue?
3. If shades can be precisely defined using a device such as the VSC6000, can the methodology be adapted in a useable manner to more cost-effective hardware such as a simple scanner?

In order to answer these questions, three tasks have been defined. Each of these is described in the following sections along with the technical approach that will be used.

2.2 Task 1: Selecting Samples for the Colorimetry Study

Background. There are many worldwide stamp issues which have a wealth of color shades. For this study, the Principal Investigator (PI) has selected the postage due stamps issued in Slovenia from 1919-1921 (Scott Yugoslavia 3LJ1-7 and 3LJ8-14). These stamps were produced first in Vienna, Austria, and then in Ljubljana, Slovenia. The low (Vinar) values were printed in shades of red, with some brown components, and the high (Kruna) values were printed in shades of blue. These stamps have been selected for several reasons:

?? The PI has studied these issues for more than a decade, and has several hundred examples encompassing a wide variety of shades

?? The issues have been well-documented, and color shades defined by, scholars in Slovenia.[1,2]

?? The PI has contacts abroad, including Slovenia, that should allow even the rarest of shades to be analyzed under this effort.

To illustrate the complexity of these issues, consider Fig. 1. There are ten recognized perceptual shades of the Vienna printing of the four low values (3LJ8-14), and the five shades of the three high values.[3] The names associated with these 15 shades are presented in Table 1. The names of these colors are given in Croatian,[1] Slovenian,[2] German[1] and English (by the PI). While some of the shades shown in Figs. 1a-1j, and in Figs. 1k-1o, are quite distinct from one another, some are, at best, subtly different. (The PI is especially intrigued by the *murky brown brick red* shade—someone clearly had a vivid imagination.) These stamps are known to have been produced by only two printings in Ljubljana, and two in Vienna. This would account for some, but not all, of the wide variety of shades. Other sources of shades include: different ink batches, pressure differences during the transfer process, non-uniform cleaning of the printing plates, and many others.

Figure 1. Shades of the Vienna print as presented in Ref. 2. Vinar values (red color family) and Kruna values (blue color family)

Table 1. Description of Shades of the Vienna Print shown in Fig. 1.

Figure	Ref 1. Croatian	Ref 2. Slovenia	Ref 1. German	English
Vinar Values (Red Color Family)				
a	opekasta	opekast	ziegelrot	brick red
b	blijedoopekasta	bledo opekast	fahlziegelrot	pale brick red
c	NA	Svetlo rjavo opekast	NA	bright brownish brick
d	smedeopekasta	rjavo opekast	schmutzigbraunziegelrot	murky brown brick red
e	škrletna	škrlaten	scarlach	scarlet
f	škrletnocrvena	škrlaten rdec	scharlachrot	scarlet red
g	smedastocrvena	rjavo rdec	bräunlichrot	brownish red
h	smedastokarminska	rjavo karminski	bräunlichtkarmin	brownish carmine
i	tamnosmedekarminska	temno rjavo karminski	dunkel braunkarmin	dark carmine-brown
j	NA	pastelno rjavo rdec	NA	pastel brownish red
Kruna Values (Blue Color Family)				
k	škriljastozelenomodra	škrilasto zeleno moder	schiefergrünblau	Slate greenish-blue
l	škriljastomodra	škrilasto moder	schieferblau	Slate blue
m	modra	moder	blau	blue
n	tamnomodra	temno moder	dunkelblau	Dark blue
o	crnomodra	crno moder	schwartzblau	black blue

Work Item: Under this task, the PI will assemble at least one hundred samples of the low and high valued postage due stamps. The goal will be to have one or more examples of each shade available for analysis, and that these will cover the full gamut of currently recognized shades, e.g. those shown in Table 1 for the Vienna printings. It is anticipated that other minor shade variations will also be available. The samples will be mounted in such a manner as to be easily interfaced with the VSC6000 for efficient data collection.

2.3 Task 2: Experimental Data Collection

The sampling universe will be brought to the Smithsonian National Postal Museum for analysis. Each stamp in the sample will then be analyzed and both chromaticity data and absorption spectra will be gathered. The approach for doing this is given in the following sections.

2.3.1 Analytical Color Specification-Chromaticity Diagrams

Background. It is generally accepted that color is a result of a psycho-physiological perception rather than an independent physical phenomenon such as sound. Specifically, it is the stimulation of the human visual system by what is called visible light. This light is simply electromagnetic radiation having wavelengths ranging from 380 nanometers (nm) to 780 nm.

While color can not be measured directly, the conditions leading to our perception of color sensations can be measured. The method for doing this was introduced in 1931 by the international standards agency *Commission Internationale de l'Eclairage*, CIE. To measure the variables that create color sensations, the CIE established a reproducible, spectrophotometry-based, device-independent color model constructed from a light source, an observer, and an object. The results of a CIE-compliant measurement and transformation are coordinates that locate the specimen in a horse-shoe-shaped color space representing human color perception. Such color spaces are called ***Chromaticity Diagrams***, as seen in Fig. 2. Various improvements to the 1931 standard have resulted in newer models such as the CIE 1960 model that is claimed to better represent the human visual perception. This model, shown in Fig. 3, indicates how six color samples could be compared. Both of these models are supported by the VSC 6000.[4] A detailed discussion of these, and other, models is well beyond the scope of this study.

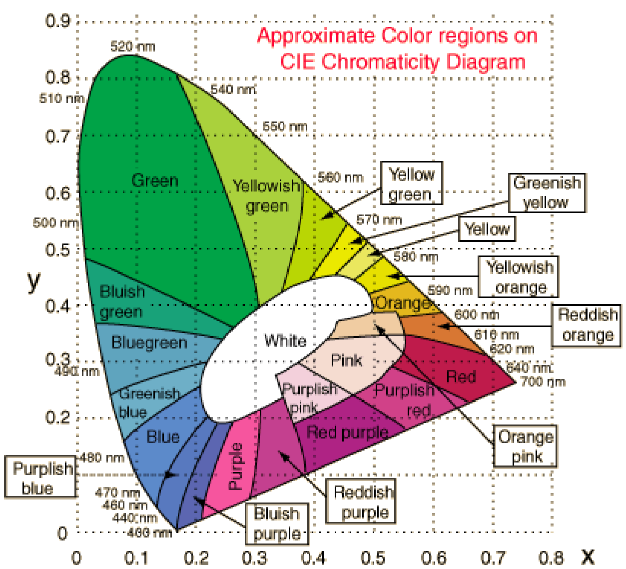

Figure 2. Chromaticity Diagram, CIE 1931

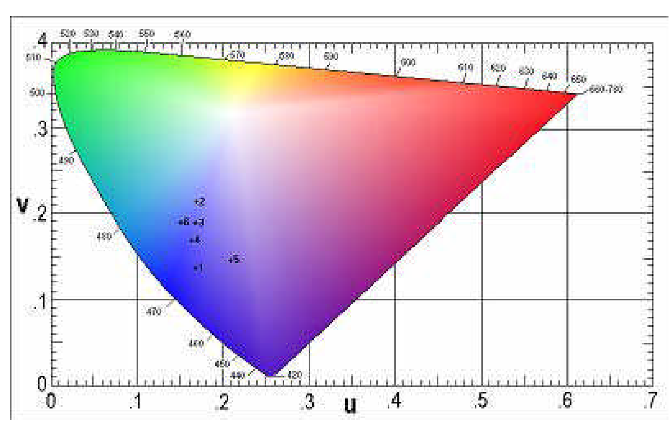

Figure 3. Chromaticity Diagram, CIE 1960

For the purposes herein, it is enough to understand that such diagrams, or in some cases the raw data used to create them, can be used to compare different stamp shades. This in turn will allow clusters of shades to be identified by chromaticity rather than "name."

Work Items. All of the test samples will be analyzed with the VSC6000 and the following data collected:

?? chromaticity diagrams (both CIE 1931 and CIE UCS 1960)

?? all of the tabular data, including: tristimulus values; CIE 1931 x,y coordinates; CIE UCS 1960 u,v coordinates; and Color Space 1976 L*a*b* coordinates.

Other appropriate results, such as luminosity, will be identified and saved. For each test, all of the input parameters will be stored in the general casework management system (CMS) provided by the VSC6000. As data are added to the CMS, each experiment will be labeled with the active parameters including the type of illumination used, camera filter, integration time and magnification. This will insure reproducibility of results should the need arise to repeat any of the measurements.

2.3.2 Absorption Spectra

Background. As noted earlier, the Slovenian postage due stamps are known to have been produced by only two printings in Ljubljiana, and two in Vienna. This alone can not account for the wide variety of shades. Current research indicates that ink may be scanned with ultraviolet or infrared light, and its absorption spectrum recorded. Every ink should give a distinct spectrum on exposure to ultraviolet, visible, or infrared light. Additionally, some inks fluoresce, or emit light, on exposure to ultraviolet, while others disappear.

Work Items. For each of the test samples, a variety of absorption spectra will be measured and saved on the CMS. This may ultimately allow a comparison of spectra to identify individual printings. All of the spectral output options of the VSC6000 will be reviewed to determine if other spectra should be measured and saved during Task 2.

2.4 Task 3: Results Analysis and Publication

Once all of these data have been collected and saved, a detailed analysis will be performed and the results documented. Work items for this task are described below.

2.4.1 Color Comparisons

Background. The area of color comparison is, in fact, an open research issue. The first breakthrough by MacAdam[5] led to a number of empirical relations for comparing colors. However, such relationships must blend optics with the study of the human eye and color perception in the brain. This makes any completely definitive result impossible. Different models have been developed, for example, for photography[6] and for fabric dyes.[7] A literature search has not uncovered any similar work in philately. Thus, this is a fertile area for original research.

Work Items. The Chromaticity diagrams (or, more probably, one or more sets of chromaticity coordinates) of the color samples will be compared. An attempt will be made to develop a semi-empirical model based on previous work. Methods will be developed to present the final results in a fashion understandable to the non-scientist. Finally, a study will be made to see if it is possible to use inexpensive scanning hardware and PC-based software to make analytical color determinations.

As required by the NPM-sponsored grants, the results of this effort will be published in the mainstream philatelic literature. The specific publication will be determined by the general importance of the results to the philatelic community and the physical size of the resulting documentation. The following are publications that will be considered:

- ?? A dedicated book (if the size warrants it and if sponsorship from major publishing bodies such as the APS, RPSL, Stuart Rossiter Trust, Collectors Club of New York, or Collectors Club of Chicago can be obtained)
- ?? The *American Philatelist* (if the article is not too technical, which may be impossible) with a circulation of about 45,000, few of whom are researchers.
- ?? The American Philatelic Congress Annual *Congress Book* (which allows papers to 40 pages or so). Circulation 500-600 most of whom are researchers.
- ?? The *London Philatelist* (which allows papers to 30 pages or so). Circulation 1000-2000 some of whom are researchers.
- ?? The *Collectors Club Philatelist* (which allows papers to 15-20 pages before serialization). Circulation 1000-1200 some of whom are researchers.

The PI feels that if the proposed research results in a generalized methodology for colorimetric analysis and identification of philatelic material, then the publishing mode should afford the maximum dissemination possible. This might indicate a need for several articles having different levels of technical content.

3. The Principal Investigator

The Principal Investigator for this effort is David L. Herendeen. Mr. Herendeen is a retired computer software executive who was responsible for bid and proposal activity and project management of many government-sponsored research efforts. Agencies included NASA, the U.S. Air Force, the USPS and many private aerospace companies. His fields are mathematics, computer science and engineering. He has been a PI for numerous contracts including a NASA Small Business Innovation Research Grant.

Mr. Herendeen is a nationally known philatelist. He is a member, officer and director of many organizations, an accredited national chief judge, editor of the France and Colonies Philatelist, and he has published extensively in his field of postage due stamps. His complete philatelic résumé may be found in Appendix A.

4.Funding

Assuming a $2,000 grant, the funding will be used to travel to Washington, DC to perform the Work Items set forth in Task 2 above. It is anticipated that this funding would be sufficient to cover air fare and 6-8 days of hotel and per diem. Naturally, all other costs will be borne by the PI including any subsequent trips to the SNPM to acquire additional data.

It is presumed that the SNPM will provide sufficient access to the VSC6000 as well as any necessary training and support on the use of this device.

5. References and Notes

1. *Prirucnik Maraka Jugoslavenskih Zemalja, Svezak 7*, Filatelicki Savez Hrvatske, Zagreb, Croatia, 1947.
2. Cicerov, S., *Slovenija Portovne Znamke 1919-1921*, Masta Trade, Ljubljana, Slovenia, 2008.
3. Adapted from Ref. 2.
4. *VSC6000 Video Spectral Comparator Software Manual*, Foster+Freeman Ltd, Evesham, Worcestershire, UK, 2009.
5. See http://en.wikipedia.org/wiki/MacAdam_ellipse
6. Kerr, D.A. “A Metric for Chromaticity Difference,” D.N. Kerr, 2008.
7. See, for example, http://en.wikipedia.org/wiki/Color_difference