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< Statement on Spectroscopic Imaging in Art Conservation: A New Tool for Materials Investigations >

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[Figure goes here in the Artist's Statement] [Caption: "Drawing as it appears to the eye (left), and enhanced using spectroscopic imaging and principal-components analysis to highlight differences among near-infrared spectra of materials (right). Charcoal lines are coded red."]

The remote-sensing technique of spectroscopic imaging has been adapted to non-destructive examination of works of art [1]. The technique allows the art materials to be distinguished by their composition, and underdrawings revealed [2]. Our initial results indicate that, even over limited wavelength ranges and with relatively coarse spectral resolution, a number of pigments can be distinguished on the basis of variations in their near-infrared reflectance spectra. Non-destructive identification of pigments can be used to address issues of attribution, age dating, and conservation. Since the technique produces images, it also provides information on the distribution of the pigment types in the work being examined. By acquiring an image at each of dozens of wavelengths spaced at 10-nanometer intervals through an extended spectral range (650-1040 nm), we can build up what is known as a 3-dimensional spectroscopic imaging data cube. An additional advantage of this technique is that it can be performed off-site using portable instrumentation, and under relatively benign lighting conditions. The equipment it utilizes is specialized but relatively inexpensive.

The technique has been applied to the examination of a fifteenth-century drawing, Untitled (The Holy Trinity), in the collection of The Winnipeg Art Gallery. Software adapted from the remote-sensing image-processing field has been used to successfully map the areas of different brown and black pigments across the drawing. Multivariate image analysis [3] produced a set of principal-component (PC) images highlighting different materials aspects of the drawing. A color composite image produced from the PC images provided a direct visualization of the compositional characteristics of the work (see figure). The images produced are easily interpreted, and the information obtained is directly usable by conservators, art historians, and curators alike. Features of the underdrawing have been exposed, and its material tentatively identified as charcoal, by comparison with reference data. Identification of the other pigments awaits the creation of a more appropriate database of near-IR pigment spectra.

Based on the success of our preliminary work [4,5,6], the collaboration between our institutions (University of Winnipeg, Winnipeg Art Gallery, and Institute for Biodiagnostics of the National Research Council of Canada) has been formalized as C-SCAPE, the Centre for Scientific and Curatorial Analysis of Painting Elements. With federal, provincial, corporate, and private funding, C-SCAPE is purchasing dedicated instrumentation for infrared spectroscopic imaging, as well as other equipment for chemical and computer analysis of artworks. The research program being drawn up includes the following components: building a spectral library of historical pigments and other art materials, based on collections held elsewhere and on preparation of known media types according to traditional recipes; collecting more data from known media types including acquiring spectra and spectroscopic images of them to correlating spectral properties with media, by analyzing works whose media are already known; investigating multivariate computer techniques for the analysis and visualization of spectroscopic IR image sets; and analyzing works in other collections from the same period for corroboration of our results. The collaboration is also open to extending the application of these techniques to other types of works of art such as textiles, ethnographic specimens, pottery, stone, etc. Infrared spectroscopic imaging could also prove useful in document and forgery analysis, as well as in attributions of works of art.

References 1 Colarusso, P. Kidder, L.H., Levin, I.W., Fraser, J.C., Arens, J.F., and Lewis, E.N., 'Infrared spectroscopic imaging: from planetary to cellular systems', Applied Spectroscopy 52 (1998) 106A-120A.

2 Walmsley, E., Metzger, C., Delaney, J.K., and Fletcher, C., 'Improved visualization of underdrawings with solid-state detectors operating in the infrared', Studies in Conservation 39 (1994) 217-231.

3 Geladi, P., and Grahn, H., Multivariate Image Analysis, Wiley, New York, (1996). 4 Mansfield, J.R., Sowa, M.G., Scarth, G.B., Somorjai, R.L., and Mantsch, H.H., 'Analysis of spectroscopic imaging data by fuzzy C-means clustering', Analytical Chemistry 69 (1997) 3370-3374.

5 Mansfield, J.R., Sowa, M.G., Mazjels, C., Collins, C., Cloutis, E., and Mantsch, H.H., 'Near infrared spectroscopic reflectance

imaging: supervised vs. unsupervised analysis using an art conservation application', Vibrational Spectroscopy 19 (1999) 33-45.

6 Mansfield, J.R., Attas, M., Mazjels, C., Cloutis, E., Collins, C., and Mantsch, H.H., 'Near infrared spectroscopic reflectance imaging: a new tool in art conservation', Vibrational Spectroscopy 28 (2002) 59-66.