FORGERY DETECTION
DESTRUCTIVE AND NONDESTRUCTIVE EXAMINATION TECHNIQUES

Introduction:

Art conservators and art historians have a number of methods at their disposal for studying the materials and techniques of art. Through common methods of examination, they can establish the authenticity of a work of art, learn more about the artist's choice of materials, or determine how best to treat a work of art. These methods range from the simple (such as basic visual examination, or pH testing) to the technical (Mass Spectrometry). They can be destructive or non-destructive, expensive or free. However, they all enable the conservator or art historian to gain a better understanding of the object and the circumstances under which it was made.

Destructive examination techniques involve removing a sample of original material for testing. They can give great results, but samples should be as small as possible and taken from as unobtrusive an area as possible. Nondestructive examination techniques do not involve sampling, and are generally preferred as a first step.

In this lab, you are conservators or art historians working for a major museum. The curator of the museum wishes to obtain a copy of a specific print for their collection. There are a number of copies available for purchase at the moment, but the print is very commonly forged. Some people copy the print by drawing copies, some make photocopies, and some of the better forgeries were printed directly from the original block after the artist died. The curator has asked you, using your knowledge of art history and conservation science, to determine which copy to buy. An allied institution has loaned your museum their copy of the print to use as a point of comparison.

Your team (or, for smaller classes, you) will be assigned one of the copies to examine. You are permitted to take small samples to examine. Using the following destructive and nondestructive examination techniques, determine whether or not the copy was original, and explain why you came to this conclusion.

PART A: Visual Examination

The first step in any examination should be just to look at it, to examine the texture and quality of the surface, the color of the paper and the ink. This initial visual examination can give you a good impression of the condition, age, and authenticity of an object.

1. Examination under normal light conditions
   - Look at your object and the original lying on the bench in front of you.
   - Is the paper color the same? How about the ink? Are there any obvious differences between your copy and the original?

2. Examination with raking light
• Hold the original up so that the light is almost parallel to the surface of the original. Look at the object with your eye perpendicular to the paper's edge. What sort of texture does it have?
• Repeat with your object. What sort of texture does it have?
• How are they alike? How are they different?

3. Examination with transmitted light.

Early papermaking involved the use of a papermaking mould: a screen made with a mesh of relatively thick wires. When the paper was manufactured, the areas of the paper where these wires ran would be thinner than the rest of the paper. The lines left were called laid and chain lines. In the late 18th century, Wove paper, a paper with a smooth surface lacking in laid and chain lines, was invented. By examining a paper, it is possible to determine whether it is a laid or wove surface, and therefore to narrow down the date of manufacture. Although laid papers, and 'antiqued' paper (machine-made paper with artificial laid and chain lines impressed upon it) are still manufactured, any wove paper cannot date to earlier than the late 18th century.

This print was made in the early 16th century, well before the invention of wove paper. Therefore, it was printed on laid paper. Laid paper can be identified by the presence of laid and chain lines. It can be hard to see laid lines under normal light conditions. The best way to tell whether an object is laid or wove paper to view it with the light shining through it. This is called 'transmitted light'.

• Hold the original up so that light may be transmitted through it to see the laid and chain lines in the paper.
• Hold up your object to the light. Can you determine if it is printed on laid or wove paper?

PART B: Paper Fiber Analysis

There are a number of fibers used for papermaking. Paper materials in the West include wood pulp, cotton, linen, and hemp. Paper materials in the East (particularly Japan) are primarily long-fibered materials like mulberry. With a couple of tests, you can distinguish between different kinds of fibers.

1. Lignin Testing

Wood pulp paper contains acidic lignin, responsible for its rapid yellowing and degradation. Other papers do not contain lignin. Wood pulp has only been used for papermaking since the 1780s, so any paper that contains lignin cannot date to before that point. It is simple to tell whether paper is wood pulp paper or not by using a lignin pen.

• Apply a dot of the lignin pen on the back of the original. Is the original wood pulp paper?
• Apply a dot of the lignin pen on the back of your object. Is your object wood pulp paper?

2. Microscopic Fiber Examination
Western papers are predominantly made of short-length fibers. Eastern papers are predominantly made of long-length fibers. These can be distinguished under magnification.

- Tear off a small piece of the original from an unobtrusive area. Look at it under a microscope. How long are the fibers? What do the fibers look like? Set your sample to one side.
- Tear off a small piece of your object from an unobtrusive area. Look it under a microscope. How long are the fibers? What do the fibers look like? Set your sample to one side.

PART C: Detecting Additives in Paper

1. **Does the Paper Contain Starch?**
   Starch is a common additive in many kinds of paper. Iodine reacts with the starch in paper to turn a purple-black.
   - Apply a small dot of iodine to the back of the original. Does it react positively, indicating that it may contain starch?
   - Apply a small dot of iodine to the back of your object. Does it react positively, indicating that it may contain starch?

2. **Does the Paper Contain Whiteners?**
   Aged or dirty paper and fibers often appear yellow (reflect yellow light). To counteract this yellow appearance manufacturers sometimes add organic or inorganic chemicals to paper and cloth that reflects blue or UV/blue light that makes the paper or cloth appear to be whiter.
   a. **“Optical Whiteners” or Organic Dyes**
      Organic dyes that are added to make paper or cloth whiter are called “optical whiteners or brighteners”. Optical brighteners are a recent addition to papermaking, and are only found in the 20th and 21st centuries.
      It is relatively simple to check paper or cloth for the presence of optical whiteners by looking at the paper or cloth with the aid of an ultraviolet lamp (blacklight). Optical brighteners will fluoresce (glow brightly) when exposed to UV light.
      - Look at the original under UV light. Does it fluoresce? Does it contain optical brighteners?
      - Look at your object under UV light. Does it fluoresce? Does it contain optical brighteners?
   b. **Whiting (calcium carbonate, CaCO3)**
      Some papers, particularly those that appear very bright and white, have large amounts of whiting or calcium carbonate added to them instead of or in addition to optical brighteners. Calcium carbonate is very white and is a weak base that serves as a buffer against acid deterioration in paper. Because it is a base, it will react with an acid such as HCl to give off carbon dioxide gas. This provides a convenient way to analyze paper for its calcium carbonate content.
• Set your sample of the original from Part B in a microwell dish. Apply a drop of HCl, and observe under magnification to see if it bubbles. Does the original contain whiting?
• Set your sample of your object from Part B in a microwell dish. Apply a drop of HCl, and observe under magnification to see if it bubbles. Does your object contain whiting?

PART D: Ink Examination

1. How Was the Ink Applied?

Painted or drawn objects will have signs of brushmarks or drawing lines when you look at it under magnification. Objects printed with a photocopier or printer will be printed with many miniscule dots packed tightly together. Looking at it with a magnifying glass can tell you how the design was applied.

• Look at the original with a magnifying glass. Can you see signs indicating that it was printed by an inkjet printer? Can you see signs indicating that it was painted or drawn?
• Look at your object with a magnifying glass. Can you see signs indicating that it was printed by an inkjet printer? Can you see signs indicating that it was painted or drawn?

2. Ink Chromatography

In 1901, Russian botanist Mikhail Tsvet discovered that the green color (chlorophyll) from plant leaves could be separated into several different colored materials. To do this he used a method he called "chromatography" or color writing, which related to his last name, which meant “color” or “flower” in Russian. Today scientists use chromatography to separate and identify many different chemicals used in industry, food processing and in health care. There are many kinds of chromatography. Today we will use one called paper chromatography to separate and analyze the ink from the original and from your object.

In all types of chromatography there are two "phases", the stationary phase and the mobile phase. One phase moves up the “plate” and the other remains in place. These two phases compete in attracting the various chemicals in the chemical mixture you wish to separate. In paper chromatography, a small spot of the mixture to be separated is placed on the paper (the stationary phase). Then the paper is placed upright in a container with a shallow layer of solvent (the mobile phase) on the bottom. Capillary action draws the solvent up into the paper. As the solvent passes over the spots of the mixture, the chemicals in the mixture are carried along with it. Chemicals that are more attracted to the mobile phase will be carried farther and more rapidly than chemicals that are attracted to the stationary phase.

After the separation is complete, the paper is removed and dried. The dried paper with the separated colored streaks or spots is called a chromatogram. The separated spots may be of a different color than the original substance that was applied to the paper. For example, some black felt-tipped pen inks will separate into individual colors of violet, blue, red, and yellow.

• Take a small sample of the ink area from the original.
• Place the sample in a small test tube with a few drops of isopropyl alcohol, and leave it to sit until the ink dissolves.
• With a pencil, draw a very light pencil line about 1/2" from the edge of the short side of one end of the two paper strips. This will be your origin — the place where you apply the ink.
• Place a drop of the dissolved ink on the test strip.
• Add isopropyl alcohol to the developing tank, and place the bottom of your test paper in the tank.
• Let sit until the isopropyl alcohol has risen to within 1/2" of the top.
• Repeat with a small sample from your object.
• Compare the two chromatography papers. Is the ink the same? Is it different?

PART E: Discussion

Think about the examination techniques you have used today. On the included worksheet, note down the results for each of the tests, and note whether each examination technique was destructive or nondestructive.

Decide whether you believe your object to be authentic or a forgery. Write in your lab notebook how you came to this conclusion, and which of the tests used was most useful for determining the authenticity of your object.

Lastly, meet with the other groups to exchange test results. Note them down on the lab worksheet. Then, as a class, make a recommendation about which object the museum should add to its collection. Write in your lab notebook the reasons why this recommendation was made, using the results of specific tests to corroborate your answer.
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<tr>
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<th>Original</th>
<th>Object 1</th>
<th>Object 2</th>
<th>Object 3</th>
<th>Destructive/Nondestructive?</th>
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<tbody>
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<td>Normal Light (overall appearance)</td>
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<td>Raking Light (paper texture)</td>
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<td>Transmitted Light (laid or wove)</td>
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<td>Lignin Pen (color of mark)</td>
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<td>Microscopy (appearance of fibers)</td>
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<td>Iodine Test (color of mark)</td>
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<td>UV Light (does it fluoresce?)</td>
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<td>Presence of Whiting (reaction with HCl)</td>
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<td>Magnification (appearance of ink surface)</td>
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<td>Ink Chromatography (colors in ink)</td>
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<td>Is It Genuine?</td>
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