Analytical to Quantum: Seeing and Hearing the Chemistry of Art

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Benjamin Sanchez
Lengeling
Science vs. Art

Obtained from http://flavorwire.com/130726/damien-hirsts-medicine-cabinets
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Installation view, Damien Hirst: 'Medicine Cabinets', L & M Arts, 2010. Courtesy of Tom Powel Imaging Inc./L & M Gallery © Damien Hirst and Science Ltd. All rights reserved, DACS 2012. Obtained from damienhirst.com
“Dendrites”
Eric Heller
(chemistry and physics professor at Harvard)

“This image was made in a computer simulation by launching 100,000 electrons from the upper middle of the image, and following their tracks.”
Science AND Art

Scientific images can be beautiful!

Koch Institute at MIT
first floor gallery
Science AND Art

100,000 dpi!

Science AND Art

“Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand.” - Albert Einstein

Cutting-edge science research requires creativity!
Science AND Art

Part 1: SEEING
Using analytical chemistry to learn more about art

Part 2: HEARING
Using quantum chemistry to make art
Art Restoration
Art Restoration

Broken statue at the Met, covered in the NY Times

“There were 28 recognizable pieces and hundreds of smaller fragments.”

Tullio Lombardo, Adam, ~1490
Metropolitan Museum of Art
Art Restoration: Lombardo’s Adam

Tullio Lombardo, Adam, ~1490 (after restoration 2002-2014)
Metropolitan Museum of Art

Broken statue at the Met, covered in the NY Times:

“There were 28 recognizable pieces and hundreds of smaller fragments.”
Materials matter!

What artwork is made out of can tell us:
• How to alter it without hurting it
  – Prevent future degradation
  – Restore artwork
When I go to an art museum...

Dancer Taking a Bow (The Star)
About 1877
Edgar Degas
French, 1834–1917
Pastel and gouache on paper

The classical ballet occupied Degas’s artistic imagination for nearly four decades. Here, a prima ballerina opens and extends her arms in a bow, while other performers are seen backstage or peeking between the painted flats of scenery. This gaslit environment is a world apart from the grassy meadow where the folk dancers pound their steps in Russian Dancers on the adjacent wall. Here, Degas’s spirited variety of squiggles, crisscrosses, and strokes—formed by a subtle combination of dry and wet pastel, with successive layers of color being fixed and worked over—depict a poised and brightly lit moment at the end of a performance.

Lent anonymously
L.2008.7
Key Question in Conservation Science

What is this art work made out of?

(and *how* was it made?)

Now, we use analytical chemistry!
Anatomy of a painting

Pigment: color source (e.g. ultramarine, vermilion)

Binder: keeps the pigment suspended (e.g. oil, acrylic polymer)

Paint layer

Varnish
Jackson Pollack - before his time?

Untitled splatter painting attributed to Jackson Pollack

Black paint was found to contain materials that were not developed until 1965 (Pollack died in 1956).

Questions?
The Conservation Science Toolbox

Non-destructive techniques

X-ray imaging
Spectroscopy (Raman, IR, etc)

*similar to X-rays or MRI at a hospital*

Destructive techniques

Cross sections for spectroscopy or imaging
Chromatography and mass spectrometry (LC-MS or GC-MS)
Peptide mass fingerprinting (PMF) for identifying proteins

*similar to blood work or surgery at a hospital*
Infrared spectroscopy

Untitled splatter painting attributed to Jackson Pollack

Gum arabic reference

AcryloidTM B-67 reference

Pigment Black 1 (PBk1) ref

X-ray imaging

Vincent van Gogh, Three Pairs of Shoes, 1886-1887
Harvard Art Museums
X-ray imaging

http://www.harvardartmuseums.org/tour/art-science/slide/523
Light projections: Rothko murals

As-is

Compare with and without projections here: http://www.harvardartmuseums.org/tour/art-science/slide/512
Light projections: Rothko murals

With correction

Compare with and without projections here: http://www.harvardartmuseums.org/tour/art-science/slide/512
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Cross-sections
Sample size requirement

Images courtesy of Dan Kirby
Proteins in art work

Egg tempera

Sheep parchment

14th-century altarpiece (attributed to Bernardo Daddi) indicating sampling locations

9th c. Qur’an folio (Harvard Art Museums, Acc. # 1927.163), showing the sampling location along the left edge (inset).

All images courtesy of Dan Kirby
How peptide mass fingerprinting works

1. Cut protein into smaller “peptide” pieces

2. Mass spectroscopy of peptides to see “fingerprint”
Peptide mass fingerprints (PMF) of egg tempera from different egg species
PMF for identifying eggs’ species

Peptide mass fingerprint from Metropolitan Museum of Art; Acc. # 65.150, Fortuny Textiles; image courtesy of Dan Kirby
PMF for speciation: Alaskan kayak

Yup’ik kayak

Deck and deck strap (Bearded seal)

Stitching (Caribou)

Images courtesy of Dan Kirby
"The bynding of this booke is all that remains of my dear friende Jonas Wright, who was flayed alive by the Wavuma on the Fourth Day of August, 1632."

Book and spectrum courtesy of Dan Kirby; sheep photo by Andreas Cappell, used under CC BY 2.0
Materials matter!

Using both non-destructive (X-ray imaging, spectroscopy) and destructive (cross sections, peptide mass fingerprinting) techniques, we can learn:

• How/when it was made
  - Learn more about artists/their techniques
  - Identify art forgeries

• How to alter it without hurting it
  - Prevent future degradation
  - Restore artwork
Additional Resources

**Science in Art: The Chemistry of Art Materials and Conservation**
Learn the chemistry behind the visual arts, and how an understanding of art's material properties helps preserve our cultural heritage.

[https://www.edx.org/course/science-art-chemistry-art-materials-trinityx-t001x](https://www.edx.org/course/science-art-chemistry-art-materials-trinityx-t001x)

**What you'll learn**

- Understanding of materials used to create art
- Science behind human perception of art
- Techniques used to conserve and date art objects
- How art fakes and forgeries are detected


Questions?
Science AND Art

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Body of slides

• (ben’s part goes here)
Thank you!

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