Katherine Faber (right) and the Art Institute of Chicago’s Francesca Casadio codirect the Northwestern–Art Institute of Chicago Center for Scientific Studies in the Arts. The center uses Northwestern technology, such as the instruments at NUANCE, to research objects of cultural heritage.
JOHANN FRIEDRICH BÖTTGER was a teenager in 1701, and like many teens he was a bit of a braggart. The budding German alchemist boasted about his ability to turn lead into gold—boasted so successfully, in fact, that his claims reached Augustus the Strong, elector of Saxony and king of Poland. Hungry for riches, Augustus summoned Böttger to prove his claims and then imprisoned him, forcing him to perform one fruitless experiment after another.

Böttger never made gold, of course. But during his servitude he managed to make other creations that would secure his place as the father of European ceramics. Among them was perlmuttglasur, a delicate, pale purple glaze that has captivated porcelain lovers and art historians ever since. For centuries, Böttger’s recipe for this uniquely iridescent luster had remained a mystery.

That is, until 2010, when researchers from McCormick and the Art Institute of Chicago got involved. Using a transmission electron microscope at the Northwestern University Atomic and Nanoscale Characterization Experimental (NUANCE) Center, researchers analyzed a tiny fragment of Böttger luster from a private collection to determine its composition. Then an undergraduate researcher reverse-engineered the process to learn how Böttger made the luster.

“We believe he started with gold chloride, which would have been available in the early 1700s, placed it in suspension, layered it on top of the glaze, and heated it in a way so the gold diffused into the glaze,” says Katherine T. Faber, Walter P. Murphy Professor of Materials Science and Engineering at McCormick. “And in the process he kept Augustus happy. It really is a wonderful story.”

Over the past eight years the Northwestern–Art Institute collaboration has led to a nanoscale understanding of masterpieces like these—and a greater understanding of how best to conserve them. Partnerships like this are rare; in the United States, scientific research on art collections is typically undertaken inside the walls of museums, at least those museums that can afford a laboratory. Only a few dozen American institutions have the necessary tools and expertise.

Now a $2.5 million grant from the Andrew W. Mellon Foundation has made it possible for Northwestern and the Art Institute to create the Northwestern University–Art Institute of Chicago Center for Scientific Studies in the Arts (NU-ACCESS), an interdisciplinary center that offers scientific research services to museums across the country that are unable to afford their own labs.

“It’s good for students to see how they can use their technical backgrounds to work on atypical problems.”

The Northwestern–Art Institute partnership began in 2004, around the time the museum hired Francesca Casadio, Andrew W. Mellon Senior Conservation Scientist, for a new position. Interested in collaborating with materials science experts, leaders from the Art Institute contacted Faber, then chair of McCormick’s Department of Materials Science and Engineering. “I had never conducted research on an object of cultural heritage before,” Faber says, “but it was obvious to me that these were materials about which we could offer our expertise.”

In 2004 Casadio brought the first project to McCormick: a study of A Sunday on La Grande Jatte—1884. Created by Georges Seurat in the 1880s, the world-famous pointillist painting consists of thousands of tiny dots of paint that form images of park goers alongside the Seine River in France, but over the years, the luminous yellow dots used to highlight the lawn in the painting had turned a dark ochre color.

A team of researchers led by Kimberly Gray, professor of civil and environmental engineering and of chemical and biological engineering, accelerated the aging process on reconstructions of the painting’s yellow...
Several other key pieces in the Art Institute of Chicago's collection have been studied through its ongoing partnership with Northwestern.

1 Bathers by a River by Henri Matisse. (Charles H. and Mary F. S. Worcester Collection, 1953.158.) Imaging technology developed by the Department of Electrical Engineering and Computer Science was used to colorize archival black-and-white photographs of the painting's early versions, providing insights into Matisse's working methods and the development of this masterpiece over time. The painting was part of the Art Institute's 2010 show Matisse: Radical Invention, 1913–1917.

2 For to Be a Farmer's Boy by Winslow Homer. (Gift of Mrs. George T. Langhorne in memory of Edward Carson Waller, 1963.760.) Conservators discovered that the painting's sky was originally painted in unstable red and orange colorants that have almost completely faded. Work by a team of Northwestern chemists to determine the original colors was included in the 2008 exhibition Watercolors by Winslow Homer: The Color of Light.

3 Sketch of Margaret Sloane, Looking Right by Mary Cassatt. (Gift of Laura May Ripley, 1992.158.) A research team removed tiny colored flecks from this pastel study and examined them using a highly sensitive technique called surface-enhanced Raman spectroscopy. Researchers were able to detect and identify organic pigments that could be matched to pastel sticks in Cassatt's paint box.

4 A Sunday on La Grande Jatte—1884 by Georges Seurat. (Helen Birch Bartlett Memorial Collection, 1926.224.) The luminous yellow began to change within years of Seurat's completing the painting, but no one knew why. Scientists determined that exposure to a humid climate and burning coal caused the darkening of the zinc yellow pigment Seurat used.

5 Head of a Woman (Fernande) by Pablo Picasso. (Estate of Pablo Picasso/Artists Rights Society [ARS], New York.) The Art Institute's current Picasso and Chicago show includes a study analyzing the metal alloys of modern sculptures. Having determined that many of the Picasso sculptures are made of high-zinc brass alloys, a research team was able to trace many of the unmarked works to the Valsuani foundry in Paris. Fernande is different; it has a low-zinc bronze composition more typical of sand-cast sculptures. The search for its unknown casting foundry is one of the open questions the new Center for Scientific Studies in the Arts hopes to address by broadening the alloy research to collections in other museums.
paint and determined that exposure to a humid climate and burning coal had caused the color to change. Follow-up studies at the Advanced Photon Source of Argonne National Laboratory with Jean-François Gaillard, professor of civil and environmental engineering, as well as hands-on research by a summer intern, elucidated the precise reaction that caused the color change. The information provided guidelines for optimal storage and transportation conditions for other paintings containing the yellow pigment.

Since then scientists have analyzed faded watercolors by Winslow Homer to discover the pieces’ original hues; determined the makeup of metal alloys in Picasso sculptures; and developed imaging technology to colorize archival black-and-white photographs of early versions of a Matisse painting. Projects are often driven by the Art Institute’s shows, such as Matisse: Radical Invention, 1913–1917 in 2010 and Watercolors by Winslow Homer: The Color of Light in 2008.

Arts-related research has also sparked findings in other, unintended areas of study. In one ongoing project Faber, Kenneth Shull, professor of materials science and engineering; and Linda Broadbelt, Sarah Rebecca Roland Professor of Chemical and Biological Engineering, have been studying the composition of house paints Picasso used in some of his works. The three are developing tests to understand the physical and mechanical properties of a similar paint system: an indentation test, which involves pressing on the paint to test its response, and a “quartz resonator” test, in which researchers coat paint onto a vibrating piece of quartz to analyze its nanoscale structure. If paint samples that behave like Picasso’s house paints can be developed, they can be used to test methods for cleaning the artwork.

The research has led to unexpected discoveries. “The focus is on paint, but there is an opportunity here to develop characterization methods for a variety of protective coatings and to learn how they degrade,” says Shull. “These oil-based materials, which are important to the art community, are also sustainable materials that could have tremendous value elsewhere.” Shull is currently investigating the application of the techniques in creating dental fillings.

For the Art Institute’s current Picasso and Chicago show (through May 12), researchers traced some of Picasso’s modern bronze sculptures to a specific foundry in Paris by using emission spectroscopy and x-ray fluorescence to determine the chemical composition. The researchers included David Dunand, the James N. and Margie M. Krebs Professor of Materials Science and Engineering.

Since the Northwestern–Art Institute collaboration began, the partnership has been supported by the Mellon Foundation with additional grant support from the National Science Foundation. In January the Mellon Foundation announced the sizable grant to establish NU-ACCESS for six years. Casadio and Faber direct the center, which serves as a collaborative hub, facilitating interdisciplinary research partnerships in art studies and conservation on a national scale.

Museums and cultural institutions will be asked to submit proposals for the study of objects in their own collections or for object-inspired research. Faber and Casadio expect three to five major projects and up to 10 minor projects to be carried out each year.

Faber says she hopes the center will inspire other arts organizations and universities to bridge the gap between science and the arts. “We are thrilled to be offering this service, but I suspect the need is greater than we can handle,” Faber says. “We’re hoping this can be a model for other large museums.”

PHOTOGRAPHER: ALLAN INKMAN

Researchers using transmission electron microscopy learned how the 18th-century German alchemist Johann Friedrich Böttger made his pale purple glaze (seen on the ceramics in front of Casadio and Faber).