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Copper Connects Life.™

Edition #11

Copper in Art Through the Ages

The usefulness of copper in metalwork is known to all, but few people realize how much it has contributed to art and painting throughout history. Copper-based pigments were an important ingredient in ancient paints, and the metal itself was frequently employed as a “canvas” on which Renaissance artists painted. Copper also served as an engraving plate for etchings and prints by master artists such as Rembrandt.

As an ingredient in paint, natural copper ores such as azurite (blue) and malachite (green), add a depth and dimensionality to paintings that cannot be duplicated by man-made substitutes. As for copper’s use as a canvas, there was virtually nothing else available to artists in pre-technological times that approached its smoothness and durability.

COPPER PIGMENTS IN HISTORY

From artifacts dating back to the Egyptian Fourth Dynasty in 3000 BC, we have proof of the existence of a copper-based paint called Egyptian Blue, a permanent mixture of malachite with silicate and limestone. The deep cerulean hue was used on parchments, sarcophagi, statues, walls, buildings and objects. “The Egyptians did incredible decorative work,” says George O’Hanlon, an owner of Natural Pigments, an artists’ supply

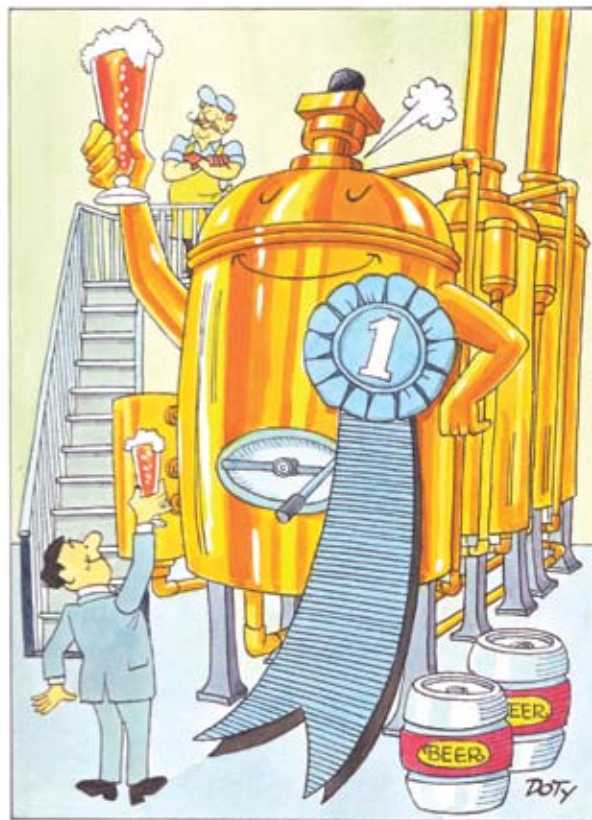
Continued Inside

Using Copper for What Ales You

At one time or another, every beer drinker encounters an uncharacteristically sour or “skunky” beer. A primary cause of this is hydrogen sulfide, which is a normal byproduct of the fermentation process.

According to a study cited in the Technical Quarterly of the Master Brewers Association of the Americas, researchers have determined the most efficient way of containing this unwanted byproduct is through the use of copper.

To eliminate the hydrogen sulfide, a small amount of copper is introduced to the fermenting beer via two copper electrodes. The copper interacts with the hydrogen sulfide to form copper sulfide, which is easily removed from the final fermented product. Tests have shown that this process is capable of reducing the amount of hydrogen sulfide to undetectable levels. So, next time you enjoy a cold one, copper probably played an important role in delivering the wonderful taste! **Cu**



A Library Enhanced by Copper

Des Moines, the capital of Iowa, is one of the fastest growing cities in the Midwestern United States. With a population of about 200,000, the city is undergoing an enormous construction boom, especially throughout the downtown area. Earlier this year, Des Moines

unveiled the new jewel of its downtown, the home of the central branch of the Des Moines public library.

Designed by famed British architect David Chipperfield, the library is notable for a number of reasons, especially the 18-foot floor-to-ceiling copper-mesh glass walls that encompass the facility. The copper window walls truly define the library. The panes are a unique sandwich of glass and copper mesh called Okalux, developed by a German company, Okalux GmbH. The copper-colored glass provides enormous aesthetic appeal and due to its high refraction, it can block up to 87 percent of the sun’s ultraviolet rays, abolishing the need for regular shades, while

*Okalux glass with copper being installed at library**Continued Inside*

outlet in Willits, California, and a recognized authority on natural mineral and historical pigments.

The formula for Egyptian Blue was lost after the Roman period until it was recreated in the 19th Century. Until then, artists who attempted to produce the color were unable to properly burn malachite at high-enough temperatures over the time necessary to extract the copper essence.

Excellent examples of Roman use of copper-based paints are found at Pompeii, where volcanic ash preserved artwork that was not destroyed by the eruption of Mt. Vesuvius. Both the Romans and ancient Greeks also created a pigment called verdigris, a bluish green color, by immersing copper plates in vats of fermenting grape leaves. Corrosion produced a blue crust that was washed and dissolved in vinegar to produce a deep green.

Today, Natural Pigments is one of only two companies in the United States that offers Egyptian Blue pigment. "It's expensive – at nearly \$20 for 10 grams," (about two teaspoons) says O'Hanlon.

"Azurite was the predominant blue from the Middle Ages through the Renaissance," he adds, noting that verdigris and malachite were also widely used during that period. "The bright greens in Michelangelo's Sistine Chapel are tints of malachite."

The use of copper-based paints fell out of favor in the 17th and 18th centuries as artists turned to new synthetic substitutes and brighter chromium-based colors.

MODERN DAY MASTERS

"Artists are currently reviving old materials, rediscovering the Old Masters and their techniques, which were quite special," says O'Hanlon. One of those artists, Virgil Elliott of Penngrove, California, strives for the rich degree of realism found in works by the great painters. He uses copper-based paints to achieve dark transparent colors that create strong contrasts in the way light plays on the canvas. "The degree of realism depends on the range of contrast," says Elliott, who is included in the Gallery of Living Masters, of the Art Renewal Center, and is author of "Traditional Oil Painting" to be published by Watson Guptil in 2007.

"I use two different copper phthalocyanine blues, one of which inclines toward green and the other is a true dark blue. By mixing the blue with transparent iron oxide red, I get a range of deep transparent browns similar to those used by the Old Masters," says Elliott.

COPPER AS CANVAS

An exhibition at the Phoenix Art Museum in 1999 examined the use of the metal as a medium in *Copper as Canvas: Two Centuries of Masterpiece Painting on Copper, 1575-1775*. In the catalog of the exhibit, curator Michael Komanecky explains that, "Beginning in the

early 16th century, European artists painted on small sheets of copper as part of a broader experimentation with painting on smooth surfaces." Those artists include some of the most famous painters of all time: Leonardo da Vinci, Jan Brueghel, El Greco and Rembrandt.

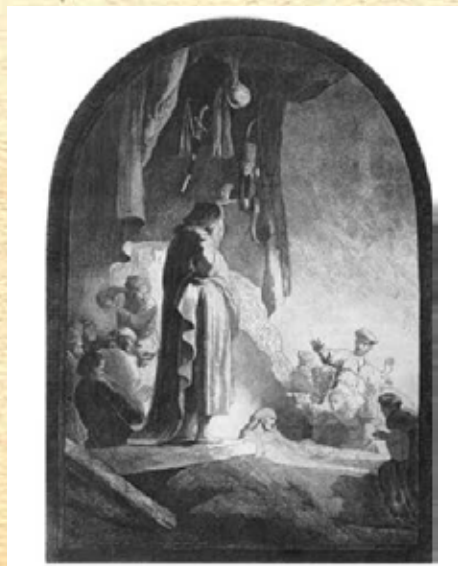
"The explosive growth of the practice was due to the discovery of the dazzling visual effects that could be achieved on this new support (copper), whether portraiture, landscape or religious subjects," Komanecky states.

According to Edgar Peters Bowron, curator of European Art at the Museum of Fine Arts in Houston, "The main reason artists chose copper was that it provided a smooth surface. There is no "tooth" to the surface, so you can use a very liquid brush that gives marvelous effects."

Barbara Berrie, senior conservation scientist at the National Gallery of Art in Washington, D.C., says the smooth copper surfaces were sometimes treated with intermediaries such as garlic or white lead paint to help oil paint adhere. Some coatings may have been highly reflective or "silvered," creating jewel-like effects, adds Bowron.

Berrie and National Gallery Chief Conservationist Ross Merrill point out that some of the artists' copper surfaces had a previous life as an etching plate. Merrill says more than half of the paintings he has seen on copper have been tested by X-rays that reveal etching on the plate. In fact, the back of the copper plate on which Rembrandt etched *Abraham Entertaining the Angels* had been used by another artist to paint a landscape.

In *Copper as Canvas*, Bowron states, "As artists accurately suspected, paintings on copper that are well cared for are extremely durable and generally survive in excellent condition. Owing to the protection given



The Raising of Lazarus by Rembrandt – Etching on a Copper Plate.



The use of chlorinated copper phthalocyanine (phthalo green) is visible in the painting, "Melancholy." The oil-on-panel work was painted in 1987.

the paint film by the solidity and durability of the support and the absence of structural treatments or restorations, they often appear as brilliant and fresh as the day they were created."

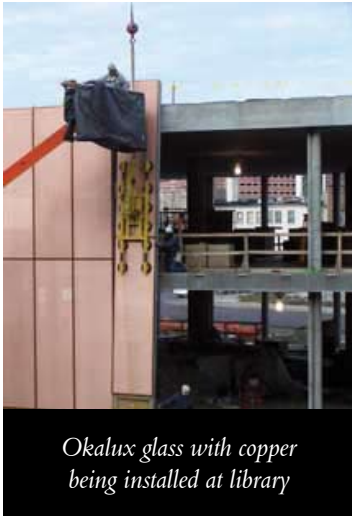
CONTEMPORARY COPPER ART

Contemporary artist David Novros is a good example of a modern-day artist who prefers the medium of copper sheets. He has a series of seven paintings on copper panels as large as 9x6 feet. His work has been shown at the Metropolitan Museum of Art and Museum of Modern Art in New York. "Copper is one of the most malleable metals; pigment bonds well to it, and I like its reflective nature," Novros explains. "Copper has a historical connection and was considered valuable, like gold and silver."

When Novros lived in the mining area of New Mexico in the 1980s, he became interested in copper. He bought copper pans, used to mine for gold, from a general store and soldered them onto thin copper sheets. Then he detonated line charge explosives atop them in a pre-planned pattern. The charge made indentations in the copper that gave it a "padded look," Novros says.

Novros subsequently painted directly on the panels with oil paints and synthetic resins. "The process of oxidation will change the painting in a way I am anticipating in my image-making," he notes.

Even modern-day artists working with copper honor its significance in history and look forward to its contribution as a natural metal in the future of art. **Cu**



Okalux glass with copper being installed at library

enhancing the building's energy-efficiency and reducing potential damage to the library's collection of books. Because the mesh is encased in glass, it does not get exposed to the atmosphere and will retain its original color. The library is one of the first buildings in the United States to utilize this type of application and the first to use it with copper screen.

Chipperfield's firm, David Chipperfield Associates, relied on some of their fundamental philosophies such as designing a building that is intimately connected to context and function

where the best results are achieved through a synthesis of concept, beauty and functional integration. The building's shape has been described to resemble an airplane or spaceship, with multiple curves and angles. Its design provides a clear view of the encompassing park from almost any location inside the facility.

Kay Runge, director of the public library, notes, "Everyday we receive compliments from the patrons. The color of the glass is stunning and we can really appreciate its energy saving capabilities."

The copper-mesh panes went through an extraordinary global manufacturing process before arriving in Iowa. The panes were

originally designed and manufactured in Germany and then sent to North Korea for additional engineering. The glass was extruded in China, anodized in Minnesota and finally assembled and installed by craftsmen at Des Moines-based Architectural Wall Systems.

Built for \$32 million dollars, the library is part of a large-scale urban renewal movement in Des Moines. Previously most of the downtown area was home to rundown businesses, hotels and apartments. Over the past few years, the city has reclaimed most of the land and converted a large portion of the area into a five-block long park. Des Moines believes the library will be a catalyst for future commercial and residential growth.

Runge concludes, "The public library is a public good for a public trust. Des Moines deserves the best there is in this wonderful capital city." **Cu**



The copper sandwiched in the exterior glass walls of the new library in Des Moines will retain the appeal of its original color and sheen because it is protected from the atmosphere preventing patination.

Architecture Defined By Copper

Copper has played an important role in the design and architecture of all types of structures for thousands of years. In ancient Egypt, the massive doors to the temple of Amen-Re at Karnak were clad with copper. The 162-foot-tall, nine-story Loha Maha Paya temple built in the third century B.C. in Sri Lanka sparkled with copper roof shingles. Copper was an integral part of European medieval architecture and today, some 10,000 years after it was first discovered by mankind, architects and building designers are finding new and innovative ways to use copper in their designs.

Copper is a superior roofing and cladding material when compared to traditional alternatives like asphalt or clay. Durable, and entirely recyclable, copper is long lasting and virtually maintenance-free.

COPPER AT THE UNIVERSITY

Copper often plays an important role in institutional architecture, which is typically designed to last for generations. Look at college campuses today and you are likely to see copper featured in the architecture. The landmark Foellinger Auditorium at the University of Illinois, the centerpiece of Thomas Jefferson's University of Virginia's campus, features a copper roof and cornice. The skyline of Saint Louis is illuminated by the copper roofs that highlight almost every building on the campus of Saint Louis University.

While copper campus roofs are typical, we are seeing a growing trend at replacing traditional ivy-covered brick walls with copper. Saint Joseph's College in Standish, Maine, recently capped its first

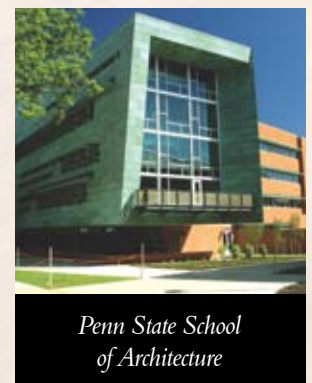
expansion in fifty years with a 50,000 square foot copper-clad classroom facility.

The 2003, expansion of the University of Minnesota's College of Architecture and Landscape, designed by TIME magazine architect of the year Steve Holl, also stands out due to its copper cladding.

According to Tom Fisher, dean of the Architecture College, "The copper on Ralph Rapson Hall did several things for us. Its initial color came close to that of the adjacent brick

building, while its eventual patina green color will help it blend with the foliage in the four gardens around the addition. The copper's horizontal raised-seams also tied the addition to the horizontal brick coursing of the original building, while catching the snow in winter as a series of white lines against the metal surface. Best of all: because of the lightness of the copper, it allowed us to have a lighter structure, reducing the overall cost of the building."

The new architecture school at Pennsylvania State University followed a similar line of thought. The building features a pre-patinated copper façade that encompasses the entire structure. The cop-



Penn State School of Architecture

"Architecture" Continued

per cladding, fabricated from 95 percent recycled copper, was chosen for its long life cycle and maintenance-free reliability, as well as its aesthetic appearance. As with Rapson Hall, the rich copper color and maturing green patina of the Penn State structure blends exceptionally well with its rural environment and the changing seasonal colors that form a backdrop for the campus.



Beth Shalom Synagogue

FAITH & COPPER

Copper also plays a very prominent role in the architecture and design of houses of worship. The Beth Shalom Synagogue near Philadelphia was designed in the 1950s by Frank Lloyd Wright and features a traditional copper laver, or fountain, used by worshippers to purify themselves before entering the temple. One of the largest churches in the Midwest, the First United Methodist Church of Jackson,

Michigan, was recently restored with a shining copper shingle roof. And another of the largest religious institutions in the country, The Church of the Epiphany in Houston, Texas, replaced its asphalt roof with copper in 2003.

One recent renovation worth noting is St. Joseph's Church in

Fayetteville, Arkansas. After years of slow deterioration from ice, snow, wind and other elements, the church decided to replace its original asphalt shingle roof with copper. According to Joe Koch, business manager for St. Joseph's, "The reason we chose copper is because it's long-lasting and we don't want to have to reroof right away."

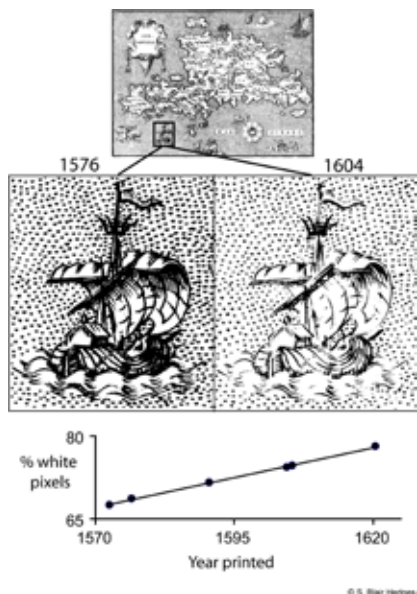
The church considered reroofing with asphalt composite shingles but quickly decided on the copper alternative. They found the cost of materials to be closely competitive, even though the average lifespan of asphalt roofs may be as much as 35 to 40 years, compared with 100 years or more for copper.

"A copper roof is common for (St. Joseph's) style of architecture," comments Koch. "It maintains the integrity of the architecture of that style of building. Many old buildings of that style have copper roofs. So having a copper roof will fit right in."

COPPER IS CLASSIC AND CONTEMPORARY

Some things never go out of style. Exterior copper architecture, embraces both timeless, traditional design and contemporary classics. It covers and protects some of the most unique and historic buildings of antiquity, as well as today's halls of learning, financial institutions, seats of government and houses of worship. Despite fads that come and go, copper continues to provide designers and architects with what can arguably be described as a preferred medium for both practical and artistic applications. **Cu**

Copper Reveals Age of Books, Art



Close-up of a galleon (ship) from two Renaissance maps made by the same copperplate in 1576 and 1604. Based on these maps and the use of a new method that dates prints based on the thinness of lines on copper plate, a third, previously undated map, was determined to have been printed in 1595.

A professor of evolutionary biology at Pennsylvania State University has discovered a potentially revolutionary new way to date rare books, maps and prints. The method, also applied to woodcuts, analyzes the depth and structure of printed lines produced by copper plates used to make artwork.

A variety of documents and reading materials were made using copper plates centuries ago. Because of the plates' cost and availability, they were reused when new prints were required. Over time, mild corrosion affected the plates, which were then polished to remove any imperfections before they were put back into service. The professor researching this subject, Blair Hedges, believes this process gradually eroded the surface of the plates, reducing the amount of ink in the grooves originally etched into the medium. As a result, less ink could be transferred by the grooves, producing paler copies.

The difference in impressions is measurable between earlier and later versions of the same print whose dates are known. Hedges says this deterioration allows researchers to calculate an average annual rate of deterioration for the plate. The lightness of an undated print then can be matched up against a baseline set of plates to determine its age.

Hedges' theory has its detractors. Others believe that the thinner lines found in the later copper plates result from the pressure of the printing presses. However, Hedges counters that pressure would produce wider grooves and lines, not thinner ones.

Industry contemporaries are currently validating the new dating method. "In the next few years, we'll see whether it is generally applicable, but I think it will be," says Hedges. "This is a huge benefit to historians and artists. Millions of books have been printed in this manner and many have no dates. Concepts and discoveries we know to be true today were proposed hundreds of years ago, and it's of interest to many people to know when these ideas were proposed and when society accepted them." **Cu**

RESOURCES:

This edition of Discover Copper is also available online at www.copper.org and at www.homeplanningnews.com.

For more information on the topics mentioned in this newsletter go to:

Des Moines Public Library — <http://www.pldminfo.org/>

National Gallery of Art — <http://www.nga.gov/>

Master Brewers Association of the Americas — <http://www.mbaa.com/>

Hedges Laboratory — <http://evo.bio.psu.edu/hedgeslab/>

Copper in Architecture — <http://www.copper.org/applications/architecture/homepage.html>