

## **Art Meets Science**

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### **Abstract**

Numerous connections between the visual arts and sciences are evident if we choose to look for them. In February 2006, students and faculty from the Art and Geol/Geog departments at NW Missouri State University put together an exhibit at a local art gallery featuring works that were born out of science, inspired by science, or exploring the science behind the art. The primary goal of this project was to provide a setting where students could make creative links and increase awareness of both arts and sciences through community outreach. Photomicrographs, scanning electron microscopic images and lightning photography were included along with written explanations describing background information such as interference colors, intricate three-dimensional structures <50 $\mu$ m in size, and timed shutter speeds. Comparatively, two pastel works, using colors, lines, and curves, had been inspired by the laws of physics while one ceramic piece depicted marine invertebrates cast in stone. Students were involved at all levels of the project from developing the displays to interacting with community members at the reception to creative writing in response to the exhibit. Outcomes from this project provide evidence of direct benefits to students as a result of integrating understanding in both arts and sciences.

### **Introduction**

Links between the arts and sciences are abundant and critical to a holistic approach to general education. As educators, we have the unique opportunity to make these interdisciplinary connections evident to our students through a variety of means including interaction in the classroom, undergraduate research, and through student organizations. In that process, it is possible to support and raise awareness of the value of a liberal education. The purpose of this paper is to present ideas that bridge the sciences with the visual arts by examining the science in different forms of art, how science can inspire art, and works of art that have come out of scientific inquiry.

Examination of an art piece, whether a painting, photo, print, sculpture, or ceramic piece leads the viewer in many different directions depending on his or her experiences and knowledge. For example, a painter might look at a painting and see the technique used, or the content and how it has been expressed, or the composition strategy. In contrast, a historian may place the piece in its historical context and look for clues to the political or socioeconomic setting of the subject or artist's view. An interior decorator might evaluate the size, color scheme, and content with individual clients, fabrics, and space in mind. There are many possible views for any single piece of art.

The following is a simple description of a landscape painting that has been on exhibit at the Strecker-Nelson art gallery in Manhattan, Kansas.

Louis Copt's oil painting, "Passing Storm", depicts an image of farmland just after a thunderstorm has passed through. The color scheme is primarily in muted tones of blue and violet along with brown and dark grey. The lower third of the painting shows standing water in the landscape while the upper two thirds provides an image of thunderstorm clouds illuminated by rays of light emerging from behind the clouds. This image can be found at the following website:

[www.strecker-nelsongallery.com/Artists\\_nu/1\\_copt/Landscapes/LandscapeSlideShow/index.htm](http://www.strecker-nelsongallery.com/Artists_nu/1_copt/Landscapes/LandscapeSlideShow/index.htm) (Web 3)

As a single individual, I can process this artwork from at least two perspectives. The first perspective is that of a young person that grew up in a farming community and commonly observed thunderstorms passing through in the spring and summer. From this perspective, the piece tends to provide a calm, quiet sense where the air would smell fresh and the breeze would be cool and damp. Although it could be in the morning, I perceive the image to be that of an early evening in late spring.

A second perspective seems to be from an adult with attention to details specifically in the earth sciences. With this perspective, several pieces of information emerge to evaluate the setting. For example, the sky is filled with cumulonimbus clouds towering to an anvil head near the top of the painting. There are also smaller strings of clouds at the lower and middle atmospheric levels. The view is most likely looking to the west and therefore the storm is probably moving toward the northeast, which is common along a cold front boundary passing through the Midwest U.S. The field, in a flat floodplain area, is prepared for row crops and may have even been planted with corn or soybeans. The trees in the background appear to be along the stream and some fog has settled in near the land surface.

In either of these two cases, it is important to note that perceptions are shaped by both experiences and knowledge. As experiences accumulate and knowledge is gained, individual perceptions have the capacity for change.

### **The Science behind the Art**

One of the fundamental components of art is color and whether vibrant or muted, primary or accent, intense or subtle, the colors are controlled by chemistry and physics. Physics governs how light energy moves while chemistry controls what interacts with the light as it moves. Light is described as waves of energy dependent on frequency and wavelength as illustrated in the

electromagnetic spectrum. In the visible spectrum these waves range in length from approximately 400 (violet) to more than 700 nanometers (red) with the colors of the rainbow in-between. Therefore, color is produced as different wavelengths of light are absorbed or emitted. Some understanding of chemistry becomes an important area of information at this point. The chemical composition of a substance and the arrangement of atoms within that substance, together, control what wavelengths get absorbed or emitted. For example, lighting gels are used in a theater to produce different colors by absorbing certain wavelengths. As the light passes through the gel, some of the energy is absorbed while the remaining energy passes through to produce the desired color.

Many of the pigments used in paints are associated with naturally occurring minerals that absorb different wavelengths of light (Web 1 and 2). For example, the mineral malachite has a bluish-green color that is controlled by the oxidized copper in its chemical formula. Vermillion, a vibrant red color is a pigment produced by the mercury bearing mineral, cinnabar. The iron hydroxide mineral, limonite, is commonly used to produce muted hues of yellow in oil paints as Yellow Ochre. Historically, archeological sites such as the cave paintings of Lascaux in France have been examined with attention to the materials used in the pigments and the source of those materials. A red color in those cave paintings has been associated with Red Ochre, an iron oxide-based color and manganese-bearing minerals for black pigments (Chalmin et al., 2006). Similarly, the brilliant ultramarine blue found in some medieval artwork (Grassi et al., 2004) is developed from lapis-lazuli, a brilliant blue mineral. It has been identified in both paintings and manuscripts (Wehling et al., 1999) from that period and historically a prized material since it had to be imported from Afghanistan. Numerous other colors can be associated to the primary or secondary elements within their chemical composition whether developed from natural materials or synthetically manufactured.

In addition to color, chemical composition and bonding may influence the reflective nature of a surface. Reflective qualities, ranging from metallic to dull in character, are also associated with the composition. Rutile, a titanium oxide mineral, is used to make the brilliant white known as titanium white. This mineral exhibits a highly reflective luster known as adamantine, commonly associated with diamonds but found in other compounds as well. Gold leaf and silver plating are other examples of compositional control on the resulting light qualities of some artwork.

Scientific reasoning and scientific methods that are usually associated with the laboratory sciences are also commonly employed in the production of visual arts. For example, an artist that paints must decide if they will use paper or canvas, oils, acrylics, or watercolors, and plan for drying times. Depending on the type of painting, the artist may choose to work from light to dark colors, dark to light, foreground to background, or background to foreground. This scientific process is also evident in the production of ceramic artwork. For example a ceramic piece may be designed with several different parts including thrown, coiled, and slab components that are put together and enhanced with slip for texture. The individual parts are made and stored so that they can be molded together to form the final piece while retaining their shape and without drying too quickly. After initial bisque firing, glazes and firing temperatures are critical in producing the desired product. The potter has to be familiar with melting temperatures for different glaze compositions (cone 6, 8, 10 or others) and flux compounds that alter melting temperatures to produce the outer glassy surface on a finished piece.

Another method that is commonly employed by artists and scientists alike is that of experimentation. As a geologist, experimentation is a common method that is used in the process of discovery. Without experimentation, and the occasional serendipitous moment, a refining process cannot take place whether in the sciences or in visual arts. Claude Monet, a well-known French impressionist painter, was known to experiment with color and light in series such as those of the lily pond at Giverny (Galenson and Weinberg, 2001). Experimentation is also quite common in ceramics as is evident in glaze kitchens and through button testing experiments. For example, different glaze mixtures behave differently depending on the temperature and oxygen levels during firing including both color and texture. Other examples of science behind the art can easily be described for photography and sculpture as well.

### **Art Inspired by Science**

In some cases it is evident that an artist draws some inspiration from the sciences. Of course, the imagination can visualize beyond the limits of scientific knowledge. But it is also interesting to note that scientific discoveries can enhance the imagination by providing detail that opens new avenues for exploration. The amount of influence that science may have on art is very much dependent on the individual artist and their interpretations.

Scientific discoveries can have a profound affect on the art that relates to a given section of history. During the 1600's technology was developing in the areas of microscopes and telescopes. People no longer had to imagine what microscopic images looked like; they could actually see detail and patterns that were not visible to the naked eye. Similarly, telescopes were developed and details of the night sky began to emerge including mountains and valleys on the surface of the moon, other moons that were orbiting planets within our solar system, other galaxies, and millions of more stars! In another context, the industrial revolutions in both Europe and North America, had a distinct impact on architectural design ranging from skyscrapers to bridges, to structures such as the Eiffel Tower built for the Universal Exhibition to celebrate the French Revolution (Web 4).

It is also evident that the development of computer technology has had a profound effect over the past 30 years from introducing digital mediums for artistic expression, enhancing the ease of multiplicity and experimentation, as well as wide dissemination of information in the arts. Capturing and manipulating imagery has become a process commonly used, and misused, to develop a desired product that may or may not have qualities that transcend the dimension of time.

### **Art Born out of Science**

One of the attractive qualities of science is that you get the chance to see and experience things that are extraordinary. Maybe it is holding a meteorite and knowing that it formed over four billion years ago, was in outer space at one time, and made it through the atmosphere to land on Earth. It might be climbing out to the ledge to get that fantastic image of a glacier flowing out of ice-capped mountains or setting the shutter speed on your camera as bolts of lighting make the hair on the back of your neck stand on end. There is beauty in the experience but often there is also beauty in the images captured or the samples collected.

Early naturalists, scientists in the natural sciences, needed to be able to draw their specimens or surroundings in detail to document their findings. As a result, drawing has been an important skill for scientists whether in a laboratory or in the field. Critical information can be gained with attention to detail, recording different points of view and lighting, and representative proportions. Although most areas of science have moved from drawing to film photography and

now to digital imaging, sketching is still an important skill for understanding and representing proportionality.

### **Art Meets Science Exhibit**

With the broad concepts outlined in this paper, an exhibit was put together called “Art Meets Science.” The exhibit was supported, in part, by a Culture of Quality grant provided by Northwest Missouri State University to make a creative link between the earth sciences and art. Displays linking the earth sciences and visual arts were put together for the exhibit at the Artisan Fine Art Gallery in Maryville, Missouri during January and February, 2006. The primary goal of the exhibit was to provide outreach to the community through student organizations, about the earth sciences through different art forms. Both students and faculty were involved in the development of the displays and attended the opening reception.

The following displays were included in the exhibit:

- Digitally enhanced images of microfossils that were originally obtained using a scanning electron microscope.
- Photography exhibiting both forked and sheet lighting obtained by variable shutter speeds and timed exposures.
- Microphotographs of rocks with interference colors generated by cross-polarized light.

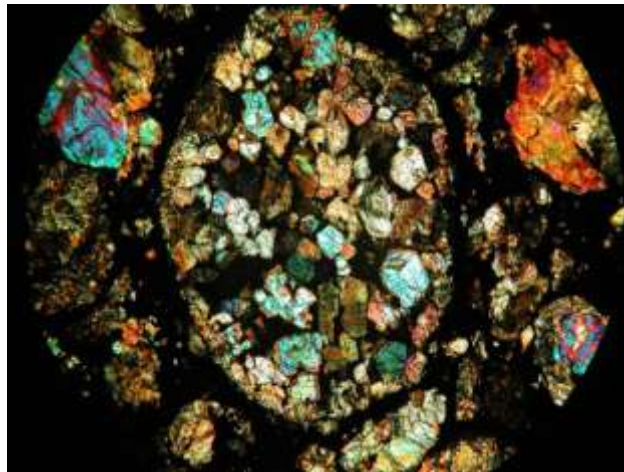


Figure 1. Microphotograph of a chondrite meteorite with an actual width of 1mm.

- Ceramic button tests (cone 6) and rock or mineral samples in a display highlighting the melting characteristics of different materials commonly used in glaze kitchens.

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- Hand-made ceramic tiles depicting fossil remains of marine invertebrate organisms
- Soapstone (talc) and alabaster (gypsum) carvings with mineral hardness display
- Cut and polished rock slices
- Permutations box of four square Plexiglas inserts with painted designs where visitors were encouraged to rearrange and imagine (or calculate) the number of possible combinations.
- Pastel drawings and artist's statement describing the inspiration rooted in physics

Students had the opportunity to interact and verbally describe how the display linked art with the earth sciences. The exhibit also provided a setting for students to discuss ideas in a neutral setting, outside of the university, and an opportunity for cultural enrichment to those involved and the community. Comment cards were available at the opening reception and then again at a special showing of the exhibit to students from the Missouri Academy of Math and Science. Specific comments are given below:

- **Opening reception**

“Excellent and eye-opening show.

“I really enjoyed it. Showed the community more about the department and great displays of cut rock”

“Interesting to think about how one can see artistic design patterns in natural state – inspiration for art interpretation.”

“There's a close relationship between the 2 – after all, nature is the ultimate artist that we try to copy. Science students should take design/composition courses to enrich what they see.”

“The SEM images are amazing! The displays are great.”

- **Selected comments from Missouri Academy of Science and Mathematics Students**

“Many people could enjoy this display, for an extreme variety of reasons.”

“I had a great experience at the local Maryville Artisan Fine Art Gallery... The striking pictures of the magnified objects and the human body abstracts were very remarkable.”

“Each part of the exhibit was different in its own way and nothing seemed to fall short of the rest.”

“The Art Meets Science Exhibit was actually quite beautiful.”

## Conclusions

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Based on the comments provided, the purpose of the Art Meets Science exhibit was fulfilled. Students and gallery patrons enjoyed the event and broadened their knowledge of both the arts and sciences. It is worth noting, that it was not an easy endeavor to bring the displays together and coordinate the efforts of students and faculty, but that it was a worthwhile one.

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