HARVARD UNIVERSITY

FS51X. CHANGING PERSPECTIVES: THE SCIENCE OF OPTICS IN THE VISUAL ARTS

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Renaissance artists began to create stunningly realistic representations of their world. Paintings started to resemble photographs, suggesting that artists had solved technical problems that escaped their forebears. Our brains effortlessly deduce three-dimensional scenes from two-dimensional images. But faithfully transferring spatial information to a flat canvas – a sense of depth, surface and shadow, geometrical accuracy – is hard to do. We will discuss how artists from van Eyck to Vermeer to Ingres to modern artists might have used science to make art. We will ask how devices like pinhole cameras, mirrors, and lenses might help artists see more deeply and create images more faithfully. We will perform science experiments with our own hands to appreciate how optical devices might be useful to artists. We will try to use devices to create our own artwork. We will meet artists and scientists who think about art and optics from different perspectives. Our seminar is a synthesis of art history, art making, and science. **Prerequisites:** No prior training in art or science. We will learn how to draw in our own workshop. We will learn the science of optics by trial and error, not with math or physics.

THE VISUAL ARTS AND THE SCIENCES have progressed side-by-side for centuries, from the Renaissance to now. How have science and technology, particularly optics, affected Western art from van Eyck to da Vinci to Vermeer? The Dutch Golden Age, in particular, saw dialogues between science and art. At the same time that Christiaan Huygens (1629-1695) was developing the astronomical telescope and Antonie van Leeuwenhoek (1632-1723) was developing the microscope and discovering microorganisms, Dutch painters – including Vermeer (1632-1675), Carel Fabritius (1622-1654), and Saenredam (1597-1665) – were enriching paintings with optical qualities, incorporating reflection, refraction, light, shadow, and geometrical perspective with ever greater accuracy and freedom. In fact, Leeuwenhoek and Vermeer were born in the same year in the same small town of Delft. The artist and scientist likely knew each other. Leeuwenhoek might even be the young man in Vermeer's *Astronomer* and *Geographer* (Fig. 1). [1]

Figure 1: (Top) *The Astronomer* by Vermeer and its Link at Google Arts and Culture. (Bottom) *The Geographer* by Vermeer and its Link at Google Arts and Culture.

[1] Arthur K. Wheelock. Vermeer becoming vermeer. *Artibus et historiae*, (84):307, 2021. ISSN 0391-9064

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DAVID HOCKNEY, contemporary artist and provocateur, has long been inspired by optical qualities in picture-making across the centuries. His controversial 'Hockney Thesis' is that artists have not just been inspired by optics, but that artists have used optical tools like mirrors, lenses, and prisms to *make* paintings with far more regularity than history records or historians admit. Hockney's suggestions are hotly debated by some and dismissed by others. Did van Eyck really use a spherical mirror to make optical projections of scenes when painting? Did Ingres really use a camera lucida to rapidly and accurately draw portraits? Nevertheless, a dialogue between optics, science, and Western art across centuries has occurred. The only uncertainty is its extent. We will use this dialogue as a starting point to think about the history and practice of picture-making, starting with questions about technology but going further by journey's end.

In our photographic age, optics are ubiquitous. Our smartphones are extraordinary imaging-making devices that did not exist a few years ago. We take optics and picture-making for granted. But once, optical effects had to be discovered, understood, and codified before artists could incorporate them into paintings. The Flemish artist Jan van Eyck (1390-1441) clearly reveled in the optical effects of reflection and refraction, portraying these complex plays of light with care and precision. The spherical mirror depicted on the back wall of his *Arnolfini Portrait* is so carefully painted that the room can be reconstructed from its curved reflections (Fig. 2).

Figure 2: *The Arnolfini Portrait* by Jan van Eyck (1390-1441) in the National Gallery of London, and Link to all of van Eyck's Paintings.

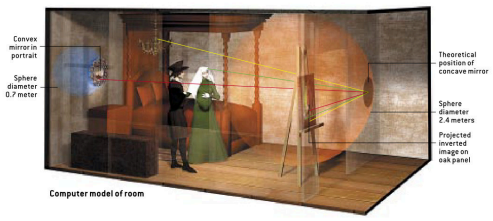

Figure 3: The room of the *Arnolfini Portrait* can be reconstructed using the reflection from the rear convex mirror, but would have required an enormous concave mirror to project onto canvas.

Hockney ventured that if van Eyck could *paint* a spherical mirror, he could have *used* a spherical mirror as an art-making tool. Convex lenses like magnifying glasses will focus light. Concave mirrors will also focus light. A good concave mirror can project a clear image of a brightly lit object onto a flat surface (see Fig. 3). Playing with concave mirrors and projected images, Hockney became convinced of their effectiveness as drawing aids. But if van Eyck used a concave mirror for the *Arnolfini Portrait*, David Stork – a scientist and Hockney skeptic – calculated that an implausibly enormous spherical mirror would have been needed. [2]

[2] David G. Stork. Optics and realism in Renaissance art. *Scientific American*, 291 (6):76–83, 2004

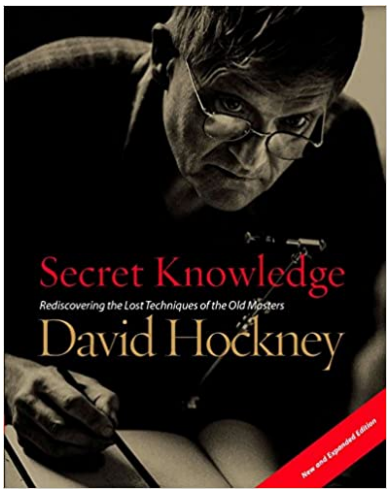

Figure 4: David Hockney using a camera lucida on the cover of his book.

OUR GOAL is not to settle debates in art history. These debates are never-ending without concrete evidence. Without historical evidence that Old Masters used tools – like concave mirrors or the camera obscura or the camera lucida – Hockney freely speculates that they did based on qualities of the pictures themselves, the theme of his book *Secret Knowledge.* The absence of evidence is not evidence of absence. Nevertheless, historians of art and science are warranted in their skepticism. It is dangerous to argue, like Hockney in *Secret Knowledge*, that the absence of concrete evidence that artists used optical tools is due to secretive hiding of evidence across centuries of Western art. Whatever happened in history, Hockney's speculations have fed his creativity. The reflections on the rear and side walls of his *Ready-made with Skull and Mirrors* may reflect Hockney's thoughts about van Eyck, whether van Eyck used mirrors to make paintings or not.

Figure 5: *Ready-made with Skull and Mirrors* by David Hockney. The skull is a *memento mori*, a symbolic trope appears in paintings from the Renaissance onward, a reminder of the inevitability of death.

THIS COURSE IS NOT ABOUT ANSWERING QUESTIONS, but asking them. Seeing and knowing the world are central occupations in art and science. This course is an invitation to look at representations that artists have made of our world across centuries. Many artists have seen more deeply and worked more effectively with the insight of science. Our goal is to enrich ourselves in the same way, with a journey across art and science from the Renaissance to now.

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OUR JOURNEY will include:

- **Making Art**. Many students might not be artists. We will learn about painting and drawing from artists who use optical tools to make art – Ethan Murrow, a Boston-based muralist at the SMFA and Abe Morell, a camera obscura artist – and artists who don't – Susan Lichtman, a figurative painter at Brandeis and Nard Kwast, a Dutch painter who incorporates 'Old Master' techniques (Fig. 6).
- **Science Experiments**. Appreciating the interplay between optics and art requires technical intuition. We will gain an understanding of optics, mirrors, lenses, reflection, and refraction by hands-on experimenting, not with equations (Fig. 7).
- **Field Trips**. We will visit local museums, especially the collections of the Harvard Art Museums and the MFA. We will visit the Boston Public Library to see their iconic murals by John Singer Sargent. We will study original artworks, evaluate their optical and aesthetic qualities, and think about the skill and technology that went into their making (Fig. 8).

Figure 6: Nard Kwast in the Dutch reality television show *Het Geheim van de Meester* on a team painting Rembrandt's *Night Watch* with old materials, old techniques, and working next to the original in the Rijksmuseum.

Figure 7: *The Arnolfini Ducky* by Daniel Davis. The image of a brightly illuminated object will be focused on a flat surface by a concave mirror at an appropriate distance and with an appropriate curvature.

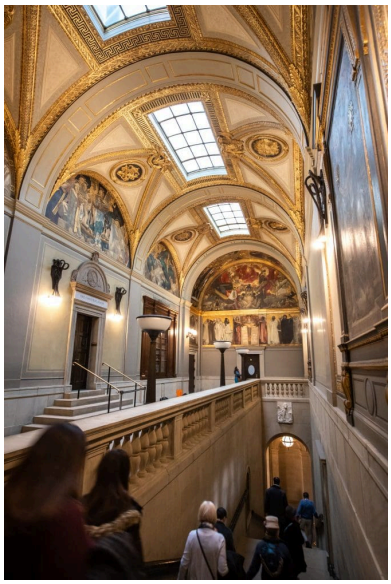

Figure 8: John Singer Sargent's mural cycle in the Boston Public Library, called the *Triumph of Religion*, was a central occupation of his life. We will visit the paintings and the extraordinary work that Sargent put into it.

WE WILL USUALLY MEET in Harvard Art Museums 0600. Except when we take field trips when we will Uber to the MFA and Boston Public Library. We will occasionally use HAM's Art Study Center to look closely at works in Harvard's collection. We will also use HAM's M-Lab, its maker space, to perform experiments and make art. We meet Thursdays from 12:45–2:45 PM.

READING AND WRITING ASSIGNMENTS will be assigned each week. Each week, students will read one or two short papers or book chapters. Each week, students will write a short essay (2-3 pages) that responds to readings and classroom discussions.

WE WILL BE SUCCESSFUL if understanding science and optics deepens our appreciation and interest in pictures and paintings, pushes us to look more carefully at the world around us, and encourages us to make our own pictures with paintbrush or pencil.

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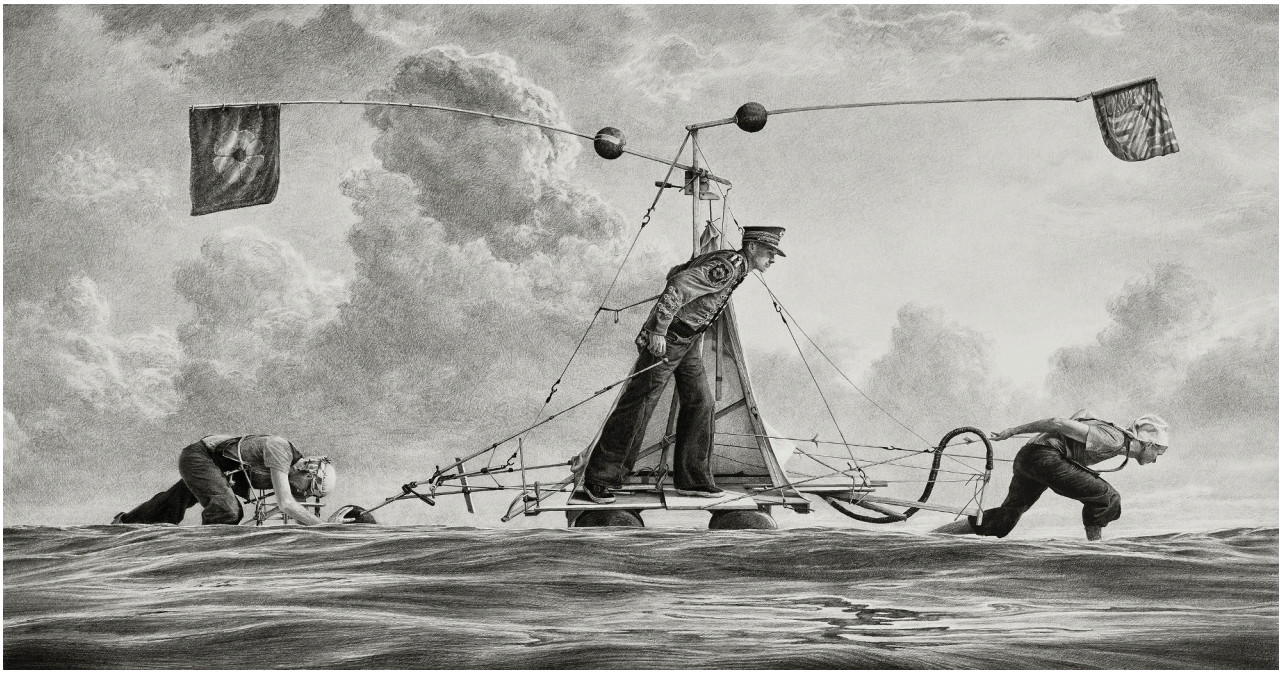

Figure 9: *For All Intents and Purposes* by Ethan Murrow. Graphite on Paper, 52" x 100".

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Dramatis Personae

Aravi Samuel '93 is the Professor. Aravi studied physics and biophysics at Harvard as an undergraduate and graduate student with Prof. Howard C. Berg. Berg, a famed microscopist of microorganisms, introduced Aravi to Leeuwenhoek, Vermeer's famed contemporary. Aravi's email: samuel@physics.harvard.edu.

Claire Swadling '26 is our Course Assistant. Claire studies physics and has long studied Studio Art. She will help with the art and science experiments, and will be available to chat about the course during the week. Feel free to contact her about course material, scheduling and transportation concerns, or interesting questions. Claire's email: cswadling@college.harvard.edu.

Chris Stokes, at the Rowland Institute at Harvard, built most of the optical devices that we will use in this course, the camera obscura, camera lucida, and so on.

Daniel Davis, from the Harvard Science Center, supports our physics experiments and demonstrations.

Nard Kwast specializes in classical painting, portraits, still-lifes, and landscapes with the style, techniques, and materials of the Dutch Golden Age. Nard's website is here.

Susan Lichtman is a figurative painter of domestic spaces, working in oil and acrylic. She is currently a professor of Painting at Brandeis University. Susan's website is here.

Abe Morell is a contemporary artist who is known for his camera obscura photography. More recently, he has pioneered the tent camera obscura, a new form of landscape photography. Abe's website is here.

Ethan Murrow is Professor at The School of the Museum of Fine Arts. He focuses on historical narratives, large scale wall drawings and murals. Ethan's website is here.

Michelle Luo '14 studied computer science at Harvard. She has worked as a product manager at Google Arts and Culture where she created vision and strategy for their Apps to find and view artwork.

Penley Knipe is Philip and Lynn Straus Senior Conservator at the Harvard Art Museums. Penley is an expert in the history and techniques of American portrait silhouettes.

Joachim Homann is Maida and George Abrams Curator of Drawings at the Harvard Art Museums. Joachim acquired many of the original drawings made with optical tools in the Harvard collection.

Kate Smith, Senior Conservator of Paintings at the Harvard Art Museums, played a major role in the restoration of the Sargent murals at the Boston Public Library.

Chris Atkins is Van Otterloo-Weatherbie Director of the Center for Netherlandish Art (CNA) at the Museum of Fine Arts, an innovative center for scholarship on Dutch and Flemish art which we will visit at the end of the semester.

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Students

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Figure 10: *School Class with a Sleeping Schoolmaster* by Jan Steen, 1672

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Calendar

Class Meeting	Topic	Hands-on Projects
Week 1. Jan 25	Introduction	Drawing with comparator and curved mirrors
Week 2. Feb 1	Seeing color	Creating color with Susan Lichtman
Week 3. Feb 8	Silhouette and shadow	The physiognotrace with Penley Knipe
Week 4. Feb 15	Ingres and Hockney	Drawing with a camera lucida
Week 5. Feb 22	Perspective from Brunelleschi to Vermeer	Drawing with a camera obscura
Week 6. Feb 29	Virtual Museums and Google Arts and Culture	Generative Imagery with Michelle Luo
Week 7. Mar 7	Field trip to the SMFA	Drawing with Ethan Murrow
Week 8. Mar 21	Painting in the Dutch Golden Age	Painting with Nard Kwast
Week 9. Mar 28	Field trip to the Boston Public Library	Painting restoration with Kate Smith
Week 10. Apr 4	The camera obscura	Photography with Abe Morell
Week 11. Apr 11	Bonnard, de Witte, de Hooch	Painting with Susan Lichtman
Week 12. Apr 18	Field trip to the MFA	Early Netherlandish painting with Chris Atkins

Figure 11: *The Baptistry in Florence* by Abe Morell, photograph taken with tent camera obscura.

Figure 12: *Family After a Meal* by Susan Lichtman.

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