



Summer 2004

Anticipating Artistic Behavior: New Research Tools for Art Historians

Robert Jensen

University of Kentucky, robert.jensen@uky.edu

[Click here to let us know how access to this document benefits you.](#)

Follow this and additional works at: https://uknowledge.uky.edu/art_facpub



Part of the [Art and Design Commons](#)

Repository Citation

Jensen, Robert, "Anticipating Artistic Behavior: New Research Tools for Art Historians" (2004). *Art & Visual Studies Faculty Publications*. 1.

https://uknowledge.uky.edu/art_facpub/1

This Article is brought to you for free and open access by the Art & Visual Studies at UKnowledge. It has been accepted for inclusion in Art & Visual Studies Faculty Publications by an authorized administrator of UKnowledge. For more information, please contact UKnowledge@lsv.uky.edu.

Anticipating Artistic Behavior: New Research Tools for Art Historians

Notes/Citation Information

Published in *Historical Methods*, v. 37, no. 3, p. 137-153.

Copyright of *Historical Methods* is the property of Taylor & Francis Ltd.

This is an Accepted Manuscript of an article published by Taylor & Francis in *Historical Methods* on Summer 2004, available online: <http://www.tandfonline.com/10.3200/HMTS.37.4.137-154>

Digital Object Identifier (DOI)

<https://doi.org/10.3200/HMTS.37.4.137-154>

**This is an Accepted Manuscript of
an article published by Taylor &
Francis in *Historical Methods* on
Summer 2004, available online:**

<http://www.tandfonline.com/10.3200/HMTS.37.4.137-154>

Anticipating Artistic Behavior: New Research Tools for Art Historians

Historical Methods

Vol. 37, No. 3 (Summer 2004)

Dr. Robert Jensen

Professor of Art History
University of Kentucky
Lexington, KY 40506
859-266-0552
robert.jensen@uky.edu

Introduction

This essay tests whether David Galenson's (2001) work on the life cycles of 19th- and 20th-century artists can be usefully extended to the study of pre-modern artists. Art historians customarily regard the young genius and the old master as no more than two artists myths in Western culture, types that reinforce the romantic image of the artist as an extraordinary individual, unlike other mortals (Kris and Kurz 1979). Galenson's work suggests that a quantitative consistency underlies these two legends and demonstrates specific patterns of creative behavior that may be associated with both types. Is Galenson's description of conceptual versus experimental artists useful to explain the differing ages at which pre-modern painters made their most significant contributions? By examining a small number of major old master artists who made their most important work either very early or very late in their careers, I will be looking for whether the respective artist's projected life cycle is consistent with the most recent scholarship on the painter.

Galenson often supports his quantitative studies with artists' testimonies regarding their respective working methods. Similar first-hand accounts are generally missing for artists before the 18th century. Other kinds of evidence that Galenson has been able to use successfully to describe the practices of modern artists may also not work so readily in reference to pre-modern artists. Therefore this paper not only examines Galenson's theory in relation to earlier Western painting, it also explores what is available within the documentary record that would allow us to extend his arguments back into the early 15th century (when the

modern idea of the artist arose). The first of two principal areas of study will be the technical examinations of old master paintings. Museum conservators usually conduct these analyses as part of the conservation of paintings in their respective collections. By seeing underneath the surface paint layer through x-radiography and similar methods one can often learn much about an artist's decision making process. The other principal area of study concerns drawing's complex and evolving relationship to painting as a means by which conceptual artists (in Galenson's terminology) might preconceive their work.

The ambition to extend Galenson's arguments back into the early Renaissance arose independently of another research agenda, which were brought together at the conference "Measuring Art: A Scientific Revolution in Art History" held at the American University of Paris in May 2003. This second project was inaugurated by the artist David Hockney's (2001) controversial proposal that artists since the early Renaissance have used optics to help them achieve the astonishing verisimilitude often found in old master painting. Hockney referred to two types of artists, those he called "eyeballers" and those whose work was "optics-based." Galenson and I wondered whether Hockney's "eyeballers" were in fact Galenson's experimental artists and Hockney's "optics-based" artists Galenson's conceptual artists. Could Galenson's life cycle profiles actually be used to predict whether or not an artist would be likely to use optics to assist in the making of his or her work? This paper does not intend to prove the use of optical devices as early as the 15th century, but only to indicate that patterns

of artistic behavior may tell us which artists were more likely to use them if they were indeed available.

Hockney's thesis has not yet been supported by published scientific research. However, the three-dimensional reconstructions of interiors reflected in the convex mirrors of early 15th-century Netherlandish painting undertaken by Martin Kemp, with Antonio Criminisi and Sing Bing Kang, published in this issue, may be the beginning of such work. Kemp and his colleagues demonstrate the extraordinary visual complexity of these representations. How was it possible for a human eye and hand, no matter how skilled, to reproduce unassisted by any mechanical device and with such precision the spatial distortions created by these mirrors? It suggests that proofs for all or some of Hockney's contentions may yet be found and that at the very least there is much still to be learned about how painters have worked since the early Renaissance.

Problems and Methods

Fundamental to Galenson's distinction between conceptual and experimental artists is that one cannot decide on an artist's position on the experimental/conceptual continuum merely by looking at a painting. Fortunately, technical imagery, systematically applied, may provide a visual profile of the various stages of a painting that extend well beyond the evidence of surface *pentimenti*. Not only might such analyses may be useful to confirm an artist's experimental or conceptual approach to painting, there is also an unexpected payoff in connecting life cycle models with technical examinations. This is because technical studies, although routinely conducted in conservation

laboratories, generally proceed in an ad hoc fashion, confined usually to the analysis of a single painting or a single artist's work. In essence, every painting is regarded as the product of a unique act of labor; even when an entire artist's work is under study, descriptions proceed from work to work. Conservators often express the opinion that generalizations about how artists work are impossible. Even excellent studies, such as the National Gallery of London's publication *Investigating van Eyck* are limited by the monographic approach (Foister et al. 2000). There is also the simple difficulty of gaining access to technical studies. Publication and discussion of technical photographs usually appear in periodicals devoted to conservation or museum bulletins. Occasionally such material is reproduced and discussed in exhibition catalogues, but usually only a few examples are included. These limitations are compounded by the fact that a small number of artists—such as Rembrandt, Vermeer, and van Eyck—receive a disproportionate share of study. Finally, comparative analyses between artists are rare and these may take the form of only determining the influence of one artist's technique on another, as exemplified by Gridley McKim-Smith, Greta Andersen-Bergdoll, and Richard Newman (1988) otherwise excellent book, *Examining Velázquez*. The general segregation of technical studies of paintings from the 15th to the 20th centuries from academic art history is evidence of art history's inability to generalize about artistic behavior. Thus, Galenson's life cycle studies offer art historians, conservators, and curators a powerful new tool with which to organize and interpret the technical examination of paintings. If one has a life cycle profile

and understands the behavior typified by that profile, one can begin to make significant comparative studies of artistic method.

Consider the careers of two of the most famous artists to have worked in 17th-century Holland: Rembrandt van Rijn and Johannes Vermeer. Their biographies and behavior could hardly be more different for two old master artists living in close geographical proximity whose lives briefly overlap. It is universally acknowledged, for example, that Rembrandt continued to mature as an artist as he grew older. Vermeer, in striking contrast, reached artistic maturity at an astonishingly early point in his career and such developments as he made later on are subtle and take a skilled eye to discern. Vermeer's life cycle neatly fits the legend of the young genius reaching artistic maturity at a young age Rembrandt's career equally exemplifies another type of artist, the old master, who through the labor of a lifetime and via many struggles achieves an unrivalled mastery of his medium: what in German is known as the phenomenon of the old age style or *Altersstil* (Galenson and Jensen 2001).

In 1653 at the age of 22 Vermeer registered with the Delft Guild of St. Luke, signifying the beginning of his professional life. His first known works span a mere two years, 1655 and 1656, and are composed of four paintings attributed to the artist. Beginning around 1657, there is a dramatic break in Vermeer's style and subject matter inaugurating Vermeer's "mature" period. Such paintings as *Woman in Blue Reading a Letter* (Rijksmuseum, Amsterdam), probably painted in 1663, when Vermeer was 31, are often held to be emblematic of Vermeer's mature style (Wheelock 2000, 41; Liedtke 2000, 39). Unlike

Rembrandt, art historians have expressed the sentiment that Vermeer's late paintings, dating after 1665, or when the artist was still merely 33, are not up to the standard set by his earlier work (Gowing 1979, 160).

Rembrandt had a very long and prolific career, especially when compared to Vermeer. Upon finishing roughly three years of apprenticeship to a Leiden artist, Rembrandt at the age of 19 set up practice as an independent artist in Leiden. The young Rembrandt was not an immediate star, although more than one patron admired the potential in his art. But as Svetlana Alpers (1983, 4) has noted, Rembrandt was a slow starter; his "earliest works hardly held forth such great promise." Shortly after the age of 25, Rembrandt settled permanently in Amsterdam, where his reputation quickly grew. Nonetheless, at the age when Vermeer had achieved his mature period—roughly around 30—a very large majority of Rembrandt's most well-known works of art still lay ahead of the artist, including *The Night Watch*, 1642 (Rijksmuseum, Amsterdam), painted at 36; *Bathsheba with King David's Letter*, 1654 (Louvre, Paris) signed by the artist when he was 48; and *The Return of the Prodigal Son*, ca. 1668, (Hermitage, St. Petersburg) probably finished when the artist was 62. Rembrandt's contemporary reputation in his old age was perhaps not what it had been at the mid-point of his career, but it is his late work that subsequently became most identified with the artist. The late work conforms to the popular and long-standing perception of Rembrandt as an increasingly isolated artist, embittered professionally and surrounded by personal tragedies, who in the midst of his sorrows and tribulations painted movingly introspective meditations on the nature of his own humanity.

The reality behind the myth is not as important in our context as the fact that it is the work of the late Rembrandt that has come to be prized above his earlier art.

Rembrandt appears to have treated drawings much as he did printmaking, as independent media. He drew extensively, but, surprisingly, very few drawings from his very large corpus have been convincingly demonstrated to be preparatory studies for any of his paintings (van de Wetering 1997). In pictures like *The Night Watch*, Rembrandt brushed his preliminary design on the canvas with a brownish paint, marking out the large areas of different tones the composition was eventually to display. Elsewhere he used bone black to do the preliminary sketch on the canvas. Scholars have also observed that Rembrandt worked in very similar ways in each medium he used. According to conservators at the Metropolitan Museum of Art (Ainsworth 1982, 112) “the preliminary sketches discovered in the autoradiographs reveal similarities to the artist’s pen-and-wash drawings. The manner in which Rembrandt used stippling and long, disengaged strokes for tonal variations in the background areas of certain paintings is also found in some of his etchings. Even the method of building up a painting from a sketch to the final layer is paralleled in Rembrandt’s printmaking.”

There are no surviving drawings by Vermeer. Scholars used to believe that Vermeer’s preliminary drawings on his canvases were done in chalk (ibid.), invisible to autoradiography, a technique that Vermeer depicts the artist using in the *Art of Painting*, ca. 1665 (Kunsthistorisches Museum, Vienna). But recent technical examinations have discovered that in some paintings Vermeer employed

a brown painted underdrawing and others have a colored underpainting (Gifford 1998, 185). About *Woman Holding a Balance*, ca. 1664 (National Gallery, Washington), in which a brown, monochrome sketch could be detected, the conservator E. Melanie Gifford (ibid., 187) argues that the “sketch was not simply a compositional guide; from the start he used it to establish the play of light as a central element describing the composition... Whenever Vermeer’s design lines could be observed, it was clear that his final paint layers conformed very closely to the sketch.” In other words, the artist’s initial compositional decisions represented by the underdrawing were modified almost not at all. Remarkably, the optical qualities for which a painting like *Woman Holding a Balance* is justly famous the artist worked out as early as the underdrawing stage. An even more striking example of how Vermeer’s initial underpainting anticipates the finished work’s optical effects is to be found in *Lady at the Virginal with a Gentleman* (*The Music Lesson*), ca. 1662-64 (Royal Collection, London). On the polished surface of a viola da gamba Vermeer painted the red reflection of the lady’s skirt. According to Gifford (ibid., 193), “In the red underpaintings [Vermeer] conveyed not only the color but the angle of the reflection of the skirt seen in the depths of the polished wood surface.”

As Rembrandt matured as an artist, the frequency and extent with which he revised his paintings grew (Ainsworth 1982, 112). Autoradiography has shown that Rembrandt even made sketches for compositional changes on his paintings after having laid down layers of paint (ibid., 18). Critical components of the painting, on which the entirety of its meaning might depend, could

sometimes be added at the very end. Such was the case with the letter held by Bathsheba in the Louvre painting. This final addition of the letter identifies the woman as a Bathsheba, rather than other possible heroines in similar circumstances, such as Susanna or Diana, whom, without the letter, she could easily have become (van de Wetering 1997, 39-40). Rembrandt also had the habit of retaining paintings in his studio for long periods of time, perhaps finishing them, like the Louvre *Bathsheba*, many years after the painting was begun (ibid., 47).

Vermeer is known to have revised, but these revisions appear most frequently in the earlier work. After the earliest paintings such revisions are achieved—strikingly—by the addition or subtraction of an entire object or group of objects rather than the adjustment of arms or postures in the sense so often found in Rembrandt. Vermeer’s adjustments may have, as some scholars argue, significantly changed the meaning of a work, but they did not fundamentally alter the painting’s initial composition. His manner of revision is in fact consistent with an artist using an optical device to transfer visual information to his canvases.

Rembrandt and Vermeer worked in close proximity to two of the foremost authorities on optics and optical devices in 17th-century Holland. Early in his career Rembrandt moved in the circle of Constantijn Huygens, who, in addition to being a great humanist scholar, had a lively interest in science, especially the science of optics, and all the kinds of knowledge that could be achieved through optical devices (Alpers 1983, 273. The executor of Vermeer’s estate, appointed

after the artist's death, was Anthony van Leeuwenhoek, famed for his work on the development of the microscope. (How well, if at all, the two men knew each other in life is not known.) Both artists, in short, appeared to have had equal and ready access to the devices and to the technical knowledge necessary to incorporate optics into their working methods. Yet, Rembrandt's penchant for constant revisions, his desire to explore and to define his picture's composition as he worked, means that the advantages of optics were nil. Vermeer, it is now pretty well agreed, did use some form of optical device in the creation of at least some of his works and that in his case the advantages are obvious (Gifford 1998, 196).

Philip Steadman (2001) has made a very convincing case for the consistent use of an elaborate optical device for the execution of many of Vermeer's pictures. Supporting his technical argument is the simple fact that Vermeer achieved maturity as an artist precisely when the painter appears to first to use such a device. According to Walter Liedtke (2000, 39), Vermeer's mature style is characterized by compositions "in which figures and inanimate objects are given equal emphasis within the field of view." This is a visual phenomenon to which we have grown accustomed since the invention of photography. Vermeer's life cycle, his working methods, and the visual results produced in his paintings all support the idea that optics played a decisive role in the development of his art.

In summary, then, the significant attributes dividing Vermeer from Rembrandt that conform to their different life cycles are: early versus late maturation; careful preconception (use of camera obscura) versus constant

revision (lack of preparatory drawings and significant changes during the painting process); the visual effects of the completed picture are anticipated in the preliminary underdrawing versus the lack of certainty as to when a painting had reached completion. Galenson would describe Vermeer's life cycle and creative behavior as consistent with that of a "conceptual" artist: someone given to preconceiving his projects prior to their actual creation. Rembrandt, conversely, is what Galenson terms an "experimental" artist. He works with a minimum of preparation and develops his ideas and his work in the act of making them. Not only does he not anticipate the final appearance of a painting in its initial stages, a quality of uncertainty as to when a work is actually finished is often in evidence.

What is further suggested by the comparison between these two artists and what binds Galenson's work to that of Hockney's arguments about early use of optics is the suggestion that conceptual artists such as Vermeer could avail themselves of optics in substitution for other preparatory techniques, whereas a strong experimentalist such as Rembrandt would find that the use of optics offered no advantages to his method of working. We should not expect an experimental artist to use such technology, whereas the use of optics is at least consistent with the life cycle profile of a conceptual artist such as Vermeer.

**

In Galenson's profiles the presence or absence of significant preparatory drawings is an important indicator of which type of artist we are studying. Conceptual artists are more likely to use aids to help visualize the painting in advance; such aids may be elaborate preparatory drawings. It is also possible that

the sort of optics-based image-making Hockney describes might substitute for preparatory studies, for similar reasons. Optical projections, like linear perspective, allows an artist to do significant pre-planning, mapping the exact location of visual elements either directly onto the painting or by transferring a drawing to the painting.

The role of drawings, and their presence or absence in an artist's *oeuvre*, have tended to be regarded by scholars as an almost accidental product of the artist's temperament, combined with the accidents of history and the tastes of collectors, rather than as an integral part of thinking about the artist's working methods (Ames-Lewis 1981, 2-13). The preponderance of preparatory drawings by some artists and the corresponding lack by others has been treated, if at all, as a chance element of artistic behavior rather than an opportunity for comparative study of artistic method.

The radical difference in the nature and quantity of drawings by artists such as Raphael and Michelangelo may offer significant comparative insights into their respective working methods. Raphael was capable of producing full-blown preparatory drawings, such as the one for the *School of Athens* in which the disposition of all but one of the figures in the painting was fully worked out. No comparable drawing survives in Michelangelo's corpus. Moreover, even when preparatory studies exist, as they do to a limited extent in Michelangelo's surviving drawings, if there are indications of significant changes to the actual painting following the transfer of the cartoon to the wall, then we may well be concerned with an experimental artist. As I will argue below preparatory

drawings in Michelangelo's case may not have been intended to pre-visualize a painting's overall composition as they were necessary tasks required by the difficult work of fresco painting, where speed of execution and comparatively marginal ability for revision are physical requirements imposed by the medium.

Overall, the same forces that were reshaping painting in the 15th-century transformed the role of drawing. Increasing demand for innovation and the growing rejection of medieval artistic conventions put pressure on artists to experiment with pictorial composition. Advances in technology, such as what occurred in papermaking—which made paper increasingly more abundant and somewhat less expensive—made drawing a more viable medium to explore ideas (ibid., 21-23). The emergence of a humanist art theory in Italy also placed growing importance on the conception rather than the practice of painting. Such theory, as advanced by Leon Battista Alberti and his successors, especially valued drawing as an essential part of the creative process.

Drawings, however, are scarce prior to the 16th century. This is particularly true in Northern Europe, where there are no more than a few hundred Netherlandish drawings in all—of which a high percentage are copies. Northern Renaissance artists did not conform to the same standards of originality that developed among Italian artist in the 15th century. Before Hieronymous Bosch, only one Netherlandish drawing has a definite attribution: Jan van Eyck's *Portrait of Cardinal Niccolò Albergati*, 1431 (Kunsthistorisches Museum, Vienna). The purposes of many drawings are also not clearly understood, partly because we lack contemporary textual sources with which to understand the role drawing

played in Netherlandish Renaissance art (Buck, 2000, 183). Where so much is unknown it may be easy to mistake a drawing made for the purpose of copying for a drawing intended as a preparatory study. The existence of nearly perfect copies in Northern Renaissance painting also suggests, following Hockney's thesis, that optics may have been used to assist workshops in the production of copies perhaps both in painted and drawn versions.

In Italy the making of preparatory drawings became a much more widespread practice than in northern Europe, probably for two reasons. The first relates to the practical necessities of fresco technique, which especially in Central Italian art was the most important medium. The second was Italian art theory, beginning with Alberti, which advocated the pre-planning of paintings. Prior to the 15th century, Italian artists drew with a brush a preliminary underdrawing (known as *sinopia*, named after the red-earth pigment sinoper normally used as the drawing medium) directly on the wall (Ames-Lewis 1981, 23-28). These drawings were subsequently covered over with the plaster layer into which the actual paint was laid. Most of these drawings were apparently schematic; they determined mainly the rough outlines of the composition. They could not anticipate much of how the painting would actually look when finished. Nor did the method permit much subtlety. And, since the underdrawing was lost under each day's area to be plastered (*giornata*), adjustments in the painting by necessity must be kept to the minimum because of the plaster's fast drying time.

Preparatory drawings offered fresco painters the opportunity to work out their compositions first on paper. In his revolutionary treatise *On Painting*

published in 1435 Alberti (1991) resituated the most important creative activity of artists at the planning—or conceptualizing—stage. Alberti shifted the significance of the artist's activities from the physical labor and practical knowledge of workshop (*botteghe*) practice to a higher, intellectual endeavor, grounded in geometry and expressed by the use of linear perspective and the application of the theory of ideal proportions. No doubt there was often a considerable difference between theory and practice in later 15th-century Italian art. But in essence, artists were urged to create preparatory studies that could be then transferred via full-scale cartoons to the wall using some form of pouncing. Despite the potential advantage of this type of working procedure, unfortunately comparatively few full composition drawings for Italian frescoes survive before the first decades of the 16th century. Those preparatory drawings that do survive belong to four (or possibly five) general types.

The first type is a cartoon actually used for physical transfer. Of these we have little before the 16th century because they were often destroyed during the process of transferring the drawing to the wall. They were often cut up to render transferring easier and would have been laid directly on a layer of moist plaster. Surviving remnants must normally have been discarded. Even if the design in a preparatory drawing were to be transferred to a panel or canvas the cartoon often would have been incised with a stylus or would have been pounced (pierced in such a way as to leave *spolveri*, usually charcoal marks, on the painting's surface) indicating the contours of a line.

A second type of drawing is the so-called contract drawing, small in scale and probably intended to be shown to the patron to gain project approval.

According to Francis Ames-Lewis (1981, 132-33), there may have been “little differentiation” between contract drawings and what might be called preparatory sketches for the painting’s final design, because, given the expense of paper, designs would not have been committed to paper until the artist’s ideas were most fully developed. These drawings, of course, would either still require enlarging via intermediary cartoons that have not survived or by the artist working out the final composition directly on the wall using the traditional *sinopia* method.

A third type of composition drawing that would have been preserved in workshop copy books could be the most developed, understood as finished works of art, and may never have been intended to be reproduced as a painting. This was probably the case with many of the composition studies preserved by later 15th-century northern Italian artists such as Jacopo Bellini.

A final type of study that may often have been used is the squared drawing—a superimposed grid over the compositional sketch. The only surviving squared drawing before the late 15th century, however, is Paolo Uccello’s *Sir John Hawkwood* (Uffizi, Florence) made for the fresco in Florence Cathedral. We also have evidence for its use in Masaccio’s fresco of the *Trinity* (Sta. Maria Novella, Florence), where an incised grid is visible in the head of Mary, implying a similarly squared preparatory study on which the painting was based (Ames-Lewis 1981, 25). No drawings by Masaccio, however, have survived.

Carmen Bambach (1999, 127-28) has recently proposed that Central Italian artists may have often used such drawings, following Alberti's advice that artists' use an optical device—a squared veil system—through which the exact coordinates of the object may be plotted. The fact that only one such drawing has come down to us Bambach attributes to contemporary prejudices “against semimechanical copying techniques.” A similar criticism was often later expressed regarding Alberti's recommendation regarding the squared veil system (Puttfarcken 2000, 54). As Alberti himself stated in defense of the use of the veil “I will not listen to those who say it is not good for a painter to get into the habit of using these things, because, though they offer him the greatest help in painting, they make the artist unable to do anything by himself without them....”(Bambach 1999, 128). The advantages of the squared veil method, of course, are similar to those offered by a mirror-based optics.

After 1500 a new type of drawing, often called preparatory, proliferates. These are characterized by a high degree of finish and are commonly described as cartoons, implying that their designs were to be transferred to paintings. Yet these “highly finished cartoons” (*ben finiti cartoni*) differ significantly from the schematic working cartoons we know many artists, including Michelangelo, actually used in the production of their frescoes. Michelangelo's schematic drawings probably did little more than place the figure on the painting's surface. Much of the pictorial realization of the painting would have been created during the act of painting itself. Most of the *ben finiti* cartoons of the early 16th century may never, in fact, have been intended as actual preparatory drawings for

frescoes. If they were to be realized as paintings now lost intermediary cartoons would have been used to transfer the outlines of *ben finiti* cartoon to the wall or panel. Bambach (1999, 281) suggests that many of the drawings Michelangelo is known to have periodically destroyed were just such immediate cartoons as well as the older type of rough preparatory cartoons. The artist chose to leave behind only such *ben finiti* drawings as might still have been in his possession.

The *ben finiti* cartoon appears to be a symptom of growing artistic autonomy. The famous cartoons by Michelangelo and Leonardo of the battles of Cascina and Anghiari respectively were literally demonstrations of artistic skill (Michelangelo, for example, showed off in his drawing the many drawing manners and materials he was capable of employing with great dexterity). Both cartoons are known to have been left unfinished by their makers, and of course, neither was realized as a fresco (*ibid.*, 251).

In addition to the problems posed by indeterminate function and survival of preparatory drawings, there is also the question of the very real differences between 15th-century artistic notions of pictorial composition and our modern understanding of what constitutes a picture. In 15th-century Italy composition was understood only as the arrangement of figures to each other and sometimes only of the proper disposition of a single figure. This was likely how Michelangelo understood composition. In fact, it might be argued that Michelangelo best realized Alberti's original meaning for the word *compositio* (composition) which he introduced into Italian art discourse with his treatise on painting. According to the art historian Thomas Puttfarcken, Alberti was careful to use the work

compositio rather than another rhetorical term *dispositio*, because of the emphasis Italian artists placed on the body as the fundamental unit of art. Puttfarcken (2000, 67-68) writes:

Disposition is the distribution of all the constituent parts of a whole (speech or picture) within the overall structure of that whole. That means the overall structure, as given or anticipated, predetermines the placing, the collocation of the parts. Composition, on the other hand, is the putting-together, the building-up of a whole (the periodic sentence or the *historia*) out of its parts. That means that the parts are understood as being prior to the whole that results from their combination.

Imagine Michelangelo composing the Sistine ceiling or the *Last Judgment* on the basis of pre-planned individual units of single figures or groups of figures and we encounter another complication when thinking about preparatory drawings. It is quite possible that Michelangelo conceived of what we would call the Sistine ceiling's composition in the act of placing his figures on the wall and not beforehand. In its individual units Michelangelo's ceiling shows significant differences between the early portions of the work and the work completed later. Taken as a whole the ceiling has the appearance of a brilliantly improvisational ensemble rather than the realization of a carefully preconceived program. In other words, Michelangelo subjected the parts, but not the whole of his painting, to preconception; in fact he was later criticized for composing his pictures in figures and groups rather than with an overall regard for the figures' relation to each other and to their setting (Puttfarcken, 2000, 121). Puttfarcken describes Ludovico

Dolce's criticism of Michelangelo published in 1557, in which the critic created a paragone between Michelangelo and Raphael in favor of the latter, on the grounds that Raphael was "the richer, more rounded artist," because whereas Michelangelo only conveyed a "mastery of the human body" Raphael's work exhibited a "mastery of the whole world" (ibid., 101).

In short, we have to be very careful in interpreting the creative record represented by drawings in 15th- and early 16th-century Europe. As we have seen preparatory drawings were subject to a complex set of traditions and functions. Even drawings confidently referred to by scholars as cartoons, such as the famous Leonardo *Virgin and Child with the infant St. John the Baptist and St. Anne* cartoon in the National Gallery in London, may have served a purpose still unknown and perhaps never to be definitively deciphered.

If there is a principle to be observed in the study of drawings in relation to artistic activity perhaps it would be that the more autonomous the artist, the more drawing is an accurate descriptor of what type of artist we are describing, whether conceptual or experimental. Conversely, whenever an artist's creative autonomy is constrained by the expectations of patrons we may encounter problems interpreting their artistic practices. Artist careers within the *botteghe* tradition were materially different from the idea forged by later Renaissance painters. A Michelangelo might claim to be equal or even superior to his patrons and thus comparatively free to realize his artistic ambitions, even significantly revising a project in the course of its realization. But for earlier artists, even someone with the stature that Jan van Eyck enjoyed in Flanders in the 1430s, the relations with

patrons could significantly affect the development of a project. It has recently been argued, for example, that van Eyck was called upon to make significant changes in his *Annunciation* (National Gallery, Washington) after the complete underdrawing for the painting had been shown to the patron (Gifford 2000, 64-65). A similar suggestion has been made for the significant alterations made by van Eyck in the composition of the *Arnolfini Double Portrait* (National Gallery, London), where “the large number of important changes between the underdrawing and the finished painting shows that the couple were in constant discussion with the painter” (Campbell, 2000, 20). Indeed, portraits from any period may be problematic indicators of artistic practices because of the need to satisfy patron demand for likeness. Van Eyck’s presumed difficulties with his clients stand in strong contrast to Michelangelo’s habit of dictating major revisions in his various projects to his clients.

A final obstacle faces any attempt to establish the life cycles for pre-modern artists, through which we might anticipate their working methods. Many 15th-century artists’ careers are still subject to art historical conjecture. We often do not know birth dates, but only the dates of activity. Firm attributions of even major paintings are still in doubt, as in the recent bold reattribution of Rogier van der Weyden’s *Escorial Deposition* (Prado, Madrid), to Robert Campin (Thürlemann 2002, 109-30). Similar problems of attribution persist even into the 17th century, as the Rembrandt Research Project has demonstrated.

**

Quantitative analyses of pre-modern artists' careers have still to be done. Conclusions about life cycles based on qualitative judgments in the current literature on the significant contributions of a given artist may only produce provisional findings and serve simply to suggest areas for further research. However, in order to put the following arguments on a little firmer ground, I begin, in modest imitation of Galenson's quantitative methods, with a simple textbook study of the frequency of reproductions of paintings by fourteen major painters working from the 15th century through the 17th century. Table 1 lists their names, dates of birth when known, and their death dates. Table 2 ranks the thirty most frequently reproduced paintings in these textbooks by these artists, their dates, and the age of the artist at each work's completion. It clearly demonstrates that these paintings were made at dramatically different ages, some very early, some very late. Finally, Table 3 indicates the span of years, from longest to shortest, necessary to include at least half of the number of reproductions of an artist's work in these texts.

Returning to our comparison between Vermeer and Rembrandt it is noteworthy that Table 2 indicates that Vermeer's most often reproduced work was the *View of Delft*, 1661 (Mauritshuis, The Hague), painted at age 29. Table 3 also shows that the majority of Vermeer's paintings reproduced in art history textbooks date from the years between 1660 and 1665, that is, when the artist was between the ages of 28 and 33. Conversely, Rembrandt's most frequently reproduced painting is *The Night Watch*, painted at the age of 36. More revealing

still is the large span of years necessary to encompass at least one half of the total reproductions of Rembrandt's work.

This small sampling is consistent with those modern artists analyzed by Galenson and supports his thesis that innovation is the decisive indicator of value for major Western painting since at least the beginning of the 15th century. The two most frequently reproduced paintings appearing in Table 2 are van Eyck's *Arnolfini Double Portrait*, 1434 and Masaccio's *The Tribute Money* (Brancacci Chapel, Florence), ca. 1427. In the textbooks both paintings are invariably discussed as major innovations in painting. Van Eyck's work is treated in the context of the application (if not discovery) of the oil medium and the rich color, precise detail, and extraordinary illusionism the medium helped permit the artist to achieve. Masaccio's painting is similarly treated in the context of the discovery and application of a new geometric means of mapping a consistent three-dimensional space on a two-dimensional surface: linear perspective. Although the innovations made by the paintings on Table 2 are not always so clearly articulated by the textbooks' authors, they are all viewed as major contributions to the history of Western painting.

Conceptual and Experimental Artists

In the following section, we will look at the work of five 15th- and 15th-century painters placed in the context of Galenson's life cycle profiles and tested against what scholars have recently learned about their techniques from the technical analysis of their paintings as well as recent studies of 15th- and 16th-

century drawings and their various purposes within the creative activities of artists.

1. Raphael (Raphaelo Santi, 1483-1520)

Raphael is an early paradigmatic example of the young genius and conceptual artist. He completed his often-reproduced picture, *The School of Athens*, in the Stanza della Signatura in the Vatican Raphael at the age of 28. The literature on Raphael has always noted his ability to precisely emulate and then successfully depart from the lessons offered by the work of his famous older contemporaries, beginning with his master Pietro Perugino, followed by Leonardo, and later still, by Michelangelo (Vasari 1965, 285). Later, Raphael absorbed the lessons of Leonardo da Vinci's art, and then later still, those of Michelangelo's. In a possibly apocryphal, yet revealing story, Vasari wrote that Raphael secretly gained access to the Sistine chapel while Michelangelo was away in Florence, having quarreled with Pope Julius, in order that he might study the aggressively foreshortened, muscular nudes of Michelangelo's ceiling. "Taking immense pains, [Raphael] forced himself as a grown man to learn within the space of a few months something which demanded the easy aptitude of youth and years of study" (ibid., 297, 316).

Raphael was renown among his contemporaries for the apparent ease with which he executed his paintings and for his skill in negotiating with his religious and secular patrons. Vasari tells us that the apparent effortless of Raphael's manner of painting was the result of hard work, a reflection on the amount of preparation that preceded Raphael's actual execution of his paintings. We know

that Raphael's drawings were highly prized by collectors in his lifetime, and therefore many have survived. And because we have so many drawings by Raphael, they provide a clear picture of his working methods.

Raphael gives us the first surviving full-scale cartoon for a fresco, the composition study for all the figures in the *School of Athens* (Oberhuber and Vitali 1972). According to Ames-Lewis (1986, 3), "Raphael seems to have perceived more clearly than earlier artists the benefit to the final design of a logical and increasingly elaborate preparatory drawing procedure." Ames-Lewis describes the methodical development of pictorial ideas from rough sketch to several more finished drawings and "how through out the preparatory process he kept fully in mind the character and purpose of the final work" (ibid., 8). The only significant difference between the cartoon and the executed painting was the addition of the architecture surrounding the figures, which Raphael physically and figuratively built around them, leaving the lower portion of the painting as he initially conceived it intact, and the addition of the figure of Heraclitus, said to be a portrait of Michelangelo.

Before Raphael, Italian artists probably did not often employ such elaborate cartoons, often developing their paintings through individual figures or groups. Raphael anticipated the overall relation of his figures in a visually interlocking group. He was probably inspired by a similarly unity achieved within a complex collection of figures and gestures realized by Leonardo a decade before in his *Last Supper* (Bell 1997). Judging by the surviving drawings by both artists, Raphael was able to articulate fully his composition prior to painting,

whereas Leonardo may still have worked out his figure arrangements during the execution of his picture.

Raphael's approach stands in even more marked contrast to Michelangelo's Sistine ceiling. Raphael planned out all the paintings in the Stanza della Signatura together in order to produce a harmonious whole. Each figure was designed to be consistent in scale from one painting to another, and each composition carefully related to each by the use of consistent compositional axes (Ames-Lewis 1986, 72ff.). Michelangelo's program for the Sistine ceiling, however marvelous in its individual figures and scenes, is inherently a sequence of isolated representations, which, although architecturally and programmatically ordered, do not essentially relate between the parts and the whole.

Raphael's skill in planning is echoed by another essential difference between his activity as an artist and that of both Leonardo and Michelangelo, his ability almost always to satisfy the terms of his commissions. Raphael left very few works unfinished in his lifetime. Assistants were even able through his extensive preparatory studies to finish the paintings Raphael left uncompleted at his early death at age 37. That Raphael did not have a long career should not distract us from the fact that he had made much earlier in his career the contributions to the history of Western art for which he would be most admired.

2. Hans Holbein the Younger (1497-1543)

We expect conceptual artists to mature early and to produce strikingly finished work right from the beginning of their careers. Hans Holbein the Younger, like Raphael, demonstrates such tendencies. Even in his earliest work,

dating from the age of 20, Holbein's paintings and drawings are remarkable for their fidelity to nature. Moreover, Holbein painted about half of his major portraits and figure paintings by the age of 35/36, including his most frequently reproduced picture (see Table 2), *The French Ambassadors* (National Gallery, London). In his catalogue raisonné of the artist's paintings John Rowlands (1985) counts 82 surviving paintings by Holbein, 48 paintings of which Rowlands believes were painted by 1533. In my textbook study, Holbein's life cycle was sharply affected by the frequent reproduction of *Henry VIII* (Galleria Nazionale Arte Antica, Rome), dated to around 1540. Rowlands (ibid., 223-26) however attributes this painting to another, unknown artist, copied with some revision from a no longer extant mural painted in 1537 on a wall in Whitehall Palace, for which a substantial cartoon survives. If we exclude *Henry VIII* painting from the list of Holbein reproductions, then the period in which at least half of Holbein's works are illustrated would span the years 1530-33, when the artist was between the age of 33 and 36.

Among the traits that indicate Holbein was a conceptual artist is the fact that he routinely worked from careful preparatory drawings. Such drawings could be made for individual portraits, as for example, the *Portrait of Sir Richard Southwell*, made ca. 1537. The black and colored chalk drawing now in the Royal Library in Windsor Castle bears uncanny resemblance to the completed painting now in the Uffizi. Drawings could also plan the entire composition of a painting, such as the *Study for the Family Portrait of Sir Thomas More*, ca. 1527 (Kupferstichkabinett, Öffentliche Kunstsammlung, Basle). There exists concrete

evidence that Holbein transferred the designs from a full-scale drawing to the final canvas. This was done, for example, for the *Portrait of Lady Mary Guildford*, 1527 (St. Louis Art Museum, St. Louis), where the underdrawing for the painting was found under technical analysis to be identical with the preparatory drawing in the Kupferstichkabinett, Öffentliche Kunstsammlung in Basle (Buck 1999, 59). And on at least one occasion Holbein generated two virtually identical paintings, the *Portrait of Erasmus Writing*, one version of which is in the Louvre, the other in Basle. Later Holbein or his shop produced numerous copies or variations on the portrait of Henry VIII.

In *Secret Knowledge*, Hockney (2001, 160-61) compares a painting by Holbein's younger contemporary, Lucas Cranach the Younger, with a painting by Velázquez to establish the effects the use of optics by the Spanish painter had on the appearance of his work. It is perhaps more relevant to compare Cranach's *Christ and the Woman Taken in Adultery* (Hermitage, St. Petersburg), said to have been painted sometime after 1532, with Holbein's contemporary *The French Ambassadors*. Cranach's generalized treatment of the faces and the incorporation of caricatures rather than illusionistic likenesses seem strikingly old-fashioned compared to Holbein's almost uncanny representations of faces and things. The differences in the style of these two near contemporary paintings are so extreme as to be hardly explainable by such standard formulae as personal style or manual dexterity or the relative difference in age. Such oppositions are highly suggestive of the impact optics could make on artists receptive to its use. Still, we need to be cautious. There are many examples in Renaissance painting, particularly in

northern Europe, which includes works by Holbein, of a general distinction between the portrayal of ideal types (the Madonna, etc.) and what are clearly portraits. So, for example, in the *Darmstadt Madonna*, 1526 (Schlossmuseum, Darmstadt), which depicts the Madonna and Child standing in a scalloped niche, flanked by the family of the artist's patron Jakob Meyer, Holbein endowed the Madonna with a generalized, idealized face, while painting highly particularized and individual portraits of Meyer, his wife, and daughter. This should remind us that the particular use of optics—if used—would be applied in some circumstances, but not others, even within a single painting.

3. Leonardo da Vinci (1452-1519)

Artists who continue to develop and produce many of their major works toward the end of their careers are indicative of an experimentalist approach to art. Outside the modern artists Galenson has described, since the early Renaissance such artists as van Eyck, Leonardo, Titian, Velázquez, and Rembrandt all produced major work late in their careers. Leonardo, for example, was 31 when he made the *Madonna of the Rocks*, ca. 1483-85 (Louvre, Paris), a painting whose novel use of light, according to the art historian Martin Kemp (1981, 98), “is fully apparent in no work by his Italian predecessors and is only incompletely anticipated in his own earlier paintings.” His most famous pictures come still later, the *Last Supper* (Santa Maria del Grazie, Milan) at age 45, *Madonna, Child, St. Anne and a Lamb* (Louvre, Paris) sometime after the age of 60, while the *Mona Lisa* (Louvre, Paris) may have been completed perhaps as late as the age of 68.

How do we reconcile Leonardo's profile as an experimental artist with the common belief that Leonardo pioneered a new conception of the preparatory drawing? It is in such instances that one may discover the value of thinking about artists in terms of Galenson's conceptual/experimental continuum, allowing us to look anew at this old problem. In an often-cited essay, "Leonardo's Method for Working out Compositions," Ernst Gombrich (1996) described Leonardo's revolutionary method of working through an improvisatory drawing style to create new compositional ideas. Leonardo, Gombrich (*ibid.*, 211) wrote, "works like a sculptor modeling in clay who never accepts any form as final but goes on creating, even at the risk of obscuring his original intentions." Both the presence of constant revision and the lack of a clear vision of the final form of the image—which is only to be discovered in the working process—are hallmarks of the experimental artist. Yet curiously, Gombrich saw this improvisatory technique as a conceptual, rather than craft activity, assuming, in fact, that invention is exclusively a conceptual activity. Not only that, Gombrich worried that "The insistence on invention, on the mental quality of art can certainly become destructive of standards of craftsmanship. In Leonardo, as we all know, it was destructive of that patience that alone could have kept him at his easel" (*ibid.*, 214). In Galenson's terms Leonardo's invention was an experimental activity, grounded in constant revision and a lively, ever-changing response to the craft of drawing or painting.

Gombrich notably confused preparatory drawing with painting, using the words virtually interchangeably, as in this typical passage: "Painting, like poetry,

is an activity of the mind, and to lay stress on tidiness of execution in a drawing is just as philistine and unworthy as to judge a poet's draft by the beauty of his handwriting" (ibid.). Gombrich's lack of interest in the relationship between the preparatory drawing and the final painting causes much of the confusion in his analyses of Leonardo's use of drawing.

Technical examinations of his early work show that Leonardo was capable of transferring a preparatory study to the canvas in a direct and essentially unmodified manner. This is evident in his portrait of *Ginevra de' Benci*, painted probably sometime between 1474 and 1480 (National Gallery, Washington), where pouncing marks have been discovered on the gesso ground indicating the use of a preliminary cartoon (Brown 1998, 113). On the other hand, in other early Leonardo paintings, such as the *Annunciation* (Louvre, Paris), which one scholar places a year or two before the portrait, pouncing marks are not in evidence (ibid., 75-76 and 105-06). Instead, Leonardo apparently employed a brush underdrawing, while in the actual execution of the *Annunciation* Leonardo resorted to blending the wet paint with his fingers throughout, leaving marks still to be seen on the painting's surface (ibid., 92). Because of the comparative imprecision of fingers versus brush, we can expect subtle changes of contour, as Leonardo subtly revised his initial conception during the process of painting. Technical examination indicates significant changes from the initial composition. It is odd—given the presumed respective dates for these pictures—that the improvisatory method more characteristic of the mature Leonardo is said to exist in the earlier painting. Perhaps the differences in procedure are to be accounted

for by the different demands of portrait painting versus a religious image or perhaps the problem lies with the works' dating.

Leonardo drew a great deal, but few drawings can be firmly established as preparatory for the execution of specific figures in his paintings. Several of Leonardo's *ben finiti cartoni* became works of art in themselves, such as the marvelous drawing of the *Madonna, Child, and St. Anne* in the National Gallery in London. As Martin Kemp (1981, 226) observes, the artist "devoted a considerable degree of effort to a composition which does not correspond to any known commission" and at a time when clients were "clamouring for works." The drawing's profoundly subtle transitions from light to dark are carried out far in excess of the requirements necessary to translate the compositional format from the drawing to the painting. Compare this, for example, to the early pricked cartoon (Uffizi, Florence) Raphael used for the *St. Georges and the Dragon* now in the National Gallery in Washington. In fact, drawing achieves in Leonardo's *oeuvre* an autonomous role.

Leonardo treated the actual act of painting, as he did the act of drawing, as exploratory, developing and revising his compositions as he worked. For example, an Italian art historian working in conjunction with conservators on restoring Leonardo's *Last Supper*, described the use by the artist in his unfinished *Adoration of the Magi* (Florence, Uffizi), 1481, of "monochromatic but stratified application of paint... [which] demonstrates that Leonardo could and did alter positions and expressions using his bistre-soaked brush" and that "Absolutely none of the studies is duplicated precisely in the painted version, where

everything resembles but also differs from the drawings. The painting is a work in progress, a visible rendering of a continuous accumulation of ideas and refinements” (Mariani 2001, 12-13). Even a wall painting like *The Last Supper*, which by nature resists revision, shows under technical examination changes in the composition as Leonardo worked on it. Conservators have discovered a perspective grid etched into the plaster surface that does not conform to the final perspective construction. “The spatial plan defined by this incised grid seems to refer to an early compositional idea, which called for the coffered ceiling to occupy all the upper area of the scene. The lines therefore disclose an initial project characterized by a perspective plan with less depth of field and a shallower space” (Barcilon 2001, 345). To this major revision in the architectural scheme for the painting, Leonardo made numerous, small changes throughout, to the placement of the figures, the treatment of the windows behind Christ and the Apostles, and the objects on the table (ibid., 416). The conservators concluded that Leonardo approached *The Last Supper*, not within the workshop traditions of *buon fresco* technique, which calls for careful planning and quick execution, but as one would a panel painting.

A rich, late career and significant changes to his compositions as he worked indicate that Leonardo was at least a moderate experimental painter. If Leonardo behaved at times as a conceptual artist might, by making preparatory drawings, it may well be that these methods are the residue of his workshop training. What marks his career and defines one of his central contributions to the history of Western painting is Leonardo’s rebellion against convention and his

revolutionary discovery of working methods that allowed maximum freedom to the artist to evolve and refine his ideas as he worked.

4. Titian (Tiziano Vecellio, c. 1485-1576)

Titian took the idea of revising and developing a painting in the act of its creation considerably further. Only thirty-nine sheets of drawings have been firmly attributed to the Titian (Chiari 1990, 11). Art historians have attributed this lacuna to accidents of history and the absence of collectors interested in collecting Venetian drawings (McKim Smith et al. 1988, 40). These unsupportable claims need to be set against the fact that the generation of artists working in the Venetian milieu before Titian—particularly the Bellini family, their relative by marriage, Andrea Mantegna, and Vittore Carpaccio—produced large quantities of drawings. Many of these are elaborate preparatory studies. It is as probable to conclude that the absence of drawings by Titian represents his general disinterest in the medium. We may go further and argue that Titian rarely considered it necessary to plan his paintings in advance. Titian discovered a new way of painting, which was made possible by the technical advance created by the conjunction of the oil medium and the stretched canvas, which allow Titian to work directly on the canvas and to revise as he worked.

The few composition studies by Titian, according to a scholar of his drawings, “are far from being ‘models’ in the Roman or Tuscan sense. For Titian, the planning stage does not stop even when the actual painting begins, as can be seen from the numerous changes of mind that have been revealed by X-rays of his pictures and from the very character of his sketches on canvas” (Chiari 1990, 11).

Vasari, in his biography of the artist, quoted an excellent account of Titian's painting method made a contemporary observer.

He used to sketch in his pictures with a great mass of colors, which served, as one might say, as a bed or a base for the compositions... Having constructed these precious foundations he used to turn his pictures to the wall and leave them there without looking at them, sometimes for several months. When he wanted to apply his brush again he would examine them with the utmost rigor, as if they were his mortal enemies, to see if he could find any faults; and if he discovered anything that did not fully conform to his intentions he would treat his picture like a good surgeon would his patient... the final stage of his last retouching involved his moderating here and there the brightest highlights by rubbing them with his fingers, reducing the contrast... and harmonizing one tone with another.”¹

Titian's improvisational approach to painting became more pronounced as the artist aged. As Vasari observed “the early works are executed with a certain finesse and an incredible diligence, so that they can be seen from close to as well as from a distance... these last pictures are executed with broad and bold strokes and smudges, so that from nearby nothing can be seen whereas from a distance they seem perfect... it is [also] known that these works are much revised and that he went over them so many times with his colors that one can appreciate how

¹ This extract was taken from the second edition of Vasari's *Lives*, and cited in translation by Francesco Valconover in *Titian: Prince of Painters* (National Gallery of Art: Washington, D.C., 1990),

much labor is involved” (1965, 458). By drawing over already painted areas of his canvases Titian overthrew the Central Italian theory that drawing should be limited to an underdrawing, perhaps transferred from a preparatory study.

Titian’s most often reproduced work is his altarpiece painted for the Pesaro family in the church of Santa Maria Gloriosa dei Frari in Venice, completed in 1526 when the artist was possibly 38 (Table 2). The painting is famous for its new, asymmetrical arrangement, weighted predominately to the left side of the painting. Its unique composition responds to the altar’s position on the sidewall of the church. Titian effectively combines both frontally and diagonally organized views, as one sees the painting standing directly before the altar, but also as one sees the painting from the side, as one walks up the nave. The enthroned Madonna, instead of facing straight out, turns to her right to take in this group of supplicants. Her diagonal alignment is reiterated by the background architecture, which retreats at a sharp diagonal into the fictive space. Technical analysis reveals that Titian’s ingenious solution was achieved experimentally—several earlier versions of the architectural setting are visible under x-ray examination. David Rosand (Rosand 1990, 96) has observed that “Reorienting the governing spatial axis of his design, from horizontal extension to vertical ascent, Titian thereby elevated the architectural space of the painting to a higher, transcendent level.”

Elsewhere Rosand (Rosand 1993, 111) has noted Titian’s practice of recording his own compositional innovations for further use “in the form of a new begun canvas, blocked in (*abbozzata*), a sketch awaiting further realization. In

the course of realizing a second redaction, he might significant modify it, and the old composition would evolve into a new variation of the theme.” This is extraordinarily suggestive of an artist for whom no composition was essentially “finished,” but was subject to potentially limitless revision. Unlike Leonardo, Titian was enormously prolific in churning out paintings on demand, which is perhaps one reason why he kept the beginnings of second or perhaps even third redactions of a composition for future. But Titian is like Leonardo in that no one solution to a pictorial problem was definitive. Thus, both artists may possibly have begun their careers as moderate conceptualists, in accordance with their respective workshop educations, yet made their fundamental contributions to the history of Western painting only as they became progressively more experimental in their approach to their craft.

5. Michelangelo Buonarroti (1475-1564)

Michelangelo Buonarroti may have been the reverse: a moderate experimentalist constrained by the nature of his projects, media, and training to conceptualize his work to a certain degree. Michelangelo possessed an “old age” style and his work steadily evolved over time. There is also no question that Michelangelo routinely revised the programs of his projects. The tomb for Pope Julius II in all its variations is but one example of a project that went through many stages and was never realized as it was initially planned. If we believe near contemporary sources the Sistine ceiling began as a relatively modest project and was utterly reworked by the artist, dramatically expanding its program. Vasari (1965, 353) tells us that even after the Sistine Chapel was open for viewing

Michelangelo remained dissatisfied with the ceiling. The artist hoped to retouch the painting “in order to enrich and to heighten the visual impact” but was deterred by the prospect of having to rebuild the elaborate scaffolding.”

We know that Michelangelo clearly planned at least individuals and figure groups for his frescoes in advance of their painting. Such designs were transferred to the wall by the means of pouncing or were incised with a stylus, using the *calco* technique—incisions in the plaster caused by a stylus roughly traced over the cartoon. But unlike Raphael, no drawings survive that indicate the composition of a painting in its entirety. This absence is most noteworthy in the *Last Judgment*, because, unlike the Sistine ceiling, there are no individual units, but only a single undivided wall. Again, unlike the ceiling, Michelangelo adhered to medieval traditions in laying out his composition. The surviving preparatory studies are devoted to individual figures or groups of figures. There is significant evidence suggesting that his works, whether in fresco, sculpture, or even architecture, developed during the working process.

The strongest evidence against Michelangelo’s experimental approach is the fact that in painting, unlike Titian, the artist’s working methods do not appear to have grown increasingly experimental as he aged. The paintings on the Sistine ceiling were subject to much greater revision from the initial cartoons than the later Sistine *Last Judgment* (Bambach 1999, 1-10; 357-63; and 365-67). The *calco* method Michelangelo used on the Sistine ceiling offered as much free revision as was possible in the fresco medium (Colalucci 1994). But as the artist aged and because he presided over a very large workshop may have delegated

important aspects of a project to his assistants, causing Michelangelo to revise his working methods. Notably, the only large-scale preparatory drawing we have for a Michelangelo fresco is for a group of figures in the very late Pauline Chapel fresco of *The Crucifixion of St. Peter*, completed in 1545 when the artist was 70. Bambach (1999, 548) believes this fragment is “more statically descriptive” than earlier drawings by the artist, concluding that “executed largely with the help of an assistant or assistants, the Pauline Chapel frescoes were among the least appreciated of Michelangelo’s paintings.”

The almost anachronistic approach Michelangelo demonstrates in the *St. Peter* cartoon may also owe something to Michelangelo’s training in Ghirlandaio’s workshop. Ames-Lewis (1981) describes Ghirlandaio as conservative in the training of his apprentices. Ghirlandaio was known to have carefully planned his paintings through preparatory drawings; this meticulous approach was joined to the artist’s habit of basing his compositional ideas “on traditional compositions or types, reorganized to include ‘patterns’ themselves derived from inventions of the mid-fifteenth century” (169). The effect of Ghirlandaio’s reliance on varying patterns of types on Michelangelo may be felt in the figures on Sistine ceiling, which, as Martin Kemp (Kemp 1981, 336) aptly observes, “all tended to come from the same Herculean mould, whether Adam and Eve, or Jonah and the aged Cumaean Sybil.”

The evidence, in summary, of Michelangelo’s life cycle and various aspects of his creative behavior suggest a moderate experimental artist, constrained by training and, because of the physical nature of his projects, by the

need to delegate tasks to others, especially as he grew older. As a painter, Michelangelo experienced less freedom to revise in his later fresco work, and, except in the execution of individual figures and groups, exhibited less innovation in composition and an increasing reliance of what had become by the mid-16th century outworn methods for fresco painting.

**

Technical examination and what we know of the respective behavior of the artists surveyed here confirm the expectations of Galenson's life cycle profiles for conceptual artists such as Vermeer, Holbein, and Raphael, as well as the life cycle profiles for experimental artists such as Rembrandt, Leonardo, and Titian. Michelangelo stands somewhere in between as a moderate experimental artist.

Optics

It would be consistent within their life cycles and related artistic behavior for painters such as Holbein, Caravaggio, and Vermeer to have used optics. But many other factors might contribute to or inhibit the adoption of such methods. An artist such as Masaccio might have taken advantage of such tools if they were known to him and if they gave him the ability to carry out a task more efficiently and more effectively than other means. Yet early 15th-century Italian artists were constrained by their media and the sites in which they worked. Church walls usually had very poor lighting and required scaffolding to reach them, which, it has been argued, already limited the use of *sinopia* underdrawing as a means of developing compositional ideas directly on the wall. One simply could not stand back and judge the development of a painting's composition while working

directly on the wall. Ames-Lewis (1981) believes that it was precisely this limitation that encouraged the development of the preparatory cartoon in 15th-century Central Italy. So, if optics were to have been used by Masaccio, it would only have been to help make the preparatory drawing prior to its transfer—none of which, as I have noted, survive. What we are able to say is that Central Italian fresco painters, backed by Alberti's theoretical strictures, were used to employing semi-mechanical techniques to transfer visual information to the wall. Choosing between a grid viewing system and a mirror-based system is a matter of opportunity and relevance of the technology to the task at hand. It does not represent a fundamental shift in the conceptual approach to painting.

At the other end of the life cycle spectrum, extreme experimental painters, such as Rembrandt, would have found no advantages from using optics. Rembrandt, of course, worked with mirrors all his life in order to generate his extraordinary series of self-portraits. But his approach was never to transfer visual information mechanically, which is why his drawings, prints, and paintings have autonomous roles within his *oeuvre*. Titian, whose working methods as he grew older closely resembles Rembrandt's (and indirectly inspired Rembrandt's own), worked in his youth in an environment dominated by a strong conceptual artist, Giorgione, and a workshop tradition favoring the use of preparatory drawings. So, just as early in his career Titian might have resorted to preparatory drawings it is also possible that he might have availed himself of optics, especially for portrait work. As the artist matured, such drawings disappear and

we should expect a similar disinterest in optics, as such a device that had little relevance to the kind of paintings he later made.

An even clearer example of an artist who in his youth may well have used optics but whose life cycle is clearly indicative of an experimental artist is Diego Velázquez. Throughout *Secret Knowledge*, Hockney (2001, 170) proposes Velázquez as a frequent user of optics, noting, for example, the value of optics for creating copies, citing as an example the nearly exact copy made after Velázquez's *Waterseller* (Contini-Bonacossi Collection, Florence). With one exception, all the paintings Hockney uses as evidence date prior to the artist's first visit to Italy in 1629, before he first came under the influence of Titian and the other Venetian painters. When he painted the original *Waterseller* (Apsley House, London) in 1619 the artist was only 20 and much under the influence of Caravaggio. In fact, the art historians Gridley McKim-Smith, Greta Andersen-Bergdoll, and Richard Newman (1988, 34) suggest that "In technical terms... Velázquez's earliest works remain competent but unexceptional examples of European painting of the first quarter of the seventeenth century." As Table 2 and Table 3 indicate, the most frequently reproduced work come later in Velázquez's career, most notably *Las Meninas* (Prado, Madrid), painted in 1656 when the artist was 57. How much would Velázquez have relied on optics to create the originals?

After seeing Titian and the other Venetian painters' work, Velázquez abandoned the "precise division of light and shade and the clear outlines of his Seville period" in favor of "a new fluency and richness"(Janson 2001, 571).

These changes in the appearance of Velázquez' paintings correspond to a fundamental change in his technique. McKim-Smith and her colleagues (1988, 39) argue, "Velázquez's pentimenti... have noticeable similarities to those of the Venetians, who also were famous for overturning the conventions of Central Italian procedures, which required preparatory drawings on paper to fix a composition. The pentimenti of Velázquez and the Venetians, or, more precisely, their habit of drawing directly on the canvas suggest a more subtle rejection of Florentine conventions: that the artists, in fact, did not necessarily both to make preliminary drawings on paper." Technical photographs of works such as the *Rokeby Venus*

indicate that Velázquez mixed strokes of chalk or charcoal among the strands of Venus's painted chestnut hair. Sometimes fragments of underdrawings in chalk, charcoal, or paint applied with a fine brush on the canvas are visible to the naked eye and in infrared photographs, as on Justinus's white cuff in the *Surrender of Breda*, or around the frames of paintings, the door, and windows in *Las Meninas*. At other times one cannot be sure that underdrawings were used to lay out the painting at all, an uncertainty that one encounters in Titian's work, too (ibid., 42).

Technical examination of his late masterpiece *Las Meninas* determined that even though the artist left very few drawings behind, his painting also possess little underdrawing (Stokstad 1999, 778-79). Instead, Velázquez built up his forms in layers of loosely applied paint. It is difficult to imagine the value of optics to the

later Velázquez, since a painting such as *Las Meninas* clearly evolved in appearance as the artist painted it.

So, even if early in his career Velázquez resorted to optics it was to accomplish specific tasks, such as the painting of the globe in his *Democritus*, 1628-29 (Rouen, Musée des Beaux-Arts). As Hockney (2001, 164) observes, “minimum use of optics can still produce maximum effects.” Overall Velázquez’s life cycle suggests, like Titian before him, that while the artist may have begun his career as a moderate conceptualist he took an increasingly experimental approach to painting. The advantages of optics would wither under his changing technical approach. This is not to say that Velázquez was not conscious of the visual effects produced by optical devices—after all, he paints a mirror as a decisive element of *Las Meninas*—but that optics after the late 1620s could no longer provide the artist with the necessary tools related to his manner of painting.

Leonardo’s relation to optics presents a slightly different problem. His intense curiosity and practical knowledge of the elements of a *camera obscura* gave Leonardo both the opportunity and the motive to attempt to create paintings using optics (Kemp, 1981, 325ff.). Hockney (2001, 136) argues especially that the *Mona Lisa* (Louvre, Paris) represented such a notable advance in illusion over earlier portraits by the artist as to suggest that optics may have played a significant role in its creation. Hockney is careful not to claim actual use but merely to suggest that optics could inspire such effects as the painting’s “soft focus.” Until that time when the *Mona Lisa* is again subject to a technical

examination with such problems in mind, this question cannot be resolved. But if we consider Martin Kemp's assertion that Leonardo despised the idea of "purely internal creativity—"beginning and ending in the mind"" we have an artist acutely sensitive to the need to resist pictorial conventions and to develop, in the act of observation, the visual image (Kemp, 1981, 336). This is not the sort of artist to delight in semi-mechanical image transfers. Moreover, according to Kemp, Leonardo's involvement with optics came late in life and affected his confidence in such planning methods as linear perspective, weakening, not strengthening his belief in mechanical methods for recording visual information. Some of Leonardo's most fascinating late drawings are of subjects that by nature resist depiction, such as storms and the torrents of water.

**

Overall, regarding the question of the use of optics in the early 15th century, if there is a basis for Hockney's contention, we should consider that two kinds of replication technology were devised at approximately the same time, around 1430, one in Italy and one in the north. In Flanders, it may well have been that the old technology of the oil medium became suddenly conjoined with the use of mirrors to create images of startling veracity. In the south, the discovery of linear perspective by Brunelleschi, put immediately into practice by Masaccio in painting and Donatello in sculpture, became a way not only to map precisely an illusionistic space on a two-dimensional surface, but it also to create a veil "lens" system to transfer precisely what the artist saw through the grid onto paper and panel and even to translate this information into properly scaled "blow ups" for

use in frescoes. The attractiveness to Italian artists of a mirror-based optics would have been increased with a corresponding knowledge of oil technique. This would account for the widespread dissemination and imitation of Flemish-style optical realism in Italy only well after the mid-15th century.

Predicting Artistic Behavior

Discussing the relationship between Velázquez and the Venetians, Titian and Tintoretto, McKim-Smith, et al. (1988, 46) conclude “If a very general comment about Velázquez’s relationship to Venice can be made at all, it is that he shared with the painters of that city a predilection for, or habit of, spontaneity in the fabrication of a canvas. Predilections can be inborn and habits can be learned, and Velázquez’s readiness to respond to the Venetians’ legacy may be a quality that defies more exact historical elucidation.” What the authors lacked was the tools for distinguishing habit from predilections, and, moreover, understanding how predilections can be used to predict patterns of artistic behavior with notable consistency.

Let me conclude by looking briefly at another artist, so far no more than touched upon in the discussions above: Michelangelo Merisi da Caravaggio—born in 1571 and dead at the age of 39 in 1610. Could we anticipate whether Caravaggio was likely to have used optics? We know that he exhibits some prominent characteristics of a conceptual artist. From my textbook study we know that Caravaggio painted his two most frequently reproduced paintings by the age of 31 (see Table 2) and that at least half the illustrations of Caravaggio’s paintings in the textbooks come from a three year period (see Table 3), between

the ages of 29 and 31, that is, between 1599 and 1601. Conceptual artists carefully plan their work yet we know that Caravaggio did not leave a significant body of drawings behind him.

To get the additional evidence we need we can turn to the technical examination of his pictures. Here we discover, for example, that at least on one occasion Caravaggio mechanically transferred the composition of one painting, *The Lute Player* (Hermitage, St. Petersburg), onto another, subsequently modifying the second version (Christiansen, 28-39). There is yet a third close copy attributed to another artist. This sort of replication of course resembles that found in Holbein's work. It obviously suggests the use of some instrument for the precise translation of one painting into another. With no surviving preparatory drawings, how did Caravaggio think up his ideas and how did he transfer them to canvas? Would not an optical projection enable the artist to lay out his paintings precisely. Certain technical examinations also have shown that Caravaggio almost never revised in any significant extent the initial underpainting of his canvases. The position of bodies and objects, as well as the contours of forms, remain virtually identical with the underpainting.²

Taken together, these clues indicate that we are concerned with an artist who used at least some kind of mechanical device in the creation of his pictures and that none of the evidence from the technical examination of Caravaggio's paintings rules out the use of the sort of optics described by Hockney. I admit to

² See, for example, the technical photographs reprinted in *The Age of Caravaggio*, exhibition catalogue (New York: Metropolitan Museum of Art, 1985), 223, 231, 239, 243, 253, 259, and 273.

the simplicity of this way of treating the evidence regarding Caravaggio's life and work. But if Hockney's assertions about Caravaggio are correct, then one has to admit the explanatory coherence of Galenson's thesis and the potential value of artists' life cycles and the creative behaviors associated with them in guiding research. It doesn't always work so neatly. Jan van Eyck, for example, appears as an excellent candidate to have used an optical device, yet his age profile suggests an experimental artist, an attitude seemingly confirmed by the many changes technical examinations have revealed in the execution of his works (Reynolds 2000, 3). But even in the study of van Eyck's work, Galenson's life cycle model provides a new way of thinking about the artist's working methods and about how optics might have been integrated into them. These are the sorts of questions Galenson's work is able to pose and through the study of an artist life cycle the kinds of new questions that are opened for art historical investigation.

Table 1. Painters Most Frequently Reproduced in 28 European and American Survey Textbooks

Rank	Artist	Number of Illustrations	Rank	Artist	Number of Illustrations
1	Raphael (1483-1520)	140	8	Masaccio (1401-1428)	74
2	Titian (1488/90-1576)	136	9	Vermeer (1632-1675)	55
3	Rembrandt van Rijn (1606-1669)	115	10	Michelangelo (1475-1564)	53
4	Velázquez (1599-1660)	101	11	Giorgione (1478-1510)	51
5	Caravaggio (1571-1610)	96	12	Hals, Frans (1580/85-1666)	50
6	Leonardo da Vinci (1452-1519)	84	13	Holbein the Younger, Hans (1497-1543)	49
7	Eyck, Jan van (ca. 1390-1441)	78	14	Campin, Robert (? Active 1406-1444)	21

Sources:

- Adams, Laurie Schneider. *Arts Across Time*. London: McGraw-Hill, 1999.
- Annoscia, Enrico and et al. *Arte: storia universale*. Milan: Leonardo Arte, 1997.
- Bertelli, Carlo, Mauro Natale, and Fernando Mazzocca. *Lezioni di storia dell'arte*. Milan: Skira, 2001.
- Cole, Bruce and Adelheid Gealt. *Art of the Western World*. New York: Summit Books, 1989.
- Copplestone, Trewin. *Art in Society*. Englewood Cliffs, N.J.: Prentice-Hall, 1983.
- Fleming, William. *Art and Ideas*, 8th ed. New York: Holt, Rinehart and Winston, 1991.
- Frontisi, Claude, ed. *Histoire visuelle de l'art*. Paris: Larousse, 2001.
- Gebhardt, Volker. *Painting: A Concise History*. London: Laurence King, 1998.
- Gombrich, Ernst. *The Story of Art*, 16th ed. Oxford: Phaidon, 1995.
- Gowing, Sir Lawrence, ed. *A History of Art*, rev. ed. Oxford: Andromeda, 1995.
- Hartt, Frederick. *Art: A History of Painting, Sculpture, Architecture*, 4th ed. New York: Prentice-Hall and Harry N. Abrams, 1993.
- Hollingsworth, Mary. *L'Arte nella storia dell'uomo*. Florence: Giunti Barbera, 1989.
- Honour, Hugh and John Fleming. *The Visual Arts: A History*, 5th rev. ed. Englewood Cliffs, N.J.: Prentice-Hall, 2000.
- Janson, H. W. *History of Art*. 6th rev. ed. Englewood Cliffs, N.J.: Prentice-Hall, 2001.
- Kemp, Martin. *The Oxford History of Western Art*. Oxford: Oxford University Press, 2000.
- Kleiner, Fred S., Christian J. Mamiya, and Richard G. Tansley. *Gardner's Art Through the Ages*, 11th ed. Fort Worth, TX: Harcourt College Publishers, 2001.
- Levey, Michael. *A Concise History of Western Painting: From Giotto to Cézanne*. New York: Frederick A. Praeger, 1962.
- Lucie-Smith, Edward. *Art and Civilization*. New York: Harry N. Abrams, 1993.
- Marseille, Jacques, ed. *Les Grands Événements de l'histoire de l'art*. Paris: Larousse, 1993.
- Milicua, José, ed. *Historia universal del arte*. Barcelona: Editorial Planeta, 1988.
- Monterado, Lucas de. *História da arte*. Rio de Janeiro: Livros Técnicos e Científicos, 1978.
- Penck, Stefanie, ed. *Prestel Atlas Bildende Kunst*. Munich, London, and New York: Prestel, 2002.
- Ristori, José María de Azcárate, Alfonso Emilio, Pérez Sánchez, and Juan Antonio Ramirez Dominguez. *Historia del arte*. Madrid: Grupo Anaya, 1990.
- Ohlig, Rudolf and Hildegard Hogen, eds. *Glanz der Residenzen: Renaissance und Barock in Europa; Schwarzafrika und Altamerika*. Leipzig and Mannheim: F. A. Brockhaus, 1998.
- Silver, Larry. *Art in History*. Englewood Cliffs, N.J.: Prentice-Hall, 1993.
- Sproccati, Sandro, ed. *A Guide to Art*. New York: Harry N. Abrams, 1992.
- Stokstad, Marilyn. *Art History*, 2nd ed. Upper Saddle River, N.J.: Prentice-Hall, 2002.
- Wilkins David G. and Bernard Schultz. *Art Past/Art Present*. Englewood Cliffs, N.J.: Prentice-Hall, 1990.

Table 2: Top Thirty Ranking of Paintings by Total Illustrations in 28 American and European Art History Survey Textbooks

Rank	Illustrations	Artist, Title	Date*	Artist's Age*
1	26	Van Eyck, <i>Arnolfini Double Portrait</i>	1434	ca. 44
2(t)	24	Michelangelo, <i>Sistine Ceiling</i>	1512	37
2(t)	24	Masaccio, <i>Tribute Money</i>	ca. 1427	ca. 26
2(t)	24	Raphael, <i>School of Athens</i>	1511	28
2(t)	24	Velázquez, <i>Las Meninas</i>	1656	57
2(t)	24	Leonardo, <i>Last Supper</i>	1498	46
7	23	Van Eyck, <i>Ghent Altarpiece</i>	1432	ca. 42
8	21	Michelangelo, <i>Last Judgment</i>	1541	66
9(t)	20	Masaccio, <i>Holy Trinity with Donors</i>	ca. 1428	ca. 27
9(t)	20	Giorgione, <i>The Tempest</i>	ca. 1508	ca. 30
11(t)	17	Caravaggio, <i>Calling of St. Matthew</i>	ca. 1600	ca. 29
11(t)	17	Leonardo, <i>Mona Lisa</i>	ca. 1506	ca. 54
11(t)	17	Masaccio, <i>Expulsion of Adam and Eve</i>	ca. 1427	ca. 26
11(t)	17	Titian, <i>Pesaro Family Altarpiece</i>	1526	36/38
15	16	Campin, <i>Meroda Altarpiece</i>	ca. 1428	not known
15(t)	16	Titian, <i>Assumption of the Virgin</i>	1518	28/30
17	15	Leonardo, <i>Virgin of the Rocks (Paris)</i>	ca. 1486	ca. 34
18(t)	13	Titian, <i>Venus of Urbino</i>	1538	48/50
18(t)	13	Rembrandt, <i>Night Watch</i>	1642	36
18(t)	13	Rembrandt, <i>Anatomy Lesson of Dr. Tulp</i>	1632	26
23(t)	13	Raphael, <i>Leo X with Two Cardinals</i>	ca. 1518	ca. 35
20(t)	12	Holbein, <i>The French Ambassadors</i>	1533	36
20(t)	12	Velázquez, <i>Surrender at Breda</i>	1635	36
23(t)	11	Van Eyck, <i>Chancellor Rolin</i>	ca. 1518	ca. 46
23(t)	11	Velázquez, <i>Water Carrier of Seville</i>	ca. 1619	20
23(t)	10	Caravaggio, <i>Conversion of St. Paul</i>	ca. 1601	ca. 30
27(t)	10	Hals, <i>Regentesses of Old Men's Home</i>	ca. 1664	79/84
27(t)	10	Vermeer, <i>View of Delft</i>	ca. 1661	ca. 29
27(7)	10	Raphael, <i>Disputà</i>	1511	28
30	9	Leonardo, <i>Virgin and St. Anne (Paris)</i>	1510	58

Table 3: Shortest Periods that Include at Least Half an Artist's Total Illustrations

Artist	Number of years	Artist ages
Campin	1	?
Giorgione	1	32
Masaccio	1	27
Van Eyck	3	42-44
Vermeer	6	28-33
Caravaggio	7	24-30
Holbein	8	27-36
Leonardo	8	46-53
Raphael	9	22-30
Hals	14	35*-48
Velázquez	18	40-57
Rembrandt	20	44-63
Titian	21	28*-48
Michelangelo	32	37-66

*Calculated according to the most recent presumed birth date of the artist.

Works Cited

- Ainsworth, Maryan Wynn. 1982. *Art and autoradiography: insights into the genesis of paintings by Rembrandt, Van Dyck, and Vermeer*. New York: Metropolitan Museum of Art.
- Alberti, Leon Battista. 1991. *On Painting*. Translated by C. Grayson. New York: Penguin.
- Alpers, Svetlana. 1983. *The art of describing: Dutch art in the seventeenth century*. Chicago: University of Chicago Press.
- Ames-Lewis, Francis. 1981. *Drawing in early Renaissance Italy*. New Haven: Yale University Press.
- — —. 1986. *The Draftsman Raphael*. New Haven: Yale University Press.
- Bambach, Carmen. 1999. *Drawing and Painting in the Italian Renaissance Workshop: theory and practice, 1300-1600*. Cambridge and New York: Cambridge University Press.
- Barcilon, Pinin Brambilla. 2001. The Restoration. In *Leonardo: the Last Supper*, edited by P. B. Barcilon and P. C. Marani. Chicago and London: University of Chicago Press.
- Bell, Janis. 1997. Color and Chiaroscuro. In *Raphael's School of Athens*, edited by M. B. Hall. Cambridge: Cambridge University Press.
- Brown, David Alan. 1998. *Leonardo da Vinci: origins of a genius*. New Haven: Yale University Press.
- Buck, Stephanie. 1999. *Hans Holbein*. Cologne: Könemann.
- — —. 2000. An Approach to Looking at Eyckian Drawings. In *Investigating Jan van Eyck*, edited by S. Foister, S. Jones and D. Cool. Turnhout, Belgium: Brepols.
- Campbell, Lorne. 2000. The Arnolfini Double Portrait. In *Investigating Jan van Eyck*, edited by S. Foister, S. Jones and D. Cool. Turnhout, Belgium: Brepols.
- Chiari Moretto Wiel, M. Agnese. 1990. *Titian drawings*. New York: Rizzoli.
- Christiansen, Keith. 1990. *A Caravaggio Rediscovered, the Lute Player*. New York: Metropolitan Museum of Art.
- Colalucci, Gianluigi. 1994. The Technique of the Sistine Ceiling Frescoes. In *The Sistine Chapel: a glorious restoration*, edited by P. d. Vecchi. New York: Harry N. Abrams.
- Galenson, David W. 2001. *Painting Outside the Lines: patterns of creativity in modern art*. Cambridge and London: Harvard University Press.
- — —. 2003. The Life Cycles of Modern Artists: theory, measurement, and implications. Paper read at Measuring Art: A Scientific Revolution in Art History, May 30-June 1, at Paris.
- Galenson, David W. and Robert Jensen. 2001. Young Geniuses and Old Masters: the life cycles of great artists from Masaccio to Jasper Johns. *Working Paper Series* (no. 8368).

- Gaskell, Ivan Michiel Jonker, eds. 1998. *Vermeer Studies*. Washington and New Haven: National Gallery of Art and Yale University Press.
- Gifford, E. Melanie. 1998. Painting Light: Recent Observations on Vermeer's Technique. In *Vermeer Studies*, edited by I. Gaskell and M. Jonker. Washington: National Gallery of Art.
- — —. 2000. Assessing the Evolution of van Eyck's Iconography through Technical Study of the Washington Annunciation, I. In *Investigating Jan van Eyck*, edited by S. Foister, S. Jones and D. Cool. Turnhout, Belgium: Brepols.
- Gombrich, E. H. 1996. Leonardo's Method for Working out Compositions. In *The Essential Gombrich : selected writings on art and culture*, edited by R. Woodfield. London: Phaidon Press.
- Gowing, Lawrence. 1970. *Vermeer*. 2nd ed. London: Faber.
- Hockney, David. 2001. *Secret knowledge: rediscovering the last techniques of the old masters*. New York: Viking Studio.
- Janson, H. W. 2001. *History of Art*. 6th ed. Englewood Cliffs, N. J.: Prentice-Hall.
- Kemp, Martin. 1981. *Leonardo da Vinci: the marvelous works of nature and man*. Cambridge, Mass.: Harvard University Press.
- Kris, Ernst Otto Kurz. 1979. *Legend, Myth, and Magic in the Image of the Artist*. New Haven and London: Yale University Press.
- Liedtke, Walter. 2000. Vermeer Teaches Himself. In *The Cambridge Companion to Vermeer*, edited by W. E. Franits. Cambridge: Cambridge University Press.
- Marani, Pietro C. 2001. Leonardo's Last Supper. In *Leonardo: the Last Supper*, edited by P. C. Marani and P. B. Barcilon. Chicago: University of Chicago Press.
- McKim-Smith, Gridley, Greta Andersen-Bergdoll, and Richard Newman. 1988. *Examining Velázquez*. New Haven and London: Yale University Press.
- Oberhuber, Konrad Lamberto Vitali. 1972. *Il cartone per la "Scuola d'Athene"*. Milan: Silvana Editoriale d'Arte.
- Puttfarken, Thomas. 2000. *Discovery of Pictorial Composition: theories of visual order in painting, 1400-1800*. London: Yale University Press.
- Reynolds, Catherine. 2000. The King of Painters. In *Investigating Jan van Eyck*, edited by S. Foister, S. Jones and D. Cool. Turnhout, Belgium: Brepols.
- Rosand, David. 1990. Titian and Pictorial Space. In *Titian: prince of painters*, edited by S. Biadene and M. Yakush. Munich and New York: Prestel.
- — —. 1993. So-And-So Reclining on Her Couch. In *Titian 500*, edited by J. Manca. Washington: National Gallery of Art.
- Rowlands, John. 1985. *Holbein*. Oxford: Phaidon Press.
- Steadman, Philip. 2001. *Vermeer's camera: uncovering the truth behind the masterpieces*. Oxford: Oxford University Press.

- Stokstad, Marilyn. 1999. *Art History*. Revised ed. New York: Harry N. Abrams.
- Thürlemann, Felix. 2002. *Robert Campin: a monographic study with critical catalogue*. Translated by I. Flett. Munich and New York: Prestel.
- Van de Wetering, Ernst. 1997. *Rembrandt: the painter at work*. Amsterdam: Amsterdam University Press.
- Vasari, Giorgio. 1965. *Lives of the Artists*. Translated by G. Bull. Harmondsworth: Penguin.
- Wheelock, Arthur K. 2000. Vermeer's Craft and Artistry. In *The Cambridge Companion to Vermeer*, edited by W. E. Franits. Cambridge: Cambridge