Approaching the New Millennium:
Society, Technology, and the Individual's Imprint

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While it seems that in the final analysis it is the dialogue an artist has with his or her medium that determines the quality of the result, this dialogue is nonetheless informed by peers and cultural influences. Perhaps this is why the question of what art is looms large as we look at the diverse ways people create and innovate. This paper grapples with this question of what art is by examining how science, society, technology and the individual's imprint intertwine as we approach the new millennium. Probing innovative art and science of various eras, particular attention will be given to how the avalanche of technologically-based representational tools of the twentieth century have called into question (1) the way we see, (2) the way we acquire knowledge, (3) the way we understand both knowledge and seeing, and (4) what art created using technology is.

Framing the issues

To say the least, the relationship of technology to art and science is a complex one, as is the relationship of art practice to perceptions of knowledge and seeing. While there are significant exceptions to this, discussions that explore all of these relationships invariably give minimal attention to two areas of interest to this investigation. First, while cultural context has increasingly become a part of analyses of art, how changes in scientific knowledge inform both the social nexus and artistic production have not fully been integrated into cultural studies of art. [1] Likewise, studies of the ongoing impact of technological innovations interweaving science, art, and culture have given minimal attention to how various time periods compare, often giving historical discussions the incorrect appearance that art evolves in a linear fashion.

Photography, for example, is inaccurately represented when defined simply as a 19th century technology that offered a means to permanently render images of nature, images that had previously only been stabilized by using the combined skills of the hand and eye. Even using the word photography obscures that many processes comprised the burgeoning technology, which was known by many names when it was first discovered. Terms like photogenic drawing, [2] daguerreotype, [3] and calotype, [4] designated particular variations in the basic process of fixing the image, increasingly on the ground glass of a camera obscura (see Newhall, 1982; Trachtenberg, 1989). What is key within this is that when the term photography was chosen (in 1855) it simplified the vocabulary, but not the contradictory responses people brought to this new medium.

One view was that fixing the picture with the camera was a mechanical activity that could free the eye to concentrate on composition and style (Newhall, 1982; Trachtenberg, 1989). This emphasis on the mechanical inferred that photographs were secondary to hand-made pictures, the rationale being a mechanical image did not embody the kind of artistry that dissolves into brushstrokes or pencil lines (Newhall, 1982; Trachtenberg, 1989). In other words, those who expressed a mechanistic point of view noticed that some skills could be transferred to an inanimate apparatus and concluded these skills were not as valuable as some less easily definable aspect an individual imprinted.

Photographers themselves illustrated there was much this mechanistic view did not address. For example, Carelton Watkins' artistry is apparent when we are looking up among the sugar pines in his 1878 photograph by that name. Julia Margaret Cameron demonstrates a quite different approach. Photographs like her striking print of Sir John Herschel show she avoided the perfect resolution and minute detail that glass negatives permitted, opting instead for carefully directed light, soft focus, and long exposures (counted in minutes when others did all they could to reduce exposure to a matter of seconds.) (Daniel, 1999). We can also find examples of extraordinary work such as a 1839 engraving of Christ's head superimposed on an oak leaf, a photogenic drawing.

These artistically informed examples show that photographers often produced sophisticated images that included state of the art science, state of the art technology, and an ever-expanding understanding of method. Still, perhaps the best examples of this convergence of art, science, and technology are photographs recorded with stereo cameras to register two slightly different images, the two lenses acting like two eyes. These recordings were then merged in printing or were printed as stereograms, which could be merged with the use of a stereoscope. When viewed through the stereoscope the images seemed to have a three-dimensional quality, one that resulted from how the technology fused the two side-by-side images into one. The depth the fusion adds is a function of the slight difference between the two images. What makes the stereograms and stereo cameras noteworthy here is that the technology mirrors the nineteenth century formulation of the idea of binocular vision, a scientific idea put forth by Sir David Brewster (1781-1868) and Sir Charles Wheatstone (1820-1875) in that century. Simply put, this scientific theory explained that we see differently out of each eye and the stereo cameras recorded the world as both eyes view it.

Photographers often crafted both stereo and single images. For example, Carleton Watkins printed *Victoria Regia* in 1878, a stereogram that is formal and quite modern in its aesthetic. His "Washington Column" (ca. 1872) is a single view, and a more naturalistic image. Maria Morris Hambourg explains Watkin's overall aesthetic sensitivity when she writes:

In landscape, as in human life, meaning lies less in objects than in relations, the links that tie specific incidents and entities together as an event or a place. In grasping myriad related connections and recording them photographically, Watkins created an intelligible world that maps and illustrates mental activity, mimicking the skeins of meaning our perceptions generate. His photographs awaken us to the exquisite pleasure of active seeing, inducing that conscious visual alertness we experience when viewing landscapes by CŽzanne, for example. Only here the artist's mental calculations are not laid down in painted strokes. They merge diaphanously with the trees and dissolve on the surface of the objective world. (Hambourg, 1999, p. 16)

Hambourg continues:

Looking at the photograph, we think we see the true structure of nature, its orderly scaffolding and superb textures merely disclosed; it takes real imaginative effort to recognize that no things in the picture nor the relations between them were self-evident. Everything -- the slant of a shadow on fresh clapboards, the depth of the darkness in cracks in pine bark, the silkiness of slightly shimmering water -- is the delicate trace of the artist's considered attention. (Hambourg, 1999, p. 16)

The art historian Jonathan Crary adds another dimension when he proposes that we understand both avant-garde art and nineteenth century photography as 'overlapping components of a single social surface on which the modernization of 'vision' was everywhere taking place. This is to say that the development of both photography and modernist painting can be seen as parallel symptoms of a larger, more fundamental transformation occurring within Western culture, one already well under way by the middle of the nineteenth century (see Crary, 1992; Nickel, 1999).

Before relating how the sentiment Crary expresses applies to the impact of the computer on art and science as we approach the new millennium, it should be noted that we can likewise find this marriage between art, science, and technology when we look backwards and probe the invention of oil paint and perspective (Ione, 1999a; Ione, 1999b). Oil paint and perspective, like the computer and the camera, challenged long-standing ideas about representation, perception, and seeing. This is important to note since the complexity of the situation at the time artists were first developing oil technology and perspective is inadequately addressed if our chronology fails to consider the difference between binocular and monocular models.

It is not just that linear perspective is a monocular system, rather than a binocular one, which means it adopts a one-eye point of view where the main focus is the primary vanishing point. Of equal importance is that oil paint and the perspectival system quickly merged and compensated one another when artists created representations. This is an important point, one I will return to after briefly introducing some twentieth century innovations that further speak to binocularity.

Analog and digital perspectives

Autostereograms are useful in expanding the understanding of binocularity. These computer-generated images are most commonly done as random dot patterns and well known due to the popularity of the "Magic Eyes" of a few years ago Their charm is that an embedded image can be discovered when the pattern is fused by the brain. The difference between the discovery of the autostereogram and the nineteenth century photographic stereograms discussed above speaks to the kind of active seeing Hambourg mentions when commenting on the exceptional visual quality in Watkin's work. In the case of the autostereogram, however, the task requiring active seeing takes another form.

With the autostereogram the viewer must fuse the representation experientially to see an embedded image -- and thus *cannot be* a passive viewer. As Christopher Tyler, the inventor of the autostereogram, explains, "the information from each eye has to be connected so as to provide a fused representation in the brain of a single region in space." (Tyler, 1991, p. 38).

The key point here is that patience is generally required to 'see' the image embedded in the random dot pattern1[5] since the embedded image can only be seen when each eye addresses the pattern separately, sends the information to the brain, and has the brain construct a means for one to visualize the image we then see.

This is why, essentially, the image is unlike a Gestalt image, where one can perceive the pattern in more than one way (two faces or a vase, for example). The difference is that the flat autostereogram actually does not contain an image. Different densities of texture have been computed using data from scientific studies on how we see and this data allows the designer to derive patterns that *only* converge when each eye addresses the pattern separately. In other words, while the random dot stereogram (RDS) was designed to eliminate all monocular depth cues the one that remains, which is easily overlooked, is the textural density. While the RDS appears to be uniform and seems to indicate that no depth changes are occurring across the surface of the stereogram, in order to perceive the stereoscopic information appropriately the visual system must conclude that the texture densities on the nearer surfaces are finer than on the further surfaces. This is how the 3-dimensional image can be identified (Tyler, 1991).2[6]

The evidence of the eye/brain relationship revealed by the autostereogram is one of the most revolutionary aspects of the random-dot stereogram and the beauty of the discovery was that it empirically explained that neither eye alone can perceive the form because neither eye alone *contains* the stereoscopic form. Interestingly enough, the autostereogram also underlined a limitation of a long-standing academic technique in art education, at least in the West. Teaching students to draw what one sees has long included the exercise of closing one eye and pointing a finger to help define forms and relationships. This has been a common exercise despite the fact that we can easily see that we don't see this way at all. The simple experiment that offers us this knowledge only requires an individual point a finger at a spot with one eye closed. Then open the closed eye and close the open one without moving the finger. The viewer quickly sees the finger is no longer pointing at the original spot. Likewise, with the autostereogram, we find that closing either eye does nothing to clarify the hidden result. It is only our eventual perception of the embedded image that indicates that we do not see the form per se with our eyes superficially. Again, it is impossible to fake the perception for it is our brains that create the fused representation we eventually see when we fuse the slightly different strips that were used to create the random dot pattern (Tyler, 1991, p. 41).

Of course, the autostereogram is only one example of how an image can be composed using computers. I have introduced it basically to explain that both photographic and computer-generated stereograms exist. What needs to be added to this is that while both the photographic and computer-generated stereograms can be converged by fusing the two eyes, they are also contextually different. A key difference I want to turn to next is that one

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[5] Tyler points out that one must dissociate convergence (coming together from different directions) and accommodation (the reconciliation of opposing views) to do this (Tyler, 1991), the point being that each eye must look independently of the other.

[6] An interesting and related element that Tyler also notes is that to demonstrate depth perception unambiguously one must ask the observer whether the cyclopean figure appears in front or behind the surround for a series of different stereograms, rather than merely asking what form is visible (Tyler, 1991)

is an analog image and the other digital. The basic technical distinction is that an analog image is continuous and digital representation is comprised of discrete elements.3[7] As such, a photograph is defined as an analog representation because it varies continuously both spatially and tonally.

A digital image, on the other hand, is encoded by subdividing the picture plane into pixels4[8] that can be stored in a computer's memory, electronically transmitted, displayed, printed, and manipulated on an ongoing basis. What is key here is that while the resulting digital image is machine generated, it does not have the continuity of color and shape as defined in a photographic image, where details and curves are smoothly interfaced. To the contrary, a digital image offers an approximation of continuity that is mapped by breaking up the components of the image into discrete steps, discrete shapes, discrete colors.

I have diverged to introduce this distinction in order to apply it include paintings in this discussion. Historically paintings have been seen as handmade, not mechanically informed images. What is intriguing about this is that digital pixels can reproduce a painting and we have more than one option here. In other words, scanning, the obvious approach to replication is only one approach to duplicating the image. We can also re-create using computer algorithms. Stylistic elements surrounding a re-created image, however, are more complex.

Jan van Eyck's Arnolfini Double Portrait will be used to explain how to digitally produce a painted image (see Mitchell, 1992). Briefly, replicating the character of the representational scenes includes re-defining the complex combinations of diffuse and spectular effects we find in the double portrait. In the painting we see the faces and figures of Giovanni Arnolfini and Giovanna Cenami are gently modeled by a flood of light from the top left so that every nuance of surface curvature is brought out -- particularly on Giovanna's swelling body as she stares into the light. We also see soft shadows on the floor plane, a diffuse wash of window light across the plane of the wall behind them, and an interior space unified by careful attention to the subtleties of diffuse interreflection. There is also a sharply defined patch of luminous sky visible through the window. In addition, a striking feature is the central axis dividing man and wife that is occupied by specular effects: metallic highlights on the candleholder, distorted reflections on the convex mirror, the smooth glossiness of outstretched palms, and the wiry, shiny coat of the little terrier.

According to Mitchell, this kind of scene can be rendered effectively (and at considerable computational expense) by a two-pass process. One would use radiosity5[9] to divide the

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[7] William J. Mitchell's book *The reconfigured eye: visual truth in the post-photographic era* has an excellent discussion on this distinction. Many of the ideas discussed in this section draw on Mitchell's work (Mitchell, 1992)

[8] The pixels are markings on a finite Cartesian grid of cells. Color and shape are defined by specific assignment and a resulting two-dimensional array of integers (the raster grid) results.

[9] The radiosity procedures begin by dividing the surfaces in the scene, rather than the picture plane, into small discrete elements independent of observer position. The method assumes that light energy is conserved in a closed environment and an attempt is made to account accurately for the way in which light emitted or reflected from each surface element is reflected from or absorbed by other surface elements. For complex scenes computation of the form factors is a massive task. In nondiffuse environments, however,

surface in the scene independent of the observer position and thus compute diffuse effects in the Arnolfini Double Portrait. Ray tracing10] would be the procedure used to create an adequate perspective by matching shapes and colors on the picture plane to compute the specular effects. Summing the results of these two procedures produces the final image, a digital version of the painter's strategy of employing a multipass process. In other words, the painter might include the underpainting, scumbling, glazing, and so on. (Mitchell, 1992, p. 156-158)

The questions of whether the computer image can be as robust an image and whether the image is art are complicated ones this paper will not address directly. This example has been introduced largely to offer a means to show Renaissance ideas about mathematical perspective are like a digital framework and the invention of oil paint added an analog-like quality. One could say that perspective was the ray tracing and oil provided the radiosity.

Conclusion

In conclusion, both the technological innovations and the philosophical ideas introduced in this paper explain why a broader schemata of what art is is needed as we consider how society, science, technology, and the individual's imprint will converge in the next millennium. The vast array and pluralistic nature of the art now being produced likewise illustrates that representation per se is generally not an artistic goal today. Even in the West, the problems that excite contemporary working artists tend to turn away from realistic representation and perspectivally based compositions. This deviation from classical Western models is often represented visually itself.

This was the case with Tony Oursler's 1996 installation at Metro Pictures in New York City [11] (see Cotter, 1996). The exhibition explored some of the dynamics we relate to seeing. Projecting color video eyes onto thirteen painted fiberglass globes with an accompanying soundtrack this close-up scrutiny of the human eyeball led the art critic Holland Cotter to say that while the art commanded attention, still

The eyes in his installation are anxious or dull or entranced, but in almost every case the stimulant they're reacting to is artificial. . . . And as to the notion of the eye as the window of the soul: does the weeping eye in the corner belong to a friend in distress or to an actor trained to cry on cue? It is impossible to tell. (Cotter, 1996, p. 95)

This artificial and less than distinct sense of reality in effect excludes key aspects of human experience. In scientific terms, one element that is not referenced is that behind the reflective surface of an individual's, as well as an artist's eyeball there is a brain that is making sense of the perceptions the eye has, more or less, as explained earlier when the autostereogram and Watkins photographs were introduced to distinguish seeing superficially from active seeing. In other words, for all intents and purposes, the eyeball is a camera obscura, admitting light in and allowing none to escape. The outer surface of the cornea, as such reflects a small portion of light, most of which it otherwise transmits to the

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radiosity calculations become much more complex and time-consuming to carry out because the energy-balance equations become more complicated when directional reflection must be considered and partly because smaller surface patches must be used to achieve satisfactory results. (Mitchell, 1992) interior of the eyeball. The cornea betrays its presence by the highlight which gleams on its domed surface, as artists have long shown. So when a Renaissance artist, for example, placed a window on a person's eye this image -- often viewed as a metaphor for the window to the soul -- not only provided a highlight that permitted us, as viewers, to see there was a window in the room, the reflection also indicated there was light hitting the otherwise invisible dome of the glistening cornea in the painted eye. (Miller, 1998)

This is not to say that Oursler's eye, complete with reflection, does not present a perceptive artistic display or that Cotter's reference to an inner person conveyed by the metaphorical idea of the eye as a window to the soul is misplaced. Rather the addition of science adds an element that is frequently understated -- or philosophically stated -- in artistic statements, despite being closely related to how constructed representations and active perception differ and interpenetrate as we see, view, and create art (Riding, 1999). Likewise the eclectic artifacts of our world show individuals stamp their imprint on what they create continuously. In sum, the creations of all of us -- be we artists or scientists -- and our interpretations of creation will seed the temper of the new millennium.

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