



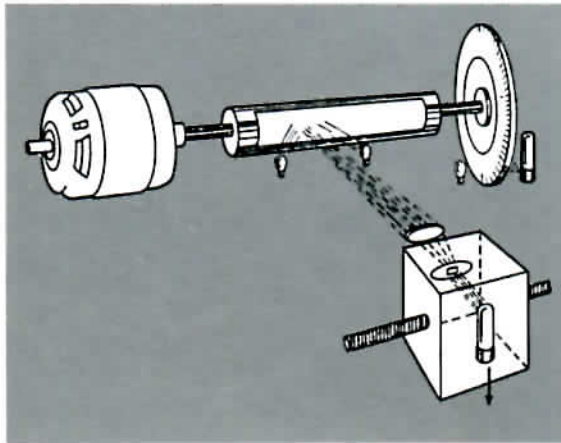
1.1 Tracing an image by hand: Karl Friedrich Schinkel,
The Invention of Drawing, 1830. Von-der-Heydt-
Museum, Wuppertal.

■ Three Snapshots

Pliny the Elder tells a mythic tale: a Corinthian maiden traces the shadow of her departing lover.¹ An image is captured by the work of her hand: painting is born (figure 1.1).²

William Henry Fox Talbot traces a scene at Lake Como with the help of a camera obscura. He begins to wonder “if it were possible to cause these natural images to imprint themselves durably.” By 1839 he has perfected the art of chemically fixing a shadow. He announces to the Royal Society his invention of a way to record images permanently on specially treated paper “by the agency of light alone, without any aid whatever from the artist’s pencil.”³ Simultaneously, Daguerreotypes make their public appearance in France. The history painter Paul Delaroche exclaims, “From this day on, painting is dead.”⁴

Scientist Russell A. Kirsch and his colleagues, working at the National Bureau of Standards in the mid-1950s, construct a simple mechanical drum scanner and use it to trace variations in intensity over the surfaces of photographs (figure 1.2).⁵ They convert the resulting photomultiplier signals into arrays of 176 by 176 binary digits, feed them to a SEAC 1500-word memory computer, and program the SEAC to extract line drawings, count objects, recognize characters, and produce oscilloscope displays (figure 1.3). Patterns of light and shade become electronically processable digital information; an early computer supplants the artist’s recording hand.



1.2 Tracing an image electronically: scanner constructed by Russell A. Kirsch and his colleagues at the National Bureau of Standards in the 1950s.



1.3 One of the first digital images: this picture was scanned from a photograph by the NBS mechanical drum scanner, processed by the SEAC computer, and displayed on an oscilloscope.

The Raster Grid

We might, of course, choose to regard the digitally encoded, computer-processable image as simply a new, nonchemical form of photograph or as single-frame video, just as the automobile was initially seen as a horseless carriage and radio as wireless telegraphy. Indeed the terms “electronic photography,” “still video,” and “digital camera” have rapidly gained currency. But such metaphors obscure the importance of this new information format and its far-reaching consequences for our visual culture. Although a digital image may look just like a photograph when it is published in a newspaper, it actually differs as profoundly from a traditional photograph as does a photograph from a painting. The difference is grounded in fundamental physical characteristics that have logical and cultural consequences.

The basic technical distinction between analog (continuous) and digital (discrete) representations is crucial here. Rolling down a ramp is continuous motion, but walking down stairs is a sequence of discrete steps—so you can count the number of steps, but not the number of levels on the ramp. A clock with a spring mechanism that smoothly rotates the hands provides an analog representation of the passage of time, but an electronic watch that displays a succession of numerals provides a digital representation. A mercury thermometer represents temperature variation in analog fashion, by the continuous rise and fall of the column of liquid, but a modern electronic thermometer replaces this with a digital readout.

A photograph is an analog representation of the differentiation of space in a scene: it varies continuously, both spatially and tonally. Edgar Allan Poe shrewdly observed this and noted its significance in his 1840 article “The Daguerreotype”:

If we examine a work of ordinary art, by means of a powerful microscope, all traces of resemblance to nature will disappear—but the closest scrutiny of the photogenic drawing discloses only a more absolute truth, a more perfect identity of aspect with the thing represented. The variations of shade, and the gradations of both linear and aerial perspective, are those of truth itself in the supremeness of its perfection.⁶

A century later, in an essay concerned with identifying the qualities that characterize photography and distinguish it from other art forms, the modernist photographer Edward Weston echoed Poe precisely:

First there is the amazing precision of definition, especially in the recording of fine detail; and second, there is the unbroken sequence of infinitely subtle gradations from black to white. These two characteristics constitute the trademark of the photograph; they pertain to the mechanics of the process and cannot be duplicated by any work of the human hand.⁷

But images are encoded digitally by uniformly subdividing the picture plane into a finite Cartesian grid of cells (known as *pixels*) and specifying the intensity or color of each cell by means of an integer number drawn from some limited range.⁸ The resulting two-dimensional array of integers (the *raster grid*) can be stored in computer memory, transmitted electronically, and interpreted by various devices to produce displays and printed images. In such images, unlike photographs, fine details and smooth curves are approximated to the grid, and continuous tonal gradients are broken up into discrete steps (figure 1.4).



1.4 Enlargement of a digital image: smooth curves and continuous gradients are approximated by discrete pixels.

There is an indefinite amount of information in a continuous-tone photograph, so enlargement usually reveals more detail but yields a fuzzier and grainier picture.⁹ (The plot of Antonioni's *Blow-Up* pivots on the observation that a photographic negative may contain more information than immediately meets the eye. We see David Hemmings, the fashionable photographer, obsessively enlarging parts of his negatives to reveal previously unnoticed details—a face half-concealed in the foliage, a hand holding a gun, and a body on the ground.) A digital image, on the other hand, has precisely limited spatial and tonal resolution and contains a fixed amount of information. Once a digital image is enlarged to the point where its gridded microstructure becomes visible, further enlargement will reveal nothing new: the discrete pixels retain their crisp, square shapes and their original colors, and they simply become more prominent.

The continuous spatial and tonal variation of analog pictures is not exactly replicable, so such images cannot be transmitted or copied without degradation. Photographs of photographs, photocopies of photocopies, and copies of videotapes are always of lower quality than the originals, and copies that are several generations away from an original are typically very poor. But discrete states *can* be replicated precisely, so a digital image that is a thousand generations away from the original is indistinguishable in quality from any one of its progenitors.¹⁰ A digital copy is not a debased descendent but is absolutely indistinguishable from the original.

Digital Image Creation

It follows from the fundamental constitution of the raster grid that, just as the elementary oper-

ation of painting a picture is the brush stroke and the elementary operation of typing a text is the keystroke, the elementary operation of digital imaging is assignment of an integer value to a pixel in order to specify (according to some coding scheme) its tone or color. Complete images are built up by assigning values to all the pixels in the gridded picture plane.

One way to assign pixel values is to employ some sort of sensor array or scanning device (like that constructed by Kirsch and his colleagues) to record intensities in a visual field—to make an exposure with a digital “camera”: this appropriates digital imaging to the tradition of photography. A second way is to employ the cursor of an interactive computer-graphics system to select pixels and assign arbitrarily chosen values to them: this makes digital imaging seem like electronic painting, and indeed computer programs for this purpose are commonly known as “paint” systems. And a third way is to make use of three-dimensional computer-graphics techniques—to calculate values by application of projection and shading procedures to a digital geometric of an object or scene: this extends the tradition of mathematically constructed perspective that began with Brunelleschi and Alberti. The digital image continues but, as we shall see, also redefines these older traditions.

Mutability and Manipulation

Edward Weston also contrasted the workability of a painting with the closure of a photograph. He valued the fragile integrity of a photograph's surface and argued that it inherently resists reworking or manipulation:

The photographic image partakes more of the nature of a mosaic than of a drawing or painting. It contains no *lines* in the painter's sense, but is entirely

Digital Images and the Postmodern Era

The tools of traditional photography were well suited to Strand's and Weston's high-modernist intentions—their quest for a kind of objective truth assured by a quasi-scientific procedure and closed, finished perfection. But (as the culturally attuned will be quick to recognize) we can construe the tools of digital imaging as more felicitously adapted to the diverse projects of our postmodern era.¹³ The intellectual residue of the poststructuralist wave arouses queasiness with Weston's unabashedly totalizing formulations and foments skittishness about hugging a logocentroid quite so closely; a medium that privileges fragmentation, indeterminacy, and heterogeneity and that emphasizes process or performance rather than the finished art object will be seen by many as no bad thing. Protagonists of the institutions of journalism, with their interest in being trusted, of the legal system, with their need for provably reliable evidence, and of science, with their foundational faith in the recording instrument, may well fight hard to maintain the hegemony of the standard photographic image—but others will see the emergence of digital imaging as a welcome opportunity to expose the aporias in photography's construction of the visual world, to deconstruct the very ideas of photographic objectivity and closure, and to resist what has become an increasingly sclerotic pictorial tradition.