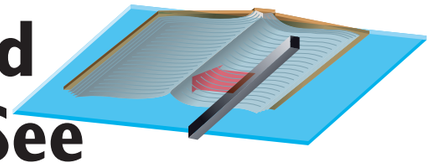
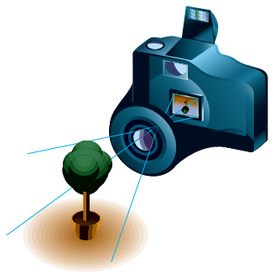
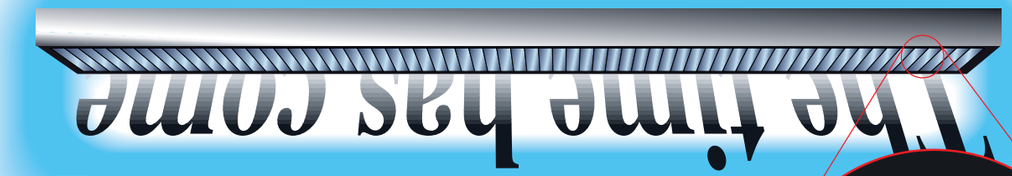
How Scanners and Digital Cameras See

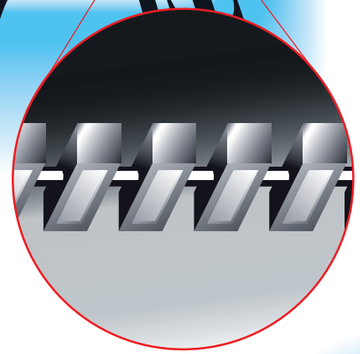


1 The analog-to-digital converter expects to receive a single, continuous stream of electrical current as its analog input. But what if more than one stream of information needs to be recorded at the same time? For example, a scanner that converts hard copy pictures and pages into digital images uses a moving scan head that takes in the entire width of a page in a single pass. A digital camera has even more data to take in at the same time. Not only does it divide light passing through the lens into red, green and blue elements, it must register all the light that falls, at the same moment, on an area the size of two postage stamps.

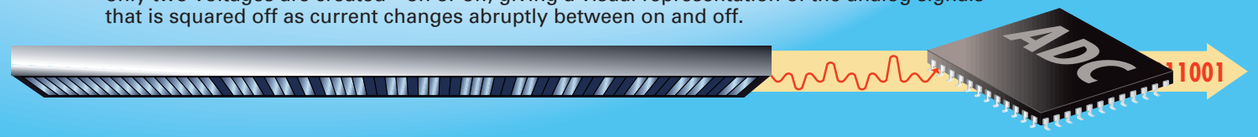




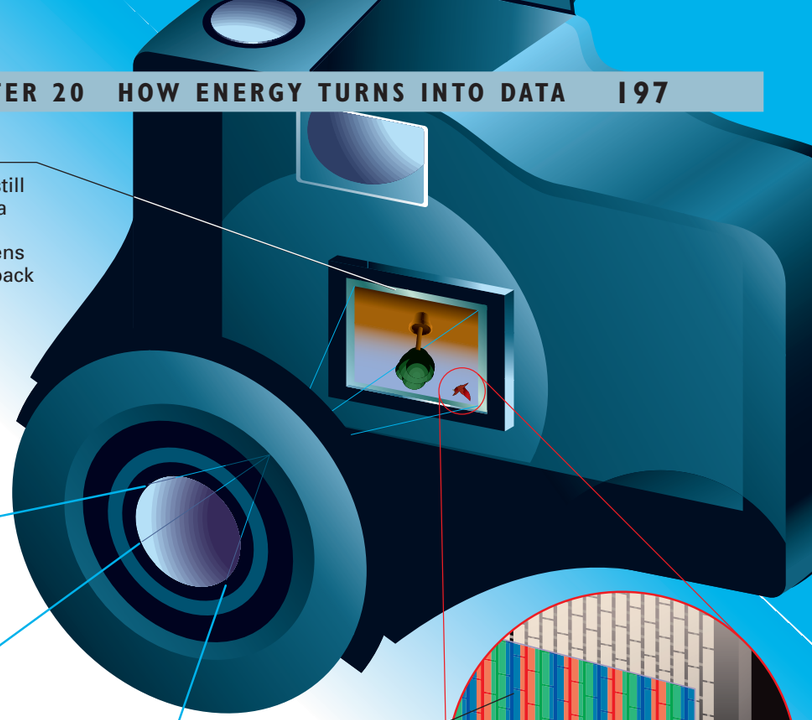
2 Both the scanner and camera, along with dozens of other computer peripherals, solve the problem with a *charge-coupled device* (*CCD*). It is a row of photodiodes connected like beads on a string. When the CCD is exposed to a varied light path, such as that reflected from the page of a book, each photodiode converts the amount light it receives into a corresponding voltage. After the microscopic instant when the diodes register the amount of light each receives, the charge at one end of the string is passed off to a circuit leading to an analog-to-digital converter chip. Instantly, all the charges in the string of diodes move to the diodes next to them in the direction of the ADC.

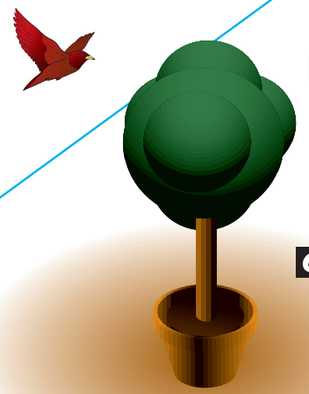


3 The process continues until the last voltage level is carried off as current to the ADC, which converts the voltages to digital values. In this case, because the original image was black and white, only two voltages are created—on or off, giving a visual representation of the analog signals that is squared off as current changes abruptly between on and off.

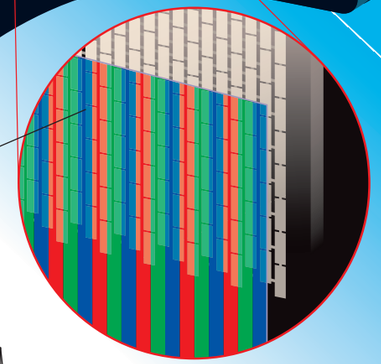


4 A *CCD array* is used in digital still and video cameras to capture a two-dimension area struck by light. Light going though the lens is focused on the array at the back of the camera.





5 The array consists of strips of CCDs that overlay the entire picture area like rows of bricks in a wall. Covering the array are colored filters that let every third stripe pick up only red, green, or blue light.



6 The diodes in each red, blue, and green CCD string are coupled as they were in the scanner. In addition, each diode in, say, the bottom blue strip is coupled vertically to next blue diode two strips away. This happens for red and yellow strips as well.

7 At the bottom of the array, the bottommost strips of red, blue, and green CCDs lead to a circuit where each of the three streams of analog voltage feed to an analog-to-digital converter. When all the voltages in the bottom row of each color has been passed to the ACD, all the voltages of the color-matched diodes move down three rows. Then the new bottommost rows pass off their charges to the ACDs, and are replaced by the next three rows. This continues until the last three rows have reached the bottom and been sent to the converter. The result is continuous streams of analog current representing each color level for the entire surface of the array. The ACDs turn those steams into digital data that record a color value for each photodiode in the CCD array.