"Pictures serve as a sort of visual undergrowth in the recesses of our lives. The weather forecast that helped me determine how I'd dress today was created by meteorologists examining sequences of still photographs. The security cameras in my office, my bank, and various public buildings around me, are snapping my picture in a stream of still frames. My wallet contains pictures of my kids, and a photo ID that allows the state and national governments to keep tabs on me. My computer screen-saver consists of a virtual slide show of pictures of my family. When I took a spill on my bike last month an X-ray photo in the emergency room determined that I hadn't broken anything. We're all living our own "Truman Show"--with photographs at the center of it all. The bottom line is, that our culture's addicted to pictures. Pictures are direct, visceral, sensory, and immediate." - David Friend, photojournalist.

You can use your home computer for digital imaging to:

- Import
- Organize
- Edit
- Print
- Email
- Create a web album or slideshow
- or insert in images into documents or movies

And, you can get started with little more than an inexpensive digital camera, a scanner, or even grab some right from the web.

Samples

Let's take a look at some other people's graphics to get a sense of what's possible. It's important to know that almost every image you see today, from the front page of the newspaper to the banner on your favorite website, has been altered in some way.

https://www.photoshop.com/index.html?bypass&wf=share

http://www.nydigitalsalon.org/10/artists.php?nav=artists

http://www.siggraph.org/artdesign/gallery/S06/index.html click the letters to the right to see many different artists' work at the Siggraph 2006 art show.

Graphics Overview

What's the analog equivalent to the word processor? Handwriting on paper. You can't copy and paste, and can't save multiple versions, or use different fonts or file formats without re-writing the entire document. By going digital, you have new flexibility and power available to you. You enhance your abilities when you go digital.

And even if you haven't yet "gone digital", you can take your analog images into the computer, and

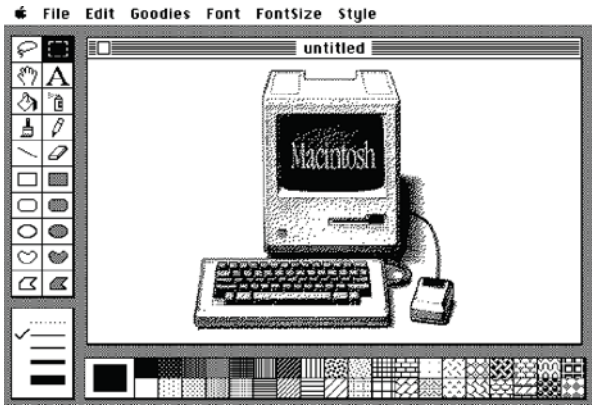
duplicate, alter, or enhance them in a lot of creative and time-saving ways.

Over the next few pages, we're going to be discussing digital imaging. We'll also talk about analog imaging, so if you're a filmmaker, or traditional photographer, you can make connections between analog and digital imaging.

Brief History of Graphics on Computers

Really, up until 1984 and the advent of the Macintosh, personal computers were seen as big, ugly, number crunchers with which artists would have little use. They were capable of doing math, spreadsheets, and word processing, but nothing a whole lot more creative than that. The original Mac in 1984 made computer imaging possible for average home users. It shipped with two programs, MacWrite, and MacPaint.

Mac Paint's tools have been the inspiration for tool palettes for just about all other current drawing, painting, and rendering programs, including Photoshop. It created bitmap graphics that you could use in other applications. For example, you could make a graphic in MacPaint, and then insert it into your MacWrite document! This was revolutionary in 1984.



Of course, the original Mac was only black and white, so MacPaint was a one bit, black and white bitmap painting program which only handled graphics at a resolution of 72 dots per inch

MacPaint has its share of groupies still, but most of us have moved on to Photoshop. Check out a bunch of MacPaint drawings to see what it could do with so little! Let's find out why. (http://www.folklore.org/StoryView.py?project=Macintosh&story=MacPaint_Gallery.txt)

There are basically two types of digital graphics file types – **vector** and **raster** (bitmap). And there are two types of applications you can use to work with these files, Illustration software (vector) and image editors (raster).

Vector Graphics

Vector graphics are mathematically drawn objects that are calculated using Bezier curves and straight lines. A vector is simply a list of numbers and directions on how to get from one point to the next. You give instructions about how thick the lines should be, what color, etc. For example, a line is defined by its start point, end point, slope, etc. This means you can represent a line of any width, color, or length with a tiny amount of data.

Since vectors are only dealing with points and lines, you can enlarge them quite easily without any loss of detail. This makes vector graphics great for logos and diagrams that might need to be output at different sizes.

Illustration software allows you to create drawings using lines and curves. Vector illustrations can be easily edited by moving points, adjusting curves, and changing the colors of various objects. Because they consist of points and objects rather than pixels on a grid, vector images are free from the confines of pixel resolution (more on this in a moment). Unlike bitmapped images, they will always print at the highest resolution possible, giving you printed output with smooth fills and crisp lines no matter what size you print it. However, vector graphics generally cannot contain the high level of detail as bitmapped images so they often have a stylized, cartoon-like appearance. Perfect for logos, maps, and other design elements that need to be output at any size. Adobe Illustrator is one of the leading software packages that create vector-based artwork.

Vector graphics are the mainstay for the computer gaming industry. Why? Because they have tiny file sizes, and are quickly drawn. This is because they simply store the instructions about how to draw the objects, not the objects themselves! All the hard work of doing the calculations needed to actually draw the objects in your online game, is done by your computer, not the remote server that is sending the images. It's ingenious! What's even cooler? They make all the backgrounds and characters by combining lots of simple geometric objects together. Objects can be lines, curves, and other geometric shapes with editable attributes such as color, fill, and outline.

Vector images are often composed with solid areas of color or gradients, but they cannot depict the continuous subtle tones of a photograph. For those, you need raster images.

Raster (bitmap) Graphics

In this book, we'll focus on *rasterized* or *bit-mapped* images. They are far more commonly used, and easier to work with for us commoners who are not trained artists. Raster images are what you get from digital cameras, scanners, and video cameras. And, it's what you get when you use the most popular image editing application on the planet, Adobe Photoshop

Rather than mathematical representations of an image, raster images are made up of thousands of little squares called pixels. Pixel is short for picture element. Can you see that the image on the left it is an extreme close up of the image on the right? It has been zoomed in to 1600% so you can see each individual pixel that is used in that image.

But, when zoomed out to its normal size (shown above right) you can't see all the individual pixels - you're eyes aren't that sensitive. So we see it as a "image" rather than a series of pixels
Though you can draw and paint, almost all image editing software includes features for photo enhancement and retouching. It's popular and fun - you can enhance your photos, combine them in interesting ways, alter the colors, fix some mistakes, etc. All without having to know how to draw.

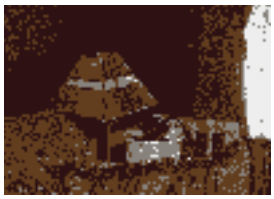
Images that are created and edited in this type of application are referred to as bitmaps because they are made up a series of pixels in a grid. The advantage to bitmapped images is that you can get a great deal of detail, as much detail as a photograph. The downside is that you will always be confined by the pixel resolution of the image

Image editors are used to edit digital photos and scanned images (which are always bitmap-based) and for creating continuous-tone and photo-realistic artwork

Bit Depth (Color Depth)

This grid of pixels (or a bit map) is filled with binary digits (bits) representing the color of each pixel. Each pixel can contain only one color.
So, if you have a 1-bit image, you get one digit to represent your color. So, a 1-bit image lets you have either a 0 (lack of color, or black) or a 1 (all colors, or white).


1-bit……..2 colors

 2-bit……..4 colors

 3-bit……..8 colors

 5-bit……...32 colors

 6-bit…….64 colors

 7-bit…….128 colors

 8-bit…….256 colors

on up to

 24-bit ……16,777,216 or "millions of colors"

Each time you have more bits available to you to store color information, the picture looks better (closer to reality). And, as the picture looks better, the file size gets larger. Why? Because there are more bits needed to represent each color in each and every pixel!
A typical 24-bit image is considered "full color" and generally uses 8 bits to display all the various shades of **R**ed, 8 bits for the **G**reens, 8 bits for the **B**lues. RGB is the same way your computer divides up color to send to your monitor. RGB mode images look fantastic when displayed on your computer (or TV) monitor. You can go even higher resolution and rather than 8 bits per "channel" (color) you can have 16-bits or even

32-bits per channel. The file size goes up accordingly, and depending on what you're using the images for, you may never need to use this high of a bit-depth.

Image Resolution
Resolution of your image refers to the actual number of pixels that make up your complete image. Or, if you think about this in analog/digital terms, it is the number of times your image is "sampled". So, lets say you take a picture with a digital camera with a resolution of 9 pixels (this wouldn't ever be the case, but this is the simplest case).

High resolution - you could fit a lot of pixels (boxes) into a small space. You would need a lot of pixels to fill a large area.

Medium resolution - you can fit few of this sized pixel into a larger space. Larger pixels like these would require somewhat fewer numbers to fill your screen than above. The bigger the individual pixels, the more likely you are to notice them.

Low resolution - where the pixels are even larger. You'd need fewer pixels to fill a large area. If you compare this last image with the first one, you can see it has exactly the same number of pixels (9), but it takes up about twice the area of the first one.

This is important

The higher the images resolution, the larger its file size will be.
To calculate how large the file size will be for any image take:
(Image Height (in pixels) * Image Width (in pixels) * Bit Depth)
divided by 8 (to convert bits to bytes)
divided by 1024 (to convert to KB)

Resources
Fundamental physics of light and color (and vision) can be found at:
http://www.glenbrook.k12.il.us/gbssci/phys/Class/light/u12l2d.html
Color in Motion - an interactive site with lots of great info on using color in communication:
www.mariaclaudiacortes.com

Drawing on Your Computer

In addition to manipulating photos, you can also use your computer as a drawing tool. Of course it helps to know how to draw, but it's not necessary in all cases.

One of the first computer drawing applications was created by Harold Cohen in the 1970s. The application AARON was designed using artificial intelligence to create an autonomous machine that created visual art. Thousands of AARON images have been created, and they have changed and grown over the past 40 years.

"*I wrote it to discover what an independent (machine) intelligence might do, given some knowledge of the world and some rudimentary physical capabilities. And, in the process, to have it teach me about possibilities I hadn't imagined. I'd be happier if AARON's work in the future were less like human work, not more like human work." - Cohen*
(To see some of AARON's images and learn more about the project go to
http://www.viewingspace.com/genetics_culture/pages_genetics_culture/gc_w05/cohen_h.htm

Unlike Cohen's AARON - where the machine actually creates the images, the applications we'll be talking about require you to bring your own human ideas to them to create images.

Many of the painting and drawing applications let you simulate the quality of the paper, and the writing implement you'll use to draw with. You can make crayon drawings, or sophisticated vector-based artwork from scratch. Corel's Painter is a leader in this space - http://www.corel.com/servlet/Satellite/us/en/Product/1166553885783 (free trial download available)

Other applications let you paint complete terrains and landscapes to create realistic imagery for use with video or print. Bryce is a leader in this space. http://www.daz3d.com/i.x/software/bryce/-/

Many people who use these programs decide to use a graphics tablet rather than a mouse to draw. A tablet is typically connected to your computer by the USB port (there are also wireless-bluetooth enabled-tablets). The graphics tablet lets you draw like you were using a pen on a tablet surface, giving you more precise control with more natural movement than a mouse. The tablet senses where the pen is, and also how much pressure is being applied, so you can get quite natural looking results.

Using a Digital Still Camera

There are a lot of different digital still cameras on the market today. Probably the most important thing to look for in a digital camera is its image resolution, and how, and on what media it stores images.

A 3 megapixel camera is a solid camera that will take high resolution pictures that you can print out with good quality. What is a megapixel? Take the (number of pixels wide) times the (number of pixels high) and if the result is 3 million pixels, then you've got a 3 megapixel camera.

There are cheaper 1 megapixel cameras that may be adequate for some needs (certainly okay for web images, probably okay for making small prints). There are digital cameras on the market that are up to 20 megapixels, and higher. In general, the higher pixel count, the more expensive the camera.

You'll find that you can get "pocket cameras" which are typically small and are pretty much automatic everything. Even the camera on your cell phone can be better than missing that great photo opportunity. On the other end of price spectrum, you can get digital SLR (single lens reflex) which are great for the more serious photographer. Like all electronics, price comes down every day, and a good DSLR camera is possible for a lot of people now. The DSLR's often let you change the lenses, just like you might have done with your old film SLR - and you can get completely automatic or fully manually access to settings.

Another issue is how your camera stores the pictures you take. Most cameras have either a smart media card or compact flash card that lets you store a lot of pictures on a large card. You can take the photos from the card, and then import them into your computer (usually via USB). This way you can then erase the memory card so you can use it over and over. No film needed, ever.

As a general idea - a 4 megapixel camera shooting at its full resolution will let your store close to 700 images on a 2GB memory card. An 8 megapixel camera would cut the number of images in half, etc.

How Does A Digital Camera Capture The Picture?

Every camera has a lens that can see the world around it. On a digital camera the lens focuses the light onto a CCD or charged coupled device. This CCD has a matrix of millions of photocells that create pixels. These photocells sense the intensity of light that is shining through the lens. To capture color information, each pixel has RGB sensors.

So a digital camera can "sample" image data from the real-world, and then convert it into digital pixel information that your computer understands. The more samples your camera stores, the better resolution, the better quality your digital pictures will be, the larger the file size.

You can transfer these pictures into your computer and then use an image manipulation program like Photoshop to edit, crop, and enhance them.

Resources

If you are looking to purchase a digital camera, this site can help you narrow down your choices.
http://www.dpreview.com/reviews/compare.asp

How Does a Scanner Work?

A scanner "takes a picture" of sorts to get a fairly accurate representation of your printed document. It works a little like a photocopier, so anything you can place on your scanner can be scanned. You can use a document, but you can also scan your kid's latest painting, or even a three-dimensional object. The resolution of your scanner is indicated by how many samples are taken from an image, on a per inch basis.

Scanner resolution is often referred to as dpi (dots-per-inch) or as ppi (pixels-per-inch). The standard scanning resolution for the images to be used on the web, sent through email, or generally "seen on a computer screen" is 72 dpi. This is the average resolution of most personal computer screens. This resolution works well because it is relatively low, so it keeps the file sizes low, but high enough that we aren't complaining about the quality.

For images you want to print, the standards for scanning are significantly higher. If you intent to print out the image, for a poster, a brochure, or CD cover, you'll want to scan and work at a resolution of at least 300 dpi. You might consider scanning at the absolute highest resolution your scanner can produce.

The main thing to remember; the higher the resolution the finer the detail, the larger the file size, the better quality print you'll get.

Types of Scanners

The flatbed scanner is the most popular type of scanner. They look something like a small copy machine. You place your picture or image on a pane of glass. Flatbed scanners are ideal if you want to scan a wide range of items, such as photos, books, documents, and even 3-dimensional objects. An automatic document feeder (ADF) can be added to some models to ease scanning multiple pages. You'll find a lot of "all-in-one" printers that both copy, scan and print (maybe even fax). These are generally adequate for most consumer needs.

If you need to scan slides, negatives, or transparencies, a film scanner might be just what you need. These are specially designed with a much higher resolution than other types of scanners. If you'll only occasionally scan film, then you can get a transparency adaptor for your flatbed scanner. Film scanners are only practical for those who will scan film or negatives regularly.

You can use an image editing application like Photoshop to alter your scanned images, just like you do with images from a digital camera. Once the document or image is scanned, it is converted from analog to digital format, so you can the incorporate it into your multimedia work.

If you don't have access to a scanner but need to digitize an image, consider using a digital camera to take pictures of the artwork or image you want digitized. This is sometimes the easiest, and cheapest solution. Your local Kinkos and Office supply superstores also have good equipment you can use on a pay-per-service basis.

Graphics File Compression Formats

Just like you can save your word processing document in a variety of formats, you can save an image in even more formats. Some formats work great for one use, but terrible if you want to do something different with them. Photoshop let's you save an image file to any of these file formats show below.