Design Tools: Imaging, Vector Graphics, and Design Evolution

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Abstract

The relationship between artists and their tools has become very dynamic in the age of digital content creation. In the early days of computers, the limitations of the software tools at least partially dictated the style of art produced on the computer. With advances in computer graphics, the tools have become more

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J. Chen et al. (eds.), *Handbook of Visual Display Technology*,
DOI 10.1007/978-3-319-14346-0_157

flexible, prices have dropped, and some capabilities have been extended to the Web. This chapter provides an historical overview of the evolution of software tools for drawing and imaging and a classification of the tools being used today.

List of Abbreviations

DNG	Digital native specification
DPI	Dots per inch
GUI	Graphical user interface
PPI	Pixels per inch
SPI	Samples per inch

Introduction

Digital content creation tools, especially imaging and painting, were some of the first tools to follow the introduction of the graphical user interface (GUI) for personal computers in the 1980s. Those first products were far from easy to use. Early tools and input devices came with limitations that influenced the work. They required artists and designers to adapt their methods considerably, and, it could be argued, the advantages to early adopters were fairly modest. Most designers continued to work out their ideas on paper and then scan elements into the computer to be reassembled in content creation programs like Aldus Freehand, Adobe Illustrator, and Corel Graphics.

Tools have gradually improved, but there is still plenty of room for improvement. And as tools have evolved, artists have also evolved. There has been a continuous give and take between artists and their tools that has resulted in distinct styles for the print and the Web (Communication Arts Magazine 2009). For example, the rather arcane craft of type creation became democratized with digital tools that made it easier to fine-tune type designs. In addition, typography underwent a revolution as type was freed from physical boundaries and allowed to flow organically on the page or the web page. Similarly, early digital art featured heavy dark lines, outlines, and bold colors, because that is what the computer was able to do well.

This chapter will discuss the evolution of tools and the technological changes that have affected the field of drawing and imaging for artists.

Raster Versus Vector

The key differentiator between drawing and illustration tools for all users, professional and consumer, is raster versus vector. Raster-based programs take advantage of the computer's ability to display graphic information as pixels on the screen. For the sake of convenience, let us say that most computer screens display 72 pixels per

Fig. 1 A raster-based image will show jagged edges when zoomed on the computer screen or printed at higher resolutions

inch. This is generally true for consumers; professionals work at higher resolutions and new displays are capable of displaying much higher resolutions. Higher resolutions are needed for many professional applications because printers work within ranges of 600–2,400 pixels per inch. (And again, this may vary with the quality of the printer and its applications.) Resolutions for printers and screens, pixels per inch (PPI), may also be expressed as dots per inch (DPI), or samples per inch (SPI). Raster-based programs produce files that are resolution dependent. An image created in 72 DPI on a computer will look fine on the screen, but if blown up to comparable size on a printer, it will show considerable degradation.

In contrast, vector-based drawing programs such as Freehand and Illustrator use mathematical techniques to produce the required image. As a result, vector images can scale to any resolution and can be printed at any size. Fonts are vector based to allow them to be scaled to the required size. CAD programs and desktop publishing are also vector-based programs.

In practical use, raster programs are used for editing photographs and to create images for the Web. In addition, raster-based programs may be used for drawing and sketching, and many hobbyist's tools are raster based (Fig. 1). The majority of vector-based drawing tools have been created for professionals. Both raster and vector tools for professionals have tools that recognize and accommodate the requirements of commercial printing including color space options, registration, bleeds, etc.

The Evolution of Professional Tools

In general, computer programs for artists, typographers, and graphics designers were not created by professionals in the graphics arts industries though the developers may well have relied heavily on experts to create their programs. For example, it is widely reported on the Web that Illustrator was originally developed by Adobe as an in-house font development tool. Photoshop was first developed by Thomas Knoll to help him with his Ph.D. work on processing digital images. He wrote subroutines to simulate grayscale levels on a Mac in 1987. It was his brother John who was working at ILM who recognized the usefulness of the program for

image processing and was interested in the ability to convert files to different formats (Derrick 2000). On the Windows side, CorelDraw was developed by engineers Michel Bouillon and Pat Beirne to develop a vector-based illustration program to bundle with desktop publishing systems (Laver 1998). Even if the developers were setting out to create tools specifically for graphics professionals, there is the practical problem of expressing smooth curves on a screen – which is essentially a grid of points. Thus, an artist wishing to create a free form curve was confronted with the complication of splines and control points.

As a result of the digital origins of digital drawing and imaging tools, early adopting graphics professionals were asked to radically change the way they worked. The situation has considerably improved, but learning how to create art on the computer is still a different process from learning how to create art on paper.

In many cases, the development of graphics software was heavily influenced by printing technology and desktop publishing. For instance, the concepts of layers, fills, and gradients are more related to printing than drawing and illustration. It could be argued, however, that in the long run, the cross-pollination of disparate disciplines has been healthy for commercial art and design. Certainly, digital content creation tools have developed with capabilities that enhance the native abilities of artists and even enable those with limited abilities to work in the field. The tools have spawned the field of computer art and have inspired unique styles. On the less positive side, visual content creation tools have forced artists to adapt to them rather than adapting to the requirements of the artists. Many developers are sensitive to this limitation, and as computers become more powerful, they are trying to improve the flexibility of content creation tools to allow artists to work more intuitively.

The field of Visual Content Design has been transformed by several technology waves, some internal to the programs, but most external. “Layers” is an example of an internal technology. Adobe introduced the concept of layers to artists with Photoshop 3 in 1994 and Illustrator 5 in 1993. However, computer-aided design (CAD) systems had been using layers since the late 1970s as a means of organizing information in complicated projects.

For commercial artists working in Photoshop and Illustrator, the concept of layers has resonance because it is similar to the idea of creating separations for print. The capability also adds incredible power to the creation process and acts as a useful tool for packaging work for delivery. Illustrator makes extensive use of layers reflecting the ability of artists to work with pens, different weights of lines and fills. Likewise, layers in Photoshop lets artists try out different looks and adjustments and gives them a path back out of changes if necessary.

Other innovations in digital software that have changed the field of graphics arts include the ability to place text along a path, easily create runarounds (for instance, to set type close to a complex image), and convert raster lines to vector, making scanning and tracing a practical option for input. Text has been freed from the grid.

In fact, the impact of digital technology on artistic style has not been adequately explored but it has clearly been profound. And, as always, there are two sides of the

story. It has been argued that the dependence on software has degraded drawing skills because students spend less time doodling, sketching, and drawing and go to software sooner. The evidence for this is completely arguable and anecdotal. However, there is one important change that has impacted all work since the arrival of the computer and that is that jobs are compressing.

The people who create artwork take it all the way to the prepress stage or submit their work in a format suitable for the Web. There is considerably less handing off of work to different people to be reformatted for different output options. Rather, the artist is called upon to do this work.

The Influence of the Networking and the Web

When talking about the evolution of commercial art and digital tools, it is important to remember that the tools were created before the broad deployment of the Web and the arrival of browsers and graphical user interfaces for the Web. The tools were primarily developed for professionals working in print publishing fields. But, even though the users and developers at the time did not know it, the wheels of change were already in motion. The Internet has emerged as a new form of media. It has almost completely displaced the trade press, and it is having a huge impact on the newspaper industry and even consumer magazines are seeing the effects. The biggest factor affecting the print industry is the defection of advertisers for the Web. In late 2008, with a slowdown in the world economy, advertising was declining across all media, but it has picked up speed for the print industry. There are whole sectors of the print industry that have disappeared.

What the Web takes away, it gives back. Work for graphics artists has changed dramatically as some make the shift to creating artwork for the Web rather than for print. New jobs have been created as layout and typesetting transitions to web design. In addition, the evolution to the Internet has enabled more efficient workflows for graphics artists.

Before the Web arrived for the mainstream, companies were going digital and changing their workflows with the addition of local area networking (LAN). In hindsight, LAN can be thought of as training wheels for the Web. Local area networking, as it was gradually rolled out over the 1980s and 1990s, improved the ability of workers to collaborate. And, as the Web arrived, it extended the ability of people to collaborate over large distances and to access information from a variety of sources. Networking and the Web has improved the ability of people to collaborate; to find inspiration, photos, and clip art; and to buy software and support. Ironically, networking has also increased the need for organization as it has added to the amount and complexity of data maintained by just about any computer user.

The Internet, networking, and easy access to tools and training have served to democratize significant areas in the imaging and graphics arts fields.

The Democratization of Imaging

The evolution of the Internet, starting with the introduction and broad acceptance of a graphical user interface (GUI) in the form of browsers and simple coding via HTML (Tim Berners Lee is credited with inventing the World Wide Web in 1991), has accelerated the process of democratization. As a result, new users and new applications are appearing in this segment that once seemed so stable and dominated by a few market leaders.

So what happens when digital photography is widespread among professionals and consumers? The industry is at that point now. In research performed for The Digital Content Creation Software Report, Jon Peddie Research estimated the installed base of digital still cameras to be at 352 million in 2010. Of those, approximately 14 million were digital SLR cameras (Digital Content Creation Software Report). That was a high point for digital still camera sales. As the quality of the cameras integrated with mobile phones has increased, most people have stopped carrying an additional camera. People who buy an additional camera therefore tend to be enthusiasts. As a result, almost everyone has a camera in their pocket and those cameras are becoming more capable every year. And those people who are carrying an additional camera tend to be much more committed to photography, and they are carrying better quality cameras.

Since the first days of digital imaging, there has been a class of imaging utilities that professionals tended to use in conjunction with their professional tools such as Photoshop, CorelDraw, Canvas, Illustrator, etc. Among these programs were Jasc's PaintShop Pro and HiJaak (originally developed by Inset) which were very low cost and enabled screen capture and format conversion. However, the lightweight utilities of the past either disappeared or grew into full-blown applications that were every bit as slow to open and as unwieldy to navigate through as their high-end professional counterparts. Most of the low-cost photo products, all with similar names – PhotoStudio, PhotoImpact, and PhotoPlus – have wound up in the hands of larger companies to become part of a suite.

As some programs have blown up and become unwieldy, however, small companies have popped-up to create useful small programs and utilities. Some programs like SnagIt, a simple capture tool, perform single tasks, while others such as Irfanview, Picasa, Gimp, and Xara offer basic, stripped-down capabilities that a broad range of creative users – professionals and amateurs – might use. They take up where the useful utilities of the past left off (Table 1).

The competition now is coming from free or almost free products that are available on the Web or shipping with products. According to studies from Texas Instruments, Corel, and others, the average consumer only uses editing software for a few tasks. They are likely to use the software that came with their camera. Also, they are likely to use automatic fixes rather than fine-tune their results.

Table 1 Something for everyone – this sample gives an idea of the variety of software available for image processing (For more information about free resources for photographers see About.com. Sue Chastain has written an article listing several programs. http://graphicssoft.about.com/od/pixelbasedwin/tp/freephotoedw.htm (From Jon Peddie Research)

Company	Product	Function	Price
Abrosoft	FantaMorph	Morphing movie software	$49.95
Acorn	Flying Meet	Mac editing software with support for layers, text, vector shapes, filters	Free version and $49.95 version
Fast Stone	FastStone Soft	Resizing, change color depth, file conversion	Free
Gallery Mage	Tank Software	Nondestructive organizing software	Free
Gimp	Gimp.org open source group	Photo editing includes layers, channels, paths, etc.	Free
Morpheus	Morpheus	Morphing software	$29.95
Irfanview	Irfan Skiljan	Photo viewer with light editing	Free
Techsmith	SnagIt	Easy capture and file conversion, basic editing	$39.95
VCW	VicMan's	Photo editing	Free
Maggi	Beauty Wizard	Hairstyle and makeup software	$39.85
Photofiltre	Photofiltre.free.fr	Lightweight photo editing supports filters but not layers	Free
PhotoPlus	Serif	Photo editing with layer support, GIF animation, brushes, text	$79.95 (earlier versions offered for free as introduction to software)
Pixarra	Twisted Brush	Digital paint software with natural art tools and photo editing	$39.95
Real Illusion	FaceFilter	Photo editor	$29.95

Imaging and Digital Photography

Perhaps no other influence has affected the field of digital imaging as much as the arrival of the digital camera. At first, the use of imaging software was limited by the ability of users to obtain or produce digital images. They could create original works using the computer or scan in images and photographs. The digital camera

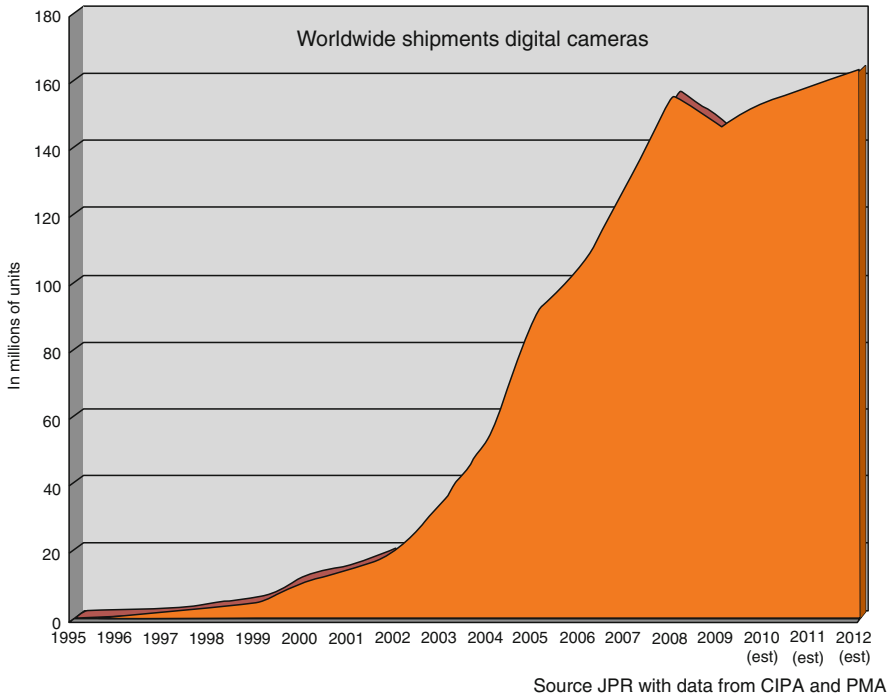

Fig. 2 Worldwide shipments of cameras are slowing down, but revenues have been bolstered by the popularity of higher-priced DSLRs. Data for 2010 is forecasted data

has made the process much easier, and as a result it has introduced the mainstream of users to imaging. Mainstream users have returned the favor and have expanded the concept of photography by using their digital cameras to document events, illustrate their blogs, create posters and other items, and to communicate more effectively on social networks (Fig. 2).

The relationship of the customer and digital cameras has evolved quickly in the decade or so since cameras have been attractively priced. Every year new cameras are introduced with larger and larger megapixel (MP) sizes – meaning that larger files are created and larger pictures can be printed. In 2014 the leading phones featured sensors which are comparable to low-cost digital still cameras of just a few years ago. For example, the Apple iPhone 6 has an 8 megapixel camera based on a (reported) 1/3 in. sensor; the Samsung Galaxy 5S has a 16 megapixel camera using a 1/2.6 sensor. As phones like these increase in sales, they are replacing digital still cameras.

On the higher end, there is new interest in digital SLR cameras, and analysts tracking digital camera sales point to the digital SLR market as the fastest growing market for cameras even as the sales of mainstream cameras level off in the USA (and even more so in Europe and Japan).

Raw Format

Increasingly, cameras with ever larger resolutions are offering uncompressed formats for users willing to work with very large files in order to get all the data in an image. Technically, RAW data is the information gathered by the camera sensor before it has been compressed into JPEG or other formats and before adjustments such as white balance, sharpening, and contrast are applied and before image quality and image size are changed, but there is no one RAW format. RAW formats vary according to camera maker, and a certain amount of processing and compression might take place.

RAW captures 12 bits of color per pixel or 4,096 shades of color per pixel (68.7 billion colors). As a point of comparison, JPEG saves 8 bits of color per pixel or 256 shades of color per pixel for 16.7 million colors. As a result, using RAW images can give users more flexibility in working with images than they would have after information is lost in JPEG.

Adobe was early to offer access to RAW data via a Camera RAW plug-in for Photoshop in 2004. Soon after, the company offered to "standardize" RAW format within its DNG (digital native specification) format. Some camera manufacturers including Leica and Hasselblad have signed on, but others including Canon, Nikon, Sony, and others prefer to maintain control over their native RAW formats. Now, RAW is available through most image editing programs, and again even mainstream photographers are learning how to use this format formerly reserved for professionals (Table 2).

There are many more products that can work with these formats, but most cameras that have a RAW format also offer their own software to deal with those formats.

RAW Software

Working with RAW camera files has become as easy as working with processed camera files such as JPEG or TIFF, thanks to the introduction of software that handles RAW files. Cameras that support raw files usually ship with software to deal with that camera's proprietary file format. In addition, there are several software programs that can work with a variety of RAW file formats including Google's Picasa, Apple's iPhoto and Aperture, Adobe's products including Photoshop and Lightroom, and Corel's AfterShot Pro and PaintShop Pro products. Commercial software products license the technology from the camera manufacturers, or they may reverse engineer, meaning they work backward from the file format, to develop software that can edit and convert RAW format files to standard file formats such as JPEG, TIFF, GIF, etc.

Table 3 is a list of available software developed to handle a variety of RAW formats. The emphasis for most of these programs is to convert files and perform basic imaging functions such as adjust white balance and sharpen.

They are particularly useful in workflows where several cameras are being used, each with their own proprietary RAW format.

Table 2 A list of common RAW formats and their associated cameras and software

Proprietary camera raw formats	Camera manufacturer	Associated software
.3fr	Hasselblad	FlexColor, Phocus
.raf	Fuji	Finepix S2 Pro
.crw, .cr2	Canon	Digital Photo Professional, ZoomBrowser
.tif, k25, .kdc, .dcs, .dcr, .drf	Kodak	EasyShare
.mrw	Minolta	(Sony acquired Minolta's camera technology)
.mef	Mamiya	–
.nef, .nrw	Nikon	Capture NX
.orf	Olympus	Studio 2
.ptx, .pef	Pentax	Pentax Photo
.arw, .srf, .sr2	Sony	Sony Image Data Suite (data converter, Lightbox)
.x3f	Sigma	PhotoPro
.erf	Epson	Photolier
.mos	Leaf	Leaf Capture, Leaf Raw Converter
.raw, .rw2	Panasonic	–
.cap, .iiq	Phase One	Capture One
.bay	Casio	–

Table 3 Several programs have been developed to handle a variety of RAW files

Product	Publisher	Camera	Platform	Price
Photostudio Darkroom	Arc	Canon, Nikon, Panasonic, Adobe (DNG), Sony, Kodak, Olympus, Sigma, Mamiya, and Epson	Win/ Mac/ Linux	$99.99
BreezeBrowser Pro	Breeze Systems	Canon EOS 50D, Canon EOS 5D Mark II, Canon PowerShot G10, and Panasonic DMC-LX3 raw conversion	Win	$89.90
Bibble Raw Editing	Bibble Labs	Supports formats from Nikon, Canon, Olympus, Kodak, Pentax, Minolta, Epson, Fuji, Sony, Panasonic, Leica, Leaf, Mamiya, Samsung	Win/ Mac/ Linux	$159.95
Lightzone	Light Crafts Inc.	RAW files from the Canon 450D, Canon 1000D, Fujifilm S100FS, Nikon D60, Nikon D700, Olympus E-420, Olympus E-520, Olympus SP-550UZ, Panasonic DMC-L10, Pentax K20D, Pentax K200D, Sony DSLR-A200, Sony DSLR-A350	Win/ Mac	$149.95
AbleRAWer	Graphic Region	.raw, .crw, .cr2, .nef, .pef, .raf, .x3f, .bay, .orf, .srf, .mrw, .dcr, .dng, .arw	Win	Free

Several companies have made it their business to understand a variety of RAW formats and enable conversion as the included list suggest. However, the trend is to add broad RAW support to products that add conversion, image editing, and perhaps even image organization.

There is considerable controversy over the usefulness of RAW, but professional photographers and graphics professionals will prefer to have the option. And such features as RAW support in software – for at least key cameras – will help separate professional products from mainstream products for many users.

For RAW editing software, differentiation comes in the breadth of formats supported and also flexibility. If nondestructive editing is a major feature for RAW workflows – the ease with which users can step back from adjustments differentiates professional products from low-cost, mainstream software.

OpenRAW

The OpenRAW organization was formed in an attempt to encourage camera manufacturers to open up their RAW formats to make it easier for users to work with RAW files. The group surveyed photographers and not surprisingly found photographers to be frustrated working with RAW formats. The supporters of the OpenRAW group come primarily from user groups and software developers. Manufacturers have been disinterested, and OpenRAW has had limited success, seeing the development of an open RAW format.

As software companies have developed their own strategies for dealing with RAW formats and as these programs have become easier and easier to work with, the problem is becoming moot.

Family Photography

Although there was never any doubt that digital cameras would become popular with mainstream users very rapidly, it has been surprising to see the development of applications enabled by the widespread use of digital photography. Retail printing is enjoying a bit of a recovery after the precipitous drop-off caused by the acceptance of digital cameras. However, InfoTrends has also reported that users are moving toward electronic viewing online, using digital photo frames and, increasingly, using their new HD televisions to view photos. There is a growing demand for retail printing, and consumers are creating their own books, thanks to the arrival of low-cost digital printing on demand.

Several trends that are evolving with increased use of digital photographs include:

- Photo sharing online via social networking sites including Yahoo's Flickr, Facebook, MySpace, and others.
- Photo album software – stand-alone programs are showing considerable popularity.

- Photo scrapbooking and other project-based software.
- Increased printing – more photos are being printed, and more photos are being printed at retail locations.
- Photo books.

It has been remarked before that an increasing number of digital camera users are women. Unlike many other technical markets, women play a major role in purchasing and using cameras. The Photo Market Association (PMA) believes that women are the primary users of cameras in over 50 % of the households owning a digital camera. In addition, even when women are not taking pictures themselves, they are often the archivers and the people reusing images. For that reason they are helping drive the sales of album software, and photo books, they maintain photo sharing sites, and they buy and share retail prints.

Interestingly, printer manufacturers HP and the PMA have both found that users are increasingly keeping photos on their cameras. They do not download them until the memory is full. Tara Bunch, General Manager, HP Imaging and Printing group, observes that people use their cameras as digital photo albums.

It helps to keep a sense of perspective when talking about consumer trends. The vast majority of images are likely to remain digital, and the applications for them will be primarily digital, but that opens up a very fluid range of possibilities for the future.

The Cloud

In a related trend, we are seeing people become more comfortable with putting their images online. Services like Google's Picasa and Flickr allow people to store and share images online. Adobe is expanding its use of the cloud as a customer resource. The company has transitioned to a subscription-only model for its software and offers free services and storage for consumers. Customers are gradually showing a willingness to pay for online storage, and vendors including Google, Apple, Adobe, and others are making increasingly good deals in return for access to customers via a subscription relationship.

Free/Online Editing

The divide between professional tools and consumer tools has widened considerably with the entrance of free online tools such as Picasa offered by Google and Photoshop Express offered by Adobe. In addition, there are photo organizing and sharing sites including Flickr that offer some editing capabilities. The sites are free for various reasons – Google can sell ads and services and Adobe hopes to sell products and protect its professional products from low-cost interlopers – but whatever the reason, free tools obviously threaten the position of low-cost photo editing tools. Adobe with the industry standard Photoshop has a unique position in the market. Photoshop is a requirement for many photographers and imaging

professionals. As a result, the company has been able to move to a subscription model. The company offers its photography tools Photoshop and Lightroom for $9.99 a month and access to all of its creative tools for $49.99 a month. As of 2014 the company has over three million subscribers. Other companies are introducing subscription models, but no other company selling imaging tools has had this success with subscription sales. That may change as people become accustomed to the idea of subscriptions.

Mid-Range Tools

No vacuum lasts for long, and the gaping vacuum between the professional tools and consumer tools has been filled by several classes of tools – the leaders are Apple's Aperture and Adobe's Lightroom. Both combine organization for professionals and serious hobbyists with the most commonly used tools for editing, as well as presentation tools and printing. Apple introduced Aperture at $500 originally – a price that put it well under that of Photoshop – but still put it in the class of "professional" software. It included tools that represented a subset of Photoshop tools for digital photo editing, and the company described it as the features professional photographers are likely to use most often in their day-to-day work. The price eventually dropped to $150–$199. Adobe countered with Lightroom for about $250, but it has since gone to a subscription model. In 2014 Apple announced plans to abandon Aperture in favor of new photo management and editing tools to come in the future. Corel hopes to fill the vacuum with its cross-platform product, AfterShot Pro, a RAW management and editing tool, which has dropped in price from $79.99 to $39.99.

Redefining the Market

Digital photography for consumers has created markets that have not existed before, such as online photo printing and custom t-shirts, coffee cups, and scrapbooks; consumer applications are helping drive the growth of the graphics and photo imaging market.

In addition, the consumers' enthusiasm for digital photography and sharing photographs has inspired new applications that have grown up with the social media. Among these applications are Instagram, Pixlr, and Snapchat. And, obviously, social media applications such as Facebook and Twitter also thrive with photographic content. For consumers, the camera is more indispensible than it has ever been at any point in time.

It should also be noted that the digital photography market is a useful model for a variety of digital media markets. Applications that make creative impulses easy to realize are changing the way professionals work as well (Fig. 3).

Professional users tend to be conservative in their choices of tools. They do not want to spend time learning new products and they do not want to risk

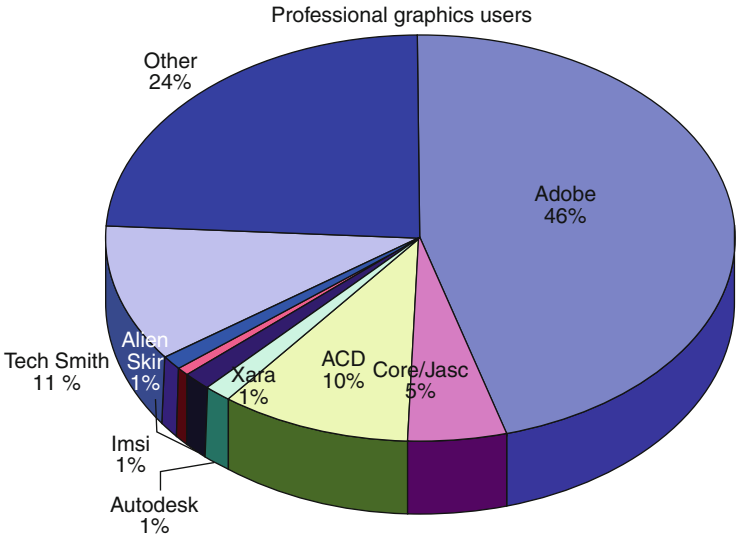

Fig. 3 Adobe owns most of the professional graphics market and has expanded it through its acquisition of Macromedia. In cases where people use other products especially plug-ins, they also use Photoshop. Jon Peddie Research estimates that there are approximately 1.5 million professional users

unpredictability. For that reason, they are much less price conscious. In the graphics field, professional users can tend to be more conservative in their upgrades and their hardware purchases as well. As long as everything is working, many professionals will prefer not to rock the boat; they only change at the point of pain, when software starts driving the hardware too much and slows down and when there is not enough memory. New operating systems may inspire the purchase of a new system but only if it is seen as a requirement – when version changes cause incompatibilities, for example, or functionality is increased to a significant degree. Even then, these users are rarely early adopters.

The consumer market for digital imaging software is large and varied (Fig. 4). Users have choices between low-cost album software that lets them organize their photos, do light editing and create slide shows, add photos to web pages, create coffee mugs, t-shirts, calendars, and scrapbooks. There is potential for more specialized products and also a broader population of general purpose users as well.

Illustration and Drawing

Digital illustration and drawing have never democratized to the same extent that imaging has for a simple and obvious reason – drawing is a skill. Anyone can take a picture, but not everyone can draw. Illustration and drawing are likely to remain the

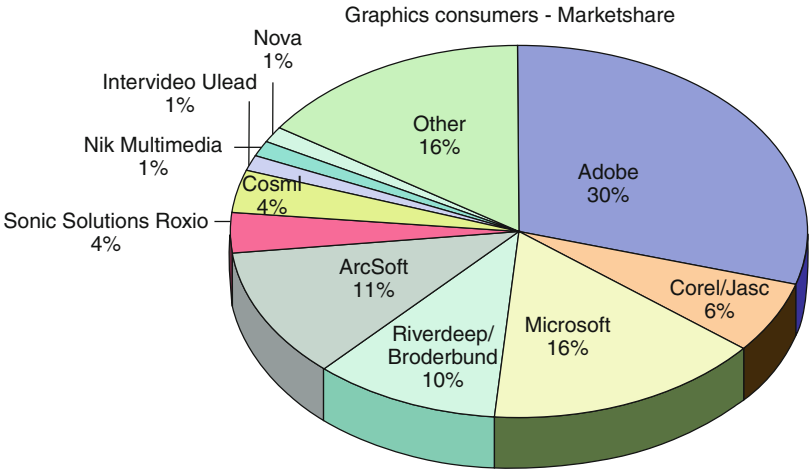

Fig. 4 The consumer market for graphics software is driven by the digital camera market. JPR estimates that there are approximately 6.6 million consumers who use graphics and imaging software. While this is the highest number of people in the digital content creation market, the numbers are relatively low compared to the number of cameras out there – approximately 350 million – and the installed base of mobile phones with cameras which is approximately three billion (multiple sources, including Jon Peddie Research)

domain of craftspeople with the ability and interest to pursue it. In addition, drawing and illustration is closely associated with the publishing industry, which is in decline. In general, applications designed for drawing are vector based to enable printing (Table 4). In general, however, raster-based drawing tools are included in photo/imaging products and are classified with those products.

Drawing products fall into two major classes: drawing tools for artists and office drawing tools. There is an overlap between the tools in many cases, and the distinction is based primarily on the types of templates and pre-drawn elements provided. For instance, office tools like Visio, EazyDraw, and SmartDraw offer pre-drawn components for block diagrams, flow charts, office layout, charts, and so on. They may offer quite a bit of clip art and that too is oriented toward office projects. There is an emphasis on making content creation for people not skilled in drawing.

Drawing tools developed for commercial arts also offer template and shortcuts, but the emphasis is on creating original art. The products usually have more features, they may be more complicated, but they are designed to fit into a professional workflow including traditional print output and web development.

Drawing Tools for Artists

Artists choose drawing tools for very personal reasons such as ease of use, intuitiveness, etc., and they may be influenced by application. Adobe Illustrator, by

Table 4 Commonly used vector drawing programs classified according to their primary use: creating office graphics or commercial art (From Jon Peddie Research)

Vector drawing programs	Company	Win	Mac	Linux	Office/ Artist	Cost	Comments
Illustrator	Adobe	Y	Y	N	A	$499	Illustrator is a de facto standard for commercial artists with strong competition
Canvas	ACDSee	Y	Y	N	A	$350	A venerable program with longtime users. ACDSee has recently introduced Canvas 11 and has added GIS support. It supports a wide variety of formats
CorelDraw	Corel	Y	Y	N	Both	$399	A leading contender in the professional drawing market. CorelDraw's early expertise in raster-to-vector conversion has given it an edge in sign-making and pattern-making
ConceptDraw	Computer Systems Odessa Corporation	Y	Y	N	O	$499	Office Drawing tool which includes ConceptDraw's project management software and MindMap. ConceptDraw includes support for Visio files
EazyDraw	EazyDraw	N	Y	N	O	$139	An Apple program for business users. The company reports growth year after year and is especially excited about new release. Also supports ClarisWorks, MacDraw, and AppleWorks
DrawPlus	Serif Software	Y	N	N	O	$100	Supports CMYK, making it suitable for professional printing applications. Serif offers earlier versions of its software as free downloads
Freehand	Adobe	Y	Y	N	A	$399	Freehand, formerly part of Macromedia and included in the MX suite, is now being phased out by Adobe in favor of Illustrator or Fireworks
Mayura	Mayura	Y	N	N	O	$39	Low-cost program that is easy to use and has good EPS output. Limited for professional use

Microsoft Expression Design	Microsoft	Y	N	N	A		Microsoft is mounting a very serious campaign against Adobe with its Expression Tools
Corel Designer	Corel	Y	N	N	O	$429	Originally developed by Micrografx, a Dallas-based software developer. Since acquiring the program, Corel has enhanced its usefulness for technical publishing. It supports a wide range of formats
Omnigraffle	Omni Group	N	Y	N	O	$200	Mac tool for business users. Oriented toward graphs, diagrams, etc., and has support for Visio files
RealDraw	MediaChance	Y	N	N	O	$55	Includes 3D capability in a big list of tools. Latest version released in November 2008
SmartDraw	SmartDraw	Y	N	N	O	$197	Windows tool for business users. The company offers a wealth of pre-drawn elements and templates to create graphs and diagrams
Visio	Microsoft	Y	N	N	O	$259	Visio has been a leading business graphics tool on the Windows side with good tools for graphs, diagrams, facilities management, etc. Strong support for Office products gives Visio a lead for many business users. Microsoft has limited access to Visio to the Office suite curtailing its use by some
Xara Extreme	Xara	Y	N	N	Both	$179	Xara had worked with Corel to create CorelXara. Xara was acquired by German company Magix 2008

virtue of its wide use in commercial art and printing, is often specified as a required tool for artists for companies. Adobe has strengthened its position with the delivery of its products in interoperable suites: the Creative Cloud (CC) line of products. In addition, Adobe formats including Illustrator EPS/AI files and PDF have become de facto standards in the industry. Adobe sells its CC tools as subscriptions.

Adobe is closely followed by Corel which was developed originally for the Windows platform and remains strong for Windows users. In addition, CorelDraw has attracted users because of its raster-to-vector conversion abilities including pattern makers and sign makers. It is also strong in office graphics because of its ease of use.

Depending on their comfort with computer graphics tools, artists are likely to use a variety of tools to get the effect they want including raster-based tools. Autodesk is promoting its Sketchbook Pro product, a raster-based product developed for tablets as a tool for industrial artists. Likewise, Corel offers its Painter tool; Ambient Design offers a popular low-cost tablet tool called ArtRage. Work created in these products may be imported into vector drawing tools for final output. The prepress industry is coalescing around PDF and EPS/AI as preferred output formats.

The tablet has become an important tool for artists who gravitate toward the ability to draw with a finger or pen in much the same way one works with pencil and paper. Apple's iPad has enjoyed an early-adopter edge, but Windows tablets with built in digital pens are becoming important contenders. Adobe and Microsoft have teamed up to make Adobe's products work better on touch-enabled screens for Windows devices. In addition Adobe has considerably built out its mobile line of products and is courting third-party developers to work under the Creative Cloud umbrella. Users working with Adobe's mobile products can feed their work directly to their Creative Cloud accounts for distribution or further editing in the desktop products.

There is considerable opportunity in the mobile world for illustration apps. Adobe and Autodesk are strong, but no company can be said to "own" the market.

As the included list suggests, there are also a wealth of low-cost drawing products that may have been on the market for some time. Artists may use them for a particular features or because they are easy to use.

Office Drawing Tools

Tools designed for office applications are usually developed from the ground up for that purpose. In many cases, these products are a hybrid between CAD and drawing tools because the orientation is toward creating 2D drawings for diagrams, chart resource management, simple design, etc. An example of this type of product is Microsoft's Visio, which was originally developed as a simple drawing tool for office users who needed to access vector content including CAD drawings. Another tool, Corel Designer, was originally developed as an all-purpose drawing tool, but Corel has refined it for use with CAD data to create technical illustrations.

SmartDraw is an example of a product that was developed from the ground up as an office productivity tool with a wealth of templates and pre-drawn components for

specific tasks including electrical diagrams, organizational charts, and simple illustrations. It is a Windows tool, but there are similar tools for the Mac such as ConceptDraw. Office drawing tools including Visio, SmartDraw, ConceptDraw, etc., have been relatively stable in terms of price. They do not have large user bases, but they meet the requirements of many office users who do not need full-blown computer-aided design (CAD) tools but need basic diagramming and drawing tools for office work.

Office drawing tools usually offer strong support for Microsoft Office products especially Word and PowerPoint. And, for its part, Microsoft has been enhancing its ability to product graphics within all its products including Word, PowerPoint, and Excel.

Desktop Publishing Programs

Desktop publishing programs are always vector based in order to accurately reproduce fonts and communicate precise visual information for printing. The entire desktop publishing market has been decimated by consolidation and is probably the most stable of all DCC segments. It is also suffering from the effects of the transition of publishing from print to online publishing. There will always be a need for printed material, but increasingly information that was printed and distributed in the real world is becoming digital and distributed on the Web.

The digital publishing software field has been reduced to two market leaders, Adobe InDesign and Quark's QuarkXpress. Professionals who have committed to one product or another tend to stay with it for a long time. In addition, customers do not upgrade machines or software unless it is strictly necessary because to do so will disrupt their production cycle. Publishers working within longer production cycles such as book publishers and some magazine publishers are better able to change direction, but that newspapers and weeklies have to plan carefully to make changes in their production pipeline.

Desktop publishing is one of the oldest subsegments of the computer graphics field. As a result, there are quite a few products that continue to be used in certain industries including Corel Ventura and Adobe's FrameMaker and PageMaker. However, in most professional publishing houses, companies settle on InDesign or Quark as a standard. At one time, Quark's output format was the standard for commercial printing houses, giving it an edge in some cases. Adobe changed the equation with its Acrobat and its PDF format which has been accepted as a universal format for publishing, both online and printed documents.

For individuals and light applications, users might turn to one of the vector drawing products listed in the previous section, or they might choose from a variety of products designed for light publishing including Microsoft Publisher, Print Shop, or Print Explosion.

In general, the desktop publishing market for professionals has consolidated around Adobe InDesign and QuarkXpress (Table 5). There are some enterprise applications that rely on Ventura Publisher or FrameMaker for very long documents or books. These programs are often used for manuals. Users who are not routinely

Table 5 Commonly used desktop publishing programs

InDesign	Adobe	$699	With QuarkXpress the leading DTP program
PageMaker	PageMaker	$499	Adobe's DTP for light applications
QuarkXpress	Quark	$799	One of the leading DTP programs for professional applications
FrameMaker	Adobe	$899	Adobe offers FrameMaker for technical publishing. It has been designed for long documents including books
iCalamus	Inverse Software	129 Eur	Developed from the ground up for Mac OS X by German company Loningen
Microsoft Publisher	Microsoft	$169	Designed for newsletters and short documents
Serifs	Page Plus	Free	This is part of Serif's lineup of older products
Pages	Apple	$79	Part of Apple's iWork suite
PageStream	Page Stream	$99/$149	First sold as Publishing Partner for Atari. PageStream is available for Windows, Mac, Linux, Amiga, and MorphOS
Print Explosion Deluxe	Nova Development	$49.95	Print program for Mac hobbyists. Includes templates for greeting cards, business cards, CD labels, and scrapbooks
Print Shop	Broderbund	$29.95–$99.99	Primarily a tool for hobbyists, Print Shop comes in three versions and has tools for all types of print projects including newsletters
Ventura Publisher	Corel	$599	Ventura was originally developed for the PC platform and was first to incorporate tagging, style sheet concepts, and XML. It is used primarily for very long documents

creating content for print publication may use some of the less-expensive programs for occasional print projects.

Most professionals use either Adobe InDesign or QuarkXpress; however, there are professional users who hang on to PageMaker, FrameMaker, and Ventura Publisher

The desktop publishing software industry is very mature. There is not much growth, nor do professional users switch programs after they have settled on one. As might be expected, the software vendors are seeing a slowdown in sales as their customers are squeezed by declines in advertising and subscriptions.

The print industry is somewhat stabilizing and publishers are learning how to adapt to online publishing. Companies are introducing new tools for digital publishing, and a new layer of management is growing up around back-end infrastructure for online sales and distribution and tracking of advertising. In 2009, Adobe acquired Omniture, which offers web tracking tools. As a result, the company is unique in offering end-to-end tools with content creation and back-end management, but there is a great deal of development going on for web-based distribution.

Adobe has used the Omniture acquisition to build the Adobe Marketing Cloud. It is a much smaller business than Adobe's core Creative Cloud, but it is a fast growing source of revenue. This is a new market with new competitors, but Adobe is unique in owning the tools for creating marketing content including Photoshop, Illustrator, and InDesign, as well as tools for tracking the effectiveness of marketing.

New Platforms and Trends

The process of digital content creation is undergoing further changes as computer processors become more powerful and new capabilities such as touch screens are added. The introduction of the iPad by Apple is opening up the ability to draw directly on the screen. The iPad along with electronic books offers a new platform for content distribution and it is seeing phenomenal uptake. New tablets, including Windows-based tablets with more powerful processors than those powering the Apple iPad, are appearing, and competition will drive down the price for these new devices. There is an increasing interoperability between all tablets and desktop products, allowing professional workflows. As a result, content creation is going to become much more mobile. It will not be necessary to rely on powerful computers for all tasks, and the process of creation will expand to include better tools for sketching and doodling. The freedom of traditional tools is returning and artists also have the additional capabilities of digital tools.

Most significantly, the democratization of digital tools means that capabilities formerly reserved for those professionals who could afford to buy high-end tools will soon be extended to almost anyone who wants them and they are becoming easy enough to use that learning the software is no longer a major barrier. Talent and training, rather than the ability to use certain tools, will differentiate artists.

Summary

Design is organization – it is the organization of ideas into a visual form that communicates. Computer graphics is just one more medium for design, but it touches almost every other medium including filmmaking, magazines, newspapers, television, online video, and web pages. There is a great deal of crossover in design tools. For example, imaging tools are used by filmmakers and video producers, illustration tools are used by desktop publishers, and so on. Increasingly workflows are becoming completely digital. In the case of print, publications are created completely on the computer and sent to the printer in digital format. They may then be repurposed for the Web. Likewise, filmmaking and TV production are also moving to a digital workflow as digital cameras gradually replace film and video tape and digital theaters replace theaters with film projectors.

As mentioned throughout this chapter, the transition to digital has had a tremendous effect on content creation. One of the major advantages of a digital workflow

is the improved ability to organize work all the way from concept to production. The computer and the reduced prices of storage allow users to save every stage of their work to use again or adapt for different mediums. And such capabilities as layers allow an increased level of organization within the project itself. Finally, the arrival of the Web enables people to share and collaborate no matter how close or how far away they are from each other.

It can also be argued that confusion, as digital content proliferates on computers, hard drives, CDs, DVDs, and across the Internet, might also be considered one of the challenges introduced by digital workflows.

There are always two sides to change. The digital revolution has had a profound effect on the design disciplines, bestowing a greater level of organization but also exacting a huge toll in facility, flexibility, and spontaneity. And, if not managed properly, digital workflows can even introduce disorganization and confusion.

Since the introduction of the personal computer, digital content creation software has steadily improved to the point that there is almost no task that cannot be accomplished on the computer. That does not mean it is easy or pleasant for all content creators. More often than not, the tools still get in the way. In the next phase of digital content creation, the tools should disappear giving artists a more direct relationship with the work they create.

Further Reading

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