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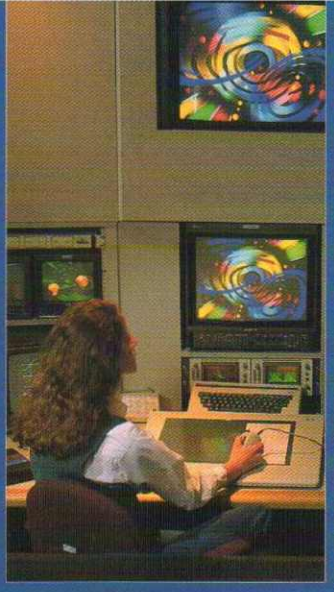

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The Image File Format Mess: What's Your TIFF?

BY VICTOR CALLAGHAN

A look at the on-going problems file format incompatibilities cause for pros in all forms of imaging, in every stage of the process—and a look at what's being done about it

It's interesting to note that when life was described as "a remorseless struggle for existence", no one had yet invented an image file format—or tried to work with one. There are over 100 broad formats competing for dominance now. How does an imaging practitioner make sense of all this? This article will examine some of the key issues involved, present the results of recent research on this issue—and invite you to participate in what could be the biggest survey on image file format usage ever conducted.

Roots of the problem

Historically, the image community was composed largely of highly trained engineers and scientists quick to create their own software and image formats to solve their problems. Given the diversity of end use applications (e.g., astronomy, medicine, publishing, etc.) and a tendency for researchers to use their own specialist conferences and journals for sharing news on developments, it is perhaps understandable that these pioneers of the image field created such a profusion of formats.

And file formats are of *central* importance to all electronic imaging applications, as they govern how easy it is to process, move or exchange images between different systems. Images are obtained, of course, from a variety of sources, ranging from scanners to digital cameras. Even at the point of capture, the question immediately arises as to which format the image should be stored in. The choice of format will be determined by factors such as the intended use of the image, how large it is (i.e., its spatial, contrast and color resolution), whether it is to be compressed (and how e.g., lossless) what auxiliary information is to be stored along with the image (e.g., grabbing conditions, author, etc.).

In scientific applications, the value of the picture may lay in subtle image data variations which may not be perceivable to the eye without the aid of some sort of image processing. Seeing, accessing and comparing text or drawings may be the key impulse in document imaging. In imaging arts, the value of the picture may be in the esthetic composition of the image itself (like any art work). It is clear that imaging applications can have vastly different requirements, in terms of the likes of tolerance to data loss and required auxiliary information.

Unnatural selection

Tools used for the manipulation of images at the various stages of the image life cycle are frequently made by differing companies. For example, a complete system used by an imaging practitioner may comprise an image acquisition system, computer, image processing package, publishing package and printer—all made by different vendors.

In addition, there may often be the requirement to exchange imagery with other systems. For each of these products, the manufacturer concerned has had to decide which subset of all the formats available will be supported. Given the inevitable differences that will arise from such free choice, it is hardly surprising to find that the unfortunate implementer of such a system is left to juggle with the combinations of supported formats, in the hope of finding one in common to all the components that will provide all the functionality required. A few moments consideration of this problem will lead you to understand how some companies make a comfortable living by selling file format translation products!

Image file format leaders

Table 1 summarizes the results of an informal "format popularity" poll which I conducted on Usenet in early 1993. It's probably not surprising that **TIFF** (Tagged Image File Format) came out top of this list. It was developed in 1985 to service the needs of scanning and desktop publishing companies. Its aim was to help prevent the introduction of competing proprietary standards by offering a fairly universal level of functionality which, in turn, has made it relatively complex. (It's also worth noting that at last count there are at least 130 flavor variations on what might be called a "TIFF file", reason in itself for some of today's confusion.)

Table 1: CAP Survey

FORMAT	USAGE
TIFF	48%
GIF	33%
VIFF	30%
PBM family	27%
Homebrew	24%
Targa	21%
SunRaster	18%
SGI	15%
EPS	9%
FITS	6%
PCX	6%

[Percentage of respondents who reported use of a given format; many chose multiples.]

GIF (Graphics Interchange Format) was developed by Compuserve, an on-line information service, to give its users a hardware independent way of exchanging color image files. **VIFF** (Visualization/Image File Format) is the image file format for the Khoros image processing package, popular in scientific imaging circles. In addition to supporting Khoros, it was intended to aid the exchange of imagery between institutions. PBM (Portable Bit-Map) is a family of formats which support the PBM plus file for-

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mat interchange package. The format was developed originally to allow bitmaps to be sent by mailers unable to handle pure binary. Homebrew refers to formats specifically developed for in-house applications. Targa (or TGA), SunRaster and SGI were, obvious;y enough, introduced by Truevision Inc., Sun and Silicon Graphics, respectively, for use on their range of workstations and video graphics products. EPS (Encapsulated PostScript) originates from Adobe and differs radically from conventional formats in that it is really a page description language rather than a bit map or array. FITS (Flexible Image Transport System) image file standard was developed to service the specialist needs of the astronomical community. ZSoft Corporation's PCX (PC graphiX) and the variant PCC (PC Clip art) are prominent in IBM PC applications.

A universal format

While in theory it should be possible to define a universal format which could be used by all imaging disciplines, in practice, providing the full gamut of features required by every application would lead to such a standard being highly complex. This in itself might be a deterrent to many developers who would have to weigh simplicity and performance considerations carefully against the benefits of easy imagery interchange.

Considering the need to create a common standard, TIFF (Tagged Image File Format) has proved itself to be more universal than most formats. It has massive flexibility built into it in the form of labelled fields (i.e., tagged fields) that can be added as required to create a very flexible format. To manage complexity, TIFF uses a notion of classes which split the fields into groups, forming minimum sets for certain applications. This allows TIFF writers to be fairly simple although readers remain relatively complex.

For some time, there have been calls to develop a single, vendor independent, universal standard. As this magazine has reported over the many years of its development, such an international standard is currently being developed under the auspices of the ISO and is known as the IPI (Image Processing and Interchange) standard (ISO-12087). It started life in 1990, after an ISO letter ballot, and is slightly unusual in that it addresses both image transfer and processing. The standard is organized into three parts: generic architecture, programmers' imaging kernel system (PIKS) and the image interchange format (IIF).

Like TIFF, it uses the concept of subclasses (called Profiles) to limit the complexity for a given application. IPI is still at least 2 years away from being validated as a full standard. Finally, for those interested in general purpose solutions, the National Center for Super-Computing Applications (NCSA) at the University of Illinois at Urbana-Champaign has developed a system HDF (Hierarchical Data Format) which can be used for images and other data. If the number of competing image file formats is to be reduced, universal formats will need to be capable

Overcoming Image File Format Problems under PostScript

BY JESSICA M. BAILEY

Helpful control and conversion schemes for transferring and printing your imagery successfully under various image formats

Do you wonder why your images don't *print* as expected, or why you can't transfer an image between two software applications that both support TIFF? Whether you're outputting engineering document files, color photos for catalog publishing, attempting to e-mail a medical or satellite image file (or many variations), you can come up against this problem—and probably do.

One image standard that great numbers of professionals often use is PostScript; most applications today can either export an Encapsulated PostScript (EPS) file or print a PostScript file. PostScript has become so popular precisely because most printers and plotters can handle these files. However, since PostScript is a language, not a format, it must be interpreted before it can be printed or displayed. That can make PostScript very slow (you'll not be surprised to hear); it makes PostScript files quite large, and can also lead to misinterpretation of the image, depending on the quality of the translation. Still, the ability to read PostScript files can extend the flexibility of most systems.

Avoiding the format pitfalls

You *can* control the image transfer process if you understand how to avoid the pitfalls you can encounter when transferring or printing an image. In truth, the ongoing, rapid proliferation of imaging formats causes most format conversion problems, and there are four basic ways image formats proliferate:

1) Loosely written standards can allow hundreds of variations of a single format (e.g., TIFF has 4 bit-depths and 6 standard compression types, and vendors regularly add their own compression types).

2) Application developers make mistakes and implement format standards incorrectly.

3) Formats can have a history of variation before they become standardized and continue to evolve after standardization.

4) Many vendors generate new formats specific to their own application because that gives them more technical flexibility and sometimes more business protection.

Image Alchemy converts a TIFF image to HP RTL on a Hewlett Packard HP 650c. Photo courtesy Oliver Woehrmann.

Applications really cannot be *expected to support all* standards and vendor-specific formats because there are so many, and the specifications are updated at a healthy rate. It may not even make business

of widespread application while keeping the associated programming complexity low enough to ensure easy usability.

Life in the jungle

In the absence of a international standard, one is left having to select which sub group of all the available formats a given application should support. This requires a comparative evaluation of image file formats, which is a daunting task. The main difficulties arise from the large diversity and quantity of image file formats in use. This, coupled with lack of any standard way of describing formats, leaves the unfortunate inquirer with an unenviable job.

The principal objective of a good image file format is to provide a structure which maximizes the utility of image data across a set of applications. Given the diverse nature of applications it is hardly surprising that there is such a profusion and variety of image formats in the world. Since a digital image is essentially just a two dimensional array, such an abundance of file types indicates there are many differing needs or opinions as to the best way of structuring image data. Thus, the selection of an appropriate image file format can be a most difficult task.

Table 2: Example of some CAP Metrics

FORMAT	Popularity	Complexity	Taxonomy
ISO12087	-	5	HE
HDF	-	5	HE
TIFF	1	5	HE
Photo CD	-	4	HE
Targa	6	4	HI
GIF	2	3	FI
PBM family	4	2	FI
SunRaster	7	3	FI

Which image format for you?

So, the question of how to select a format for a particular application arises. In sense for a truly innovative, cutting edge application developer or hardware manufacturer to devote their resources to image format support.

Successful format conversion also takes experience. The technical difficulty involved in reading and writing formats occurs because there is no structural reason to include any information in the image header beyond what the original programmer(s) felt was necessary for that system. (Formats are generally created as part of an system rather than as a standalone entity.) Often critical information such as whether the image is read top-down or bottom-up is left undocumented.

Conversion utilities

Converting your image from its current format directly to the format you need is the fastest and safest way to convert an image. Sometimes vendors collaborate to make sure that image conversion to their specific formats is successful. When they don't, your other option is to purchase an image conversion utility.

A conversion utility should support a comprehensive list of formats from as many different platforms and operating systems as you are likely to encounter. (For example, a customer of ours at Handmade Software receives images generated on Macintoshes, PCs and UNIX workstations originating from many different applications—including the ancient Harvard Graphics version 1.0. He then prepares slideshows by converting these files to Scodl for Agfa's Slide Recorder.)

Even conversion utilities are not necessarily committed to thoroughly supporting each variation of difficult formats like TIFF. Be sure to compare apples to apples: some conversion utilities imply comprehensive support of format "variations" by simply listing a number of mass market applications which they support; of course each application doesn't necessarily have a different variation. Also, if you use public domain software, these conversion routines are often written to solve a specific conversion problem and probably will not offer complete format support. They may be worth a try if you have the time; the price is right. For retail products, check for guarantees, and look for technical support reputations.

A conversion utility should allow the user *control* over colorspace (e.g., RGB, CMYK), and a variety of dithering *choices* optimized for specific situations. It helps if the manual teaches you what the parameters mean. Controlling these options may including the ability to generate a palette, or to optimize a palette for a group of images when creating a catalog or manual which uses images from various sources. (This kind of control is critical for our high-end service bureau customers, but it's also necessary for our engineering customers who plot color images on the Encad Novajet or the HP 650c, *shown in photo.*)

Final considerations

The last technical piece of the puzzle is to make sure the the scaling algorithms are first-rate when you resize an image. Enlarging an image requires literally spreading the image apart, and reducing it means omitting information, and the software has to deduce what happens to the image. This procedure is mathematically complicated, and poor scaling leads to pixelation (aliasing). The simplest type of scaling is Nearest Neighbor scaling, but most people will find the results unacceptable and need at least linear interpolation scaling algorithms. You may need to demo the software to convince yourself of the quality of the scaling abilities, especially if your reputation rests on the quality of your images.

There are a few other potentially important features: the ability to compress images (*and again to control the compression if it is lossy, like JPEG*), the ability to view the images in the conversion utility, and the ability to do batch processing. These features may be critical to your operations, they may become important as your needs change, or they may be irrelevant. Except for compression, they do not impact the technical aspect of converting the images, but they may or may not be included in an image conversion utility.

At Handmade Software, Inc. (Los Gatos CA), we've created the software packages Image Alchemy, Image Alchemy PS, and Image Alchemy Prepress to run on PC and compatibles and UNIX workstations and efficiently convert some 67 image formats, including TIFF, Targa, Sun Raster, Silicon Graphics, MacPICT, Windows BMP, PCX, XWD, IFF/ILBM, Adobe Acrobat's PDF, Photo CD, and the printer and plotter formats HP RTL, Novajet, and Calcomp. Image Alchemy PS is a PostScript interpreter, and Image Alchemy Prepress additionally supports Scitex and Iris formats. All of our tools were designed to deliver solutions on the key points I've described. ■

Jessica Margolin Bailey is the Director of Marketing at Handmade Software, Inc. For more information on Handmade Software, call: (800) 358-3588 or +1 (510) 252-0101, or call fax-on-demand at +1 (510) 252 0303.

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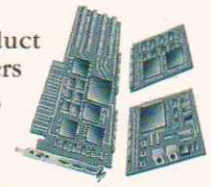

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some cases, the format choice is dictated by the use of a third party imaging package (e.g., Khoros users will adopt VIFF). However, those writing their own imaging software will have a less constrained choice. For such developers, if portability is a prime issue, then a major factor might be the relative popularity of formats.

For others, reducing programming effort or increasing software performance might outweigh portability considerations. Popularity is sometimes obtained by making the format general purpose which can in turn make it more complex, thereby increasing programming overheads or reducing performance. In these circumstances, a developer might prefer to use his own internal format (homebrew), which is well tailored to the application. The high position of homebrew formats in popularity ratings is clear evidence of this. It is apparent that in making the decision on which format to adopt, information on the popularity, complexity and functionality of formats would be useful. Whilst, in theory, this information could be extracted from file format specifications, in practice the diverse origin of these formats means that they are frequently difficult to understand and make any comparative analysis a tedious affair.

Metrics to the rescue

In everyday life, high level specifications are often found to be helpful when narrowing down choices prior to more detailed technical investigations (e.g., when buying a car or stereo). Such high-level specifications can equally be used as an aid to image file format selection. Recently, a set of high level specifications referred to as *CAP metrics* has been proposed which address the problem of comparing the virtues of image file formats. CAP metrics describe such characteristics as the popularity of a format, its relative complexity and potential flexibility. For example, the following table lists the most popular formats (*popularity rating*), together with two other CAP metrics, complexity ratings (referred to more formally as a *transformation index*) and *HI-FI taxonomies.*

The complexity rating is a measure loosely related to the number of transformations a software reading routine might have to perform on a given format before it can be displayed (e.g., decompression). The taxonomy is based on the premise that internal field hierarchy and labelling have a fundamental effect on the overall logical structure of a format. This taxonomy categorizes image file format structures as being one of four main types: HE (Hierarchical Structures with Explicit Labels), HI (Hierarchical Structures with Implicit Labels), FE (Flat Structures with Explicit Labels) and FI (Flat Structures with Implicit Labels). The use of field hier-

(continues on page 85)

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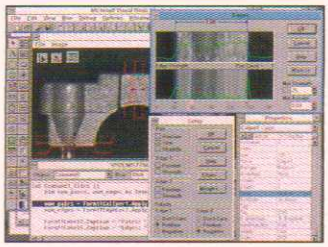

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CALLAGHAN

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archy and labels increases the flexibility of a format but places an overhead on a format reader which must be able to deal with these structures. Thus, as Table 2 also illustrates, such structures increase the complexity rating.

Popularity gives evidence of the potential user base, whilst the taxonomy might be used to assess the flexibility of the format. Complexity provides an indication of the relative programming difficulty. Such information can be difficult to distil from the varied and frequently complex format specifications. Another factor to consider is how well the features a format offers are matched to your application. A useful graphical representation known as a *functionality profile* is also included in CAP metrics, and gives a simple pictorial impression of the quantity and distribution of features within a format. In essence, a functionality profile is a histogram describing the distribution of features within a format.

As with most decisions, the choice of format will usually be a compromise between conflicting ideals. Thus, when choosing an image format, you have to balance such aspects as programming complexity, flexibility and popularity. The CAP metrics represent a convenient mechanism of summarizing some of the main factors involved and should serve as a good starting point to those searching for a suitable application format before they expend too much time wading through rather lengthy and complex descriptions of the standards themselves.

The future

Whether any single image file standard can stem the profusion of formats and bring order to this turbulent area is highly debatable. Clearly, devising a format to satisfy all imaging requirements, while keeping its level of complexity low enough to ensure widespread usability, is a most difficult task. Many argue that the "Achilles heel" of all universal formats is complexity which will result in there always being considerable opportunities for tailored formats.

There is a clear tendency in the newest formats to sacrifice simplicity for increased flexibility. In many respects, this is inevitable; if a file format is to assume the mantle of a real standard, it needs to be able to adapt to the unavoidable technological advances that will occur over its lifetime. Some would suggest there is a dilemma that only the market can solve; programmers want simplicity but successful standardization demands flexibility and thus increased complexity. Which view will predominate? The answer is in your hands! ■

SUM of the PARTS

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Program" has proven itself very successful in field trials. There is a significant amount of enthusiasm that it will prove successful on a much broader basis—and the recent exposure in Washington is expected to provide a most beneficial boost to the companies' commercialization plans. As this column regularly reminds you, a well-designed, well-marketed cooperative effort can be more efficient than the "sum of the parts."

The future

CAEI has been most successful in a short period of time bringing together private industry (both manufacturers and users), technology providers, academic institutions, and governmental entities for the common cause of promoting electronic imaging.

CAEI has also been successful in facilitating and encouraging the cooperative efforts between member companies such as Advanced Graphics and Creative Education Institute to the mutual benefit of both entities.

If enthusiasm by participating entities is any measure of future success, the leaders of the Center for Advanced Electronic Imaging (CAEI) have developed a model for an infrastructure to effectively bridge the gap between technology providers and the ultimate user to the benefit of all. ■

ADVANCED IMAGING
Image File Format Survey, March 1994

We want to know how image file format issues are impacting your work—so we can report it to all of you in an upcoming issue. Make a copy of this form, completed, and fax it or mail it to the addresses below by May 2, 1994.

1) Which image formats do you use? Circle all letters that apply—AND CIRCLE NAME of your *main* format.

a. BMP	g. GIF	m. PBM	s. TARGA
b. CCITT	h. HDF	n. PCX/PCC	t. TIFF
c. EPS	i. HIPS	o. Photo CD	u. UTAH
d. FBM	j. Homebrew (In-house)	p. PICT	v. VIFF
e. FITS	k. IFF	q. SGI	w. XBM
f. GEM	l. IPI (ISO-12087)	r. SunRaster	Note others: _____

2) Have you personally experienced problems caused by the large number of formats?

a- OFTEN b- SOMETIMES c- NO

3) Do you believe an international standard like IPI/ISO 12087 will be widely adopted by vendors and developers?

a- YES b- NO

4) Which image file features do you consider most important in deciding to support or use one? (Circle 1 to 3 choices)

a. simplicity	d. wide commercial acceptance	g. well-documented specification
b. universal functionality	e. acceptance in your discipline	h. no charge for specification
c. tailored for your discipline	f. set world standard	i. improves processing efficiency

5) Which forms of imaging does your work entail. (Circle all that apply):

a. Document imaging
b. Electronic still imaging for arts/commercial
c.Electronic still imaging for scientific/industrial
d. Digital video imaging

OPTIONAL:

Name: _____

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FAX BACK TO: Advanced Imaging, at U.S.# (516) 845-2797.
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