J. Webster (ed.), *Wiley Encyclopedia of Electrical and Electronics Engineering*

ADVANCED PUBLISHING TECHNOLOGIES AND SERVICES

The printing press was invented by Johann Gutenberg in 1455. This device launched the publishing industry, which has played an indispensable role in every aspect of human affairs. Over the centuries, print publishing continued to evolve as improvements were made in equipment, materi als, and distribution of the product. However, for more than 500 years, the basic paradigm remained unchanged: the publication process was a linear one from author to publisher to reader. The advent of desktop computers set the stage for the next revolution in publishing, one whose full effects have yet to be felt: electronic publishing. This phenomenon is actually two revolutions that occurred in rapid succession: desktop publishing and online (Internet) publishing.

Just as political revolutions often give rise to a period of chaos—a decentralization of control—that lasts until a new government is established, each major advance in electronic publishing has created similar chaos. In the traditional publishing model, for example, the publisher's reputation aids the reader in judging the accuracy and credibility of the publication. A book published by a major university press, for example, has more immediate credibility than the same book published by an obscure or vanity press. Likewise, the library has long provided assistance to the reader by organizing and cataloging the vast and diverse contents of its collection. Electronic publishing gives authors more control over the creation and distribution of their work, but a burden is then placed on the reader to find content that is of authenticated value. Over time, this burden becomes intolerable, and standards are developed to assist the reader in validating the credibility of published information and to manage the sheer volume of this information.

Desktop Publishing

Desktop publishing is the use of desktop computer technology to design "camera-ready" documents (newspapers, brochures, catalogs, and so on) that integrate text and graphical elements. The desktop publishing revolution began in the mid-1980s, when computers and printers became small, affordable, and powerful enough to be able to perform many functions, including typesetting, page layout, graphic design, photo retouching, and printing on high-quality paper.

The key elements that came together to enable desktop publishing (see Fig. 1) were

- Personal computers using direct manipulation interfaces and bitmapped graphics displays
- Support in personal computers for typography
- Affordable laser printer technology that enabled high-quality output
- Page layout programs that exploited these devices to bring traditional pre-press activities into a WYSIWYG ("what you see is what you get") interactive environment.

Desktop Computers. The first desktop computer to achieve popularity was the Macintosh, a product of Apple Corporation. Its easy-to-learn, easy-to-use commands and highly graphical screens were key to its appeal. Before long, IBM introduced a rival product, the personal computer (*PC*). Many users still preferred

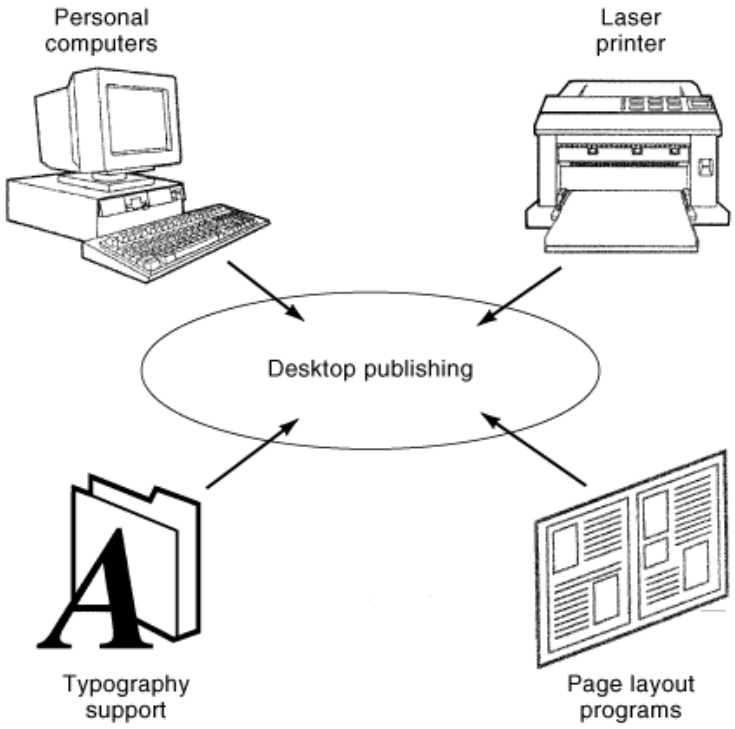

Fig. 1. *Figure 1.* Today's desktop publishing was shaped through a collaboration of personal computer, laser printer, typography, and page layout program technologies.

the "Mac," however, because the *PC*'s disk operating system (*DOS*) was text-based and difficult to learn; its command screens resembled those used in mainframe computing. Oddly enough, the Mac's superior usability caused it to be dismissed as a "toy" by many computer industry professionals. IBM and other companies continued to manufacture *PC*s, which gained a strong foothold in businesses and government. Graphic artists, however, were steadfast Mac users, and as a result many of the more sophisticated graphics software packages were developed for the Mac rather than the *PC*.

In the early 1990s, the Microsoft Corporation released software for the *PC* that radically changed *PC* computing. Known as Windows, this tool gave *PC* users the same advantages enjoyed by Mac users: graphical screens, pull-down menus instead of typewritten commands, the ability to have multiple applications open on the desktop screen at one time, and the possibility to transfer information among these applications. Windows quickly became the standard interface for *PC*s, Windows-compatible software proliferated rapidly, and desktop publishing grew even faster. Similar changes occurred in other important desktop platforms (e.g., UNIX and X-Windows). Thus, in less than ten years, a technology originally dismissed by many as not good enough for professional work has become the standard tool of designers and publishers worldwide.

Desktop Color Publishing. One aspect of true professional-quality desktop publishing output remains elusive. While desktop printers are now available with sufficient dots per inch (dpi) to provide clear, crisp type in a wide variety of fonts, desktop color printing is not yet equal to that achieved by offset printing. On the surface, the solution appears simple enough: obtain new output devices and new software that handles color. The technological difficulty lies in getting consistent, predictable color throughout the design and production process. The strategies to address this problem are known collectively as *color management*.

Color Management. Fundamentally, WYSIWYG color is an unattainable ideal. Some colors you see on a red, green, blue (*RGB*) additive color monitor cannot be achieved in cyan, magenta, yellow, black (*CMYK*) subtractive color printing. Also, there are colors you can print that you cannot see onscreen. In addition, every color input and output device has its own characteristic limitations in gamut, contrast, and distortions. The objective of color management is to provide the best predictable approximation of the original scene or design colors given the limitations of screen or ink.

Color management technology has four primary components: standard formats to describe device profiles, support for color management within the operating system of computers, the ability to create profiles for specific devices, and application software awareness of color management. The device profile and its support are the key to color management. A profile describes the color response characteristics of a device. Device manufacturers provide a "standard" profile for a "typical" sample; for example, a particular monitor model. Software and hardware products are also available to create custom profiles tuned to a particular device in use. A color-transformation engine (built into the operating system) uses the CIELAB color model to represent the behavior of real-world acquisition and imaging devices as described by their profiles. (CIE stands for Commission Internationale de l'Eclairages, an international color standards group. LAB refers to the three aspects of color as seen by the human eye: L is relative lightness; A is relative redness–greenness, and B refers to relative yellowness–blueness.) This transformation engine uses CIE to correct the distortions of, and translate between, for example, the *RGB* color space of a particular monitor and the *CMYK* space of a particular color printer. Color transformation engines will continue to improve as will the quality of color management support within the major operating systems.

Color Output Devices. There are several families of technology for color output devices, including color ink jet, thermal wax transfer, color laser, and dye sublimation (see Fig. 2). These technology families are listed in rough order of increasing cost and output quality. The important distinguishing factor is the manner in which the coloring agent is mixed and delivered to the print medium to form one of the millions of possible color mixtures.

Ink-jet printers spray microscopic ink drops from a head onto the print medium. Thermal wax printers melt a wax to a liquid form that is applied to the print medium. Color lasers produce a static electrical charge that is used to attract toners in each component color, which are then fused to the medium. Dye sublimation printers heat dyes to a gas, which is mixed while traveling from the print head to the print medium surface.

Hi-Fi Color. Even with the use of color management technology, there remain significant limitations in four-color (*CMYK*) process printing. Hi-Fi color systems (for example, the six-color Hexachrome process) produce a significantly larger range of colors and offer enhanced control of hue, saturation, and blending. This trend has not yet been widely adopted, although support for enhanced color processes is already appearing in desktop publishing software.

The Future of Print Publishing

Many pundits have predicted the demise of traditional print media in the face of online publishing. However, most experts believe that the "paperless society" will remain only a concept. Just as radio and television have not killed the magazine and newspaper industry, the Internet will not kill the print publishing industry. Paper, often underrated as a communication medium, will not be eliminated by the growth of electronic media. It remains inexpensive, extremely portable, and capable of carrying very high-resolution images.

Desktop publishing progress should be expected to continue to lower the barriers to paper publication as it has done for over a decade. As it becomes easier to publish on paper—especially in color—more and more people will do so who in the past could not because of the high cost and high level of expertise required.

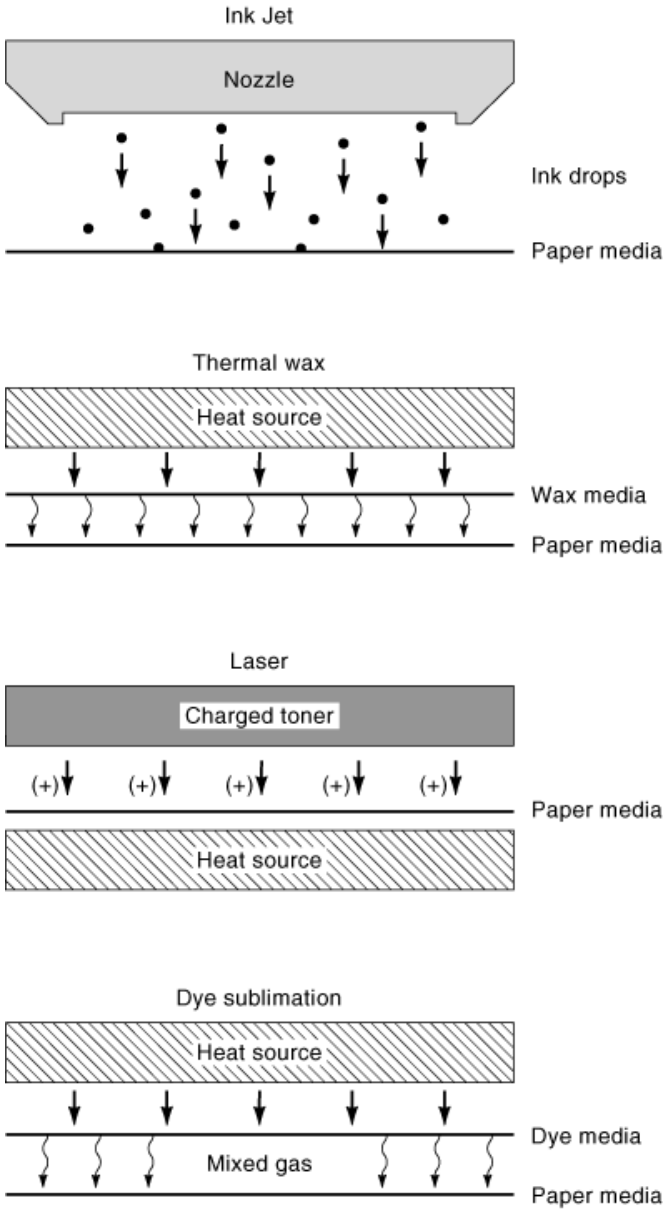

Fig. 2. *Figure 2.* There are four main printer technologies used to produce color output: ink jet, thermal wax, color lasers, and dye sublimation. Each printer's coloring agent is mixed and delivered to the media in a different way, illustrating the distinguishing factor between each technology.

One major limitation of electronic publishing, however, is its reliance on proprietary software and equipment that are always in the process of becoming obsolete. Also, as the cost of paper and shipping continues to rise, the commercial publishing houses, the federal government, and other large businesses that gener-

ate a large amount of documentation need to economize by streamlining the publishing process itself. These organizations are turning to industry standards for the solution.

SGML: An Attempt to Standardize Markup. In 1986, the International Standards Organization (*ISO*) published Standard 8879, Standard Generalized Markup Language (*SGML*). A programming language for the electronic markup of documents, *SGML* enables document reuse and interchange. *SGML* code is based on ASCII text with a few simple markup conventions. It can be read and understood both by computers and by humans.

SGML is a powerful tool for publishers because it distinguishes between the *information content* and *structure* of a document—both of which are concerned with meaning—and its *format*—which concerns how the information is displayed. The distinction can perhaps be clarified by a familiar example. In most text-processing programs, the author or compositor can mark, or *tag*, one or more characters so that they print on the page (or display on the screen) in *boldface type*. What is the significance of the boldface font? Is the author intending to emphasize the information? Does the information constitute a label or a heading? The human reader may deduce this from context, but the computer cannot. The markup command is *specific*; that is, it tells the text-processing software how to display that particular piece of information. However, the same code could be used many different times to mean different things in the same document.

The "generalized" aspect of *SGML* means that markup is used consistently throughout a document or document set. The tags that are used to mark up parts of a document have a consistent meaning that is defined in a separate file, called the document type definition (*DTD*). One *DTD* can apply to many documents. This is, in fact, where *SGML* is most useful: handling a large documentation set that has a consistent structure.

To produce an *SGML* document requires yet a third piece, the Document Style Semantics and Specification Language (*DSSSL*), which "translates" the tags into a prescribed format. Using different *DSSSL*s, a publisher can output the same document in a variety of formats, such as hardcover, paperback, large print, and Braille.

Although *SGML* is used by both government and commercial entities, the upfront investment is substantial. Creating a *DTD*, for example, requires a thorough document analysis process that is not economical or practical unless either (1) publishing is the primary business of the company or (2) the documentation involved is both vast and critical to operations (e.g., aircraft maintenance manuals). There is also a need to train authors and editors in the proper tagging of documents. So far no commercial off-the-shelf WSIWYG tool has emerged to assist in (or better yet, eliminate) the learning curve. To use *SGML* effectively requires an organizational culture of appreciation for rules and consistency that has grown rarer, thanks in large measure to the desktop computer which has largely decentralized the publishing process in many companies. As a result, the use of *SGML* is limited, despite its many advantages.

Online Publishing

The first wave of the electronic publishing revolution, desktop publishing, has opened up many opportunities for authors and publishers, but it still adheres to one aspect of the Gutenberg paradigm—the product is still a static, paper publication. Printed publications have several inherent limitations:

- The information in printed publications becomes out of date immediately.
- It is cumbersome for the reader to follow cross-references within and among publications. It is even harder to search through one or more print documents for a particular fact or concept.
- Printed publications occupy a lot of shelf space.

These limitations have become less tolerable as the number of publications and the need for the information they contain continue to increase astronomically, to the point where terms such as "information overload," "information anxiety," and "info-glut" have become common parlance since the late 1980s.

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Online (or Internet) publishing, the second wave of the electronic publishing revolution, promises significant advantages over traditional paper publishing:

- Quick access to information
- Interactive capabilities
- Ready integration of multimedia
- Fast, economical distribution
- The ability to search and index text
- Easy, real-time updating of materials
- Greater consumer control over the information experience.

Online publishing can appear in many forms, from an interactive compact disk with read-only memory (*CD-ROM*) or digital video disk (*DVD*) title to a document library on the World Wide Web. These delivery forms can be readily combined to achieve a balance between volume and timely content. The Web, in particular, has launched viable multimedia publishing. New electronic presentation formats have facilitated the inclusion of sound, video, and animation in a publication.

The associated production issues and challenges of this medium are different from those of print publishing, but no less pressing. In fact, the info-glut problem has been compounded by the rapid growth in Internet publishing, particularly via the World Wide Web.

The Web Revolution. In the early 1990s, publishing gained a vital new outlet in the form of the World Wide Web. A subset of the Internet, the Web offered a major advance over the primarily text-based means of electronic interchange available until then. The Web, accessible at the desktop computer via a special viewer or "browser," is able to display inline graphics and offer media as well as text; it also makes use of *hypertext*—a means of linking among parts of a document or to other documents.

This advance was made possible by the development of the hypertext markup language (*HTML*) by Tim Berners-Lee in 1991. *HTML* caught on very quickly because it is easy to learn and inexpensive to use in publishing. The proliferation of *web sites* has truly been explosive. In October 1998 it was estimated that nearly half a million such sites exist, and growth shows no sign of slowing. Web sites can be updated frequently, and there are no incremental distribution costs. In many cases, companies have ceased to produce paper versions of certain types of documents (newsletters and policy manuals, for example) and have achieved measurable cost savings. Office workers have become accustomed to using their desktop workstations as a primary information resource, and as a result corporate *intranets* (internal networks) are flourishing.

URLs. Documents contained on the Web are published at specific "addresses" called *uniform resource locators* (*URL*s). A company or individual sets up a web server, purchases a *domain name*, and establishes a *homepage* or website. A typical *URL* is http://www.mycompany.com. Its components can be identified as follows:

http://. This tells the browser that the *hypertext transfer protocol* is being used.

www. The name of the web server. In actuality, any name can be used for the server, but most web publishers choose www because it has become so common that it is intuitive for those who do not know the *URL* and try to guess at it.

mycompany.com. The domain name purchased for the server. The first piece, *mycompany*, is usually the name or initials of the organization. The second piece, *.com*, indicates that the organization is a commercial entity. Other common domains are .org (denoting nonprofit or other non-commercial entities) and .gov (denoting government organizations). New domains are being established, because the demand for domain names shows no sign of decreasing and, like telephone numbers, the supply will eventually run out!

HTML. *HTML*, the hypertext markup language, is by far the most important content type on the web. Based on *SGML*, *HTML* is a fairly simple system of marking up American standard code for information interchange (*ASCII*) text with *tags* that specify either presentation information (bold, centered, font change) or structural information (title, heading, emphasis). *HTML* has evolved rapidly to include features for fairly precise and elaborate presentation (much like a page description language); structural features have evolved less rapidly.

An essential feature of *HTML* is that it supports hypertext or more generically *hyperlinks*. This feature allows parts of one page to reference other pages, and the viewer may follow the link with a simple click of the mouse. Soon few people will remember that Internet information was once essentially unreachable without a painful and protracted exploration with a number of isolated tools.

The important feature of *HTML* is that it may serve as a container to hold other formats of information, such as inline graphics, movies, or sound. Although the hyperlink allows for reaching other kinds of media, it is the inline embedding that makes a diverse multimedia information source feasible. As *HTML* continues to evolve, mechanisms are added that allow dynamic behaviors to occur. These include active elements such as scripting or Java applets, which are essentially small computer programs embedded in the *HTML* code.

While *HTML* itself is nonproprietary, a seemingly infinite selection of *HTML* authoring tools are available at prices ranging from free to several hundred dollars. Some of these products produce *HTML* files that can only be edited later using that particular tool. The disadvantage of this approach should be obvious.

More Content Types. As noted previously, an *HTML* file may link to or display inline other types of files and other media. Some prevalent examples are graphics, audio, video, animation, and virtual scenes. Most of these formats and media types are proprietary and require specific "plug-ins" or "helpers" to be used.

One important example is the portable display format (.pdf), a product of Adobe Corporation. In its early versions, .pdf was an online page description format. Its primary use was to capture page images of formatted documents; these images would display on the screen and print on any printer as "exact replicas" of the original source. A .pdf file is created directly from the source information or from a PostScript (a page description language that Adobe created) rendering of the original source. This format is used extensively for documents for which it is desirable to preserve the original format (newsletters, forms, and brochures, for example). Recent versions of .pdf allow for the inclusion of hyperlinks, searching, editing, and multimedia. Leaving Internet publishing for the moment, .pdf is becoming an important format in the desktop publishing world—many service bureaus request .pdf documents for the highest-quality reproduction, and many conferences require submissions to be in .pdf format. Much as PostScript has become the printing language of the world, .pdf may be becoming the electronic portable document format of choice.

There are a wide variety of raster image formats used on the Web, the most important being graphic image format (*GIF*) and Joint Photographic Experts Group (*JPEG*), which are both understood by all browsers. The tiff format (similar to .pdf but nonproprietary) is also frequently used. There are also a variety of video formats prevalent on the Web, including proprietary formats such as Quicktime and RealVideo, as well as industry standard formats such as Moving Pictures Experts Group (*MPEG*) and Audio Video Interleave (*AVI*). Video on the web is a highly technical subject in its own right, requiring the publisher to have detailed knowledge of the target audience, the availability and popularity of the required "viewers" in the audience, the likely network connectivity of the audience, and the nature of content and compression effects on quality.

Enriching HTML: HTML 4.0 and XML. As noted earlier, while the flexibility of *HTML* is a great asset, its lack of rigor eliminates one key advantage of *SGML*; namely, the separation of format and structure markup. At first, this was not seen to be a problem when the Web was still largely experimental. Now that Web publishing is key to nearly every government agency and corporation, however, the realization that websites are costly to maintain has begun to generate interest in Web management tools.

Particularly for corporations in competitive industries, it is important to be able to update not only content but appearance. Web technology advances quickly and thus also what is considered "cutting-edge" website design. Because *HTML* does not rigorously enforce the use of structure codes rather than format codes

(e.g., there is a code for emphasis, but many Web developers use the code for bold instead), it is a considerable expense to change the design of a set of *HTML* files.

Published in 1998, *HTML* version 4.0 reintroduces some of the distinction between format and structure markup. Certain codes are no longer allowable; new codes are introduced. Once the commercial browsers adopt the *HTML* 4.0 standards, websites that use the codes as intended will reach a greater range of audience and create content of higher value.

In conjunction with *HTML* 4.0, a capability called *cascading stylesheets* (*CSS*) has been developed by the World Wide Web Consortium (W3C). *CSS* is an output specification, essentially a *DSSSL* for *HTML* documents. It is a separate file that "translates" the *HTML* structure codes into the desired display format. The same *CSS* can be applied to all the files on a website—for that matter, to all the files on a web server. This capability will make it easier for organizations to deploy a consistent style across their websites and will greatly decrease the cost of updating that style. The *CSS*, by further "abstracting" the presentation, increases the utility of *HTML* to operate over a large range of consumer devices, such as televisions and personal digital assistants (*PDA*s).

An even greater stride toward *SGML*'s original intent is promised with XML, or Extensible Markup Language. XML is a subset of *SGML*. Its goal is "to enable generic *SGML* to be served, received, and processed on the Web in the way that is now possible with *HTML*. XML has been designed for ease of implementation and for interoperability with both *SGML* and *HTML*" (from the XML 1.0 specification published in February 1998 by W3C, http://www.w3.org/TR/REC-xml). It is hoped that XML will greatly improve online searching by enabling the tagging of content for meaningful indexing. If this indeed proves to be the case, XML may help solve the information overload problem that has grown much worse in recent years.

The Future of Online Publishing

The mere act of publishing does not necessarily ensure that information reaches its intended audience. The medium chosen for publication has always had a profound impact on the audience's ability to access the information. Distribution channels, shelf placement, and advertising have also had a major impact on audience exposure to published material. Online publishing removes some impediments but introduces others.

Accessibility. When preparing a publication for access over the Internet, a publisher makes many decisions that affect the audience discovery of and access to the work. The fundamental limitation is that access to the Internet and the Web is by no means universal. Even those who are connected are limited by workstation type, operating system version, browser type, the availability of plug-in applications needed to run certain file formats, network speed, and audio or motion video capability. If the document requires the use of any technology other than the lowest common denominator version of *HTML*, the Web audience is limited to some degree. In general, the more technology incorporated into the Internet publication, the greater the likelihood that some readers will not have access. Use of the lowest common denominator may not take advantage of the power of the medium and many authors decide to incorporate advanced features regardless.

With proper knowledge and care, however, Internet documents can be authored in such a way as to present themselves to the reader at the level of the technology being used to access them. For instance, an *HTML* document may use JavaScript to enhance document navigation only if the browser supports JavaScript. A static graphic image may be replaced by animation if the browser plug-in or capability is detected.

Other steps can be taken to increase the audience. Readers can be told what technology is required for proper viewing and how to access that technology. It is common to see a website with links to browser download sites if a specific browser or browser plug-in is required by the content. If the reader is given clear instructions on what technology is required, where to locate it, and how to install it and is sufficiently motivated by the document content to go through the trouble of installing new software, he or she will do what is necessary.

The author of an online publication also needs to exercise caution about adopting new technology too soon. In many cases, what is leading-edge technology today will become "baseline" tomorrow. This has happened

repeatedly as new versions of *HTML* have been published and adopted. Only years after *HTML* first began to support tables, however, could an author count on the majority of his or her audience having table support in their browsers. Likewise, not all leading-edge technologies make it into the mainstream. The incorporation of new technologies too early can cause high audience frustration and should be avoided.

At the same time, it appears that the Internet audience has an unusually high tolerance for frustration. They have been conditioned to slow access speeds, browsers that do not behave consistently, and unintelligible error messages. Readers tend to tolerate these problems as long as the information they ultimately obtain is of value to them. Thus, just as with other media—print, television, music—the quality of the content is more important than the technology used to deliver it.

It is becoming increasingly possible for those with physical disabilities related to sight or mobility to access information using a web browser. Tools that read text aloud or respond to voice commands are becoming more sophisticated and available. The success of these tools, however, depends largely on the care with which websites are created. If *HTML* tags are used properly and a few other conventions are observed, Web information can be easier for the disabled to access than is often the case for print. Much remains to be done in this area.

Search Tools. One particularly frustrating experience for the online reader is the process of trying to find the sought-after information. There is not much use in publishing high-quality content if it is impossible to find. However, there is no Internet equivalent of the Library of Congress! Search engines provide a valuable service in helping the Internet audience to find what they are looking for, but the search engines themselves can use help. It is estimated that even the most comprehensive of the commercial search engines (Alta Vista, Lycos, and InfoSeek, for example) have been able to index only about 40% of existing websites. The author's knowledge of how these search tools work can greatly improve the likelihood that his or her documents will be found. Some search engines index their catalogs based on content, others look for *HTML* meta tags (codes that contain information about the document that does not display in the browser window), still others use a combination of the two and a human editor to provide categorization. As discussed earlier, XML offers the possibility for vastly richer tagging of content and, as a result, vastly improved searchability of XML-tagged documents. Of course, it is up to the author to exploit this and other tools to assist the reader.

Convergence. Another emerging trend is the convergence of technologies that will enrich the audience's experience. These include the Internet, broadcast, and telephone systems. With convergence comes an environment in which the audience will have access to a book, the movie based on the book, biographies of the author, and conference calling with the author, all with no clear lines of technological distinction and all using the same hardware devices (see Fig. 3).

Perhaps the most interesting recent example of convergence is the development of electronic paper and electronic books. While these devices are still in their early stages, the basic concept is that the physical paper or book can display content that it receives electronically. This technology allows for updated content while taking advantage of an output medium that is familiar and easy to use.

Electronic "Records". Information stability and reliability on the Internet are growing problems. A cultural shift on the part of the publisher and consumers may be required before progress is made in this area. If the *source of record* for a publication is online, it has to be available essentially forever at a known location (perhaps a *website of record*). Just as we expect that a library will have a book on the shelf today and in the future, we want nothing less from the Internet. Likewise, we would not expect a specific edition of a book to change content, and we expect the same from a website of record. A numbering standard or convention, perhaps similar to the ISBN (International Standard Book Numbering) assigned to a book, may provide a solution. Government, commercial publishers, and academic institutions are the logical candidates for leadership in this area.

Credentials. The credibility of a document on the Internet is always suspect. In print publishing, readers rely on the credibility of the publishing house. Publishing companies offer standards of peer review, editing, and reputation that readers come to trust. On the Internet it is difficult to know where the document came from (the *URL* is often not enough), who authored the document, and whether the named author actually

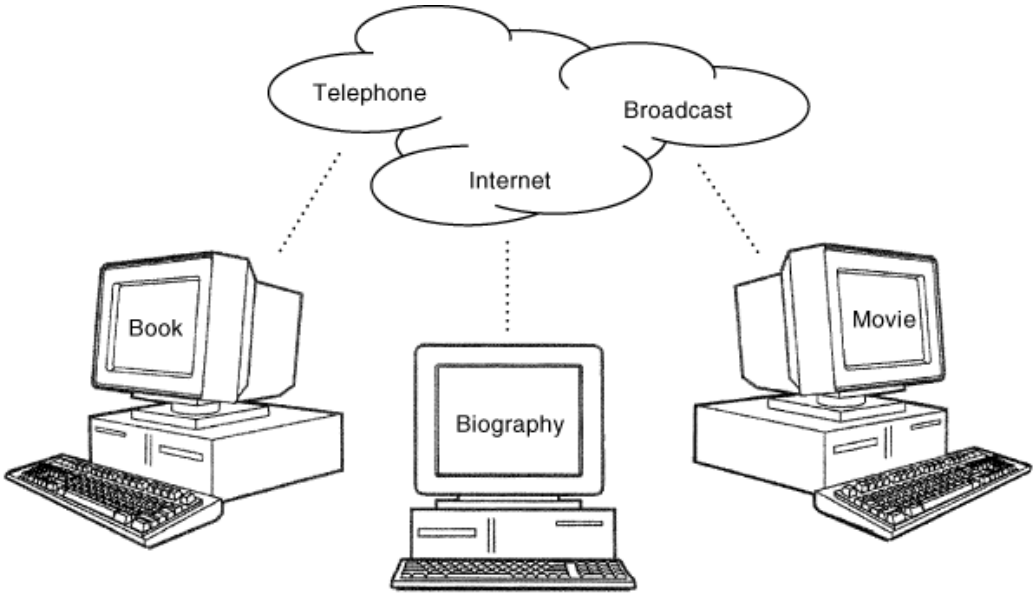

Fig. 3. *Figure 3.* The development of the Internet with new emerging technologies will soon unite broadcast and telephone systems.

created the content. Public Key Infrastructure (*PKI*), originally developed to enable secure online business transactions, may help address these problems. With *PKI*, authors and companies would be able to sign Internet content digitally. By this means, readers can be assured that what they are reading has not been altered and that the named authors and institutions are the true source. When the reader views a document, embedded in the document will be information necessary for the browser to check the digital signatures with independent and credible certificate authorities who hold credentials in trust.

Conclusion

The electronic publishing revolution has moved quickly through its period of chaos. Readers are demanding order in the form of rules, conventions, and standards. These are now being provided in a number of areas and are quickly being developed in others. The future is bright for inexpensive and timely access to a vast array of information.

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PAMELA N. NOVAK
GARY R. DANIELSON
ALAN E. TURNER
Battelle Pacific Northwest National Laboratory