
Design and development of multimedia courseware: An overview

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Parrott, L. and Kok, R. 1997. **Design and development of multimedia courseware: An overview.** *Can. Agric. Eng.* 39:131-137. An overview of some of the basic considerations of multimedia courseware development and use is presented. This includes descriptions of the common types of digital media and their formats. Methods of courseware distribution are also discussed, with emphasis on dissemination via the Internet. The material presented will be of interest to educators considering the incorporation of information technology into their classroom lectures and to those who wish to create courseware for distance learning purposes.

Cet article décrit une série de facteurs à considérer lors du développement de matériel multimédia dédié à l'enseignement. Cela inclut une description de divers types de médias numériques, ainsi que des différents formats qui leur sont associés. Les méthodes de distribution du matériel pédagogique électronique sont également discutées, l'emphase étant mise sur la dissémination via l'Internet. Le contenu de cet article intéressera autant les enseignants envisageant d'utiliser les technologies de l'information pour leur enseignement en classe, que ceux désirant produire du matériel pour l'enseignement à distance.

INTRODUCTION

Judging by the burgeoning number of Web sites on the topic, courseware is quickly becoming the focus of teaching initiatives across North America. As educational software products become more and more prevalent, universities and colleges are scrambling to establish multimedia facilities and garner a share of the market. Before being encouraged to plunge into courseware creation, educators should, however, be made aware that considerable development time and at least some technical expertise is required to produce a good quality product. Fortunately, there is a wide variety of tools that can be used by non-professionals to create simple, and often very effective, teaching packages. Competent use of these does, nevertheless, require a minimal familiarity with the various types of digital media and their formats, as well as an understanding of courseware design, authoring, delivery, and distribution.

What is courseware?

In the broadest sense, courseware can be defined as instructional material delivered in electronic format. It is the basis of computer assisted teaching programs and has a wide variety of applications ranging from elementary school learning games to post-secondary distance education. One of the fundamental aspects of courseware that distinguishes it from traditional teaching formats is interactivity; courseware is based on a "student-pull" learning model as opposed to a

"teacher-push" approach. Through the use of interactive elements, a student can direct his or her own learning process by providing instructions (usually to a computer) that affect the subsequent delivery of information.

To be an effective teaching tool, a good courseware product should be made up of three components: *educational software, instructional support, and learning motivation.* Only the software need be in electronic form; support and motivation may be delivered either electronically via, for example, online help files incorporating some type of point-based reward system, or they may be provided through direct contact with a local, or remote, instructor. Although educational software is the kernel of any courseware product, the importance of support and motivation in maintaining student interest and participation should never be underestimated.

Why use courseware?

Courseware can serve both as a classroom teaching aid and as an avenue through which to deliver instruction externally to off-campus students. Within the classroom, courseware can be used as a computer-based instruction tool that may supplement and enhance the traditional lecture format. For example, it might be used to help demonstrate the application of principles, to reinforce new concepts, or to present illustrative material. Since courseware can be delivered asynchronously in both time and space, the potential is also created to serve a much wider spectrum of students than can be adequately taught in a standard classroom. In the case where each student has access to a computer in a laboratory, for instance, the students may work through the course material either entirely independently, or in a tutorial setting. They can then proceed at a speed suited to their personal needs, which may vary between individuals, depending upon their abilities, motivational levels, and learning goals. Outside the classroom, courseware is an effective way to provide information and training to students who would otherwise not have access to education due to physical or geographical hindrances. Courseware developed in one locale can be marketed around the world, enabling an effective transfer of knowledge and technology between regions. Obviously, for distant markets the instructional support and learning motivation components of courseware must be structured for delivery in electronic form, or by a remote instructor.

Multimedia courseware

There are different types of courseware, which may be clas-

sified according to the manner in which information technology is applied. For simple products, the educational software may consist of only text files that the student reads on a computer screen, or it might be comprised of very basic simulation programs. If supplemented with good quality support and motivation (often provided by an on-site instructor) such products can be quite effective. In more sophisticated courseware, the educational software component is made up of a combination of various types of information-based objects such as text, graphics, sound, movies, and animation. The creation of such *multimedia courseware* is a reflection of the recent trend in computing towards the incorporation of multiple forms of digital media into a single software product. (The term multimedia has been borrowed from fine arts where it also refers to the concurrent use of different media in a single work.) The multimedia approach is advantageous for many teaching situations because it allows information to be presented via a number of "channels", sometimes simultaneously (e.g., text and speech, or movie and music), so that several of the student's senses are involved in the learning experience. As a consequence, that learning experience becomes much more complete than when the material is presented as a single stream by means of, for instance, text or speech alone. In this sense, multimedia is an enabling technology that allows many media types that are not ordinarily available as part of conventional teaching to be incorporated into the material presented. As well, part or all of the support and motivation components can also be delivered with multimedia methods. In the more complex products students are quizzed, encouraged and rewarded; their performance is tracked, recorded, and analyzed; and very considerable information resources are made available to support further learning, for example, by the provision of hypertext links to encyclopedias, web sites, etc. It should be noted that courseware is just one example of how the multimedia approach can be applied in interactive software; the entertainment industry has already produced thousands of multimedia games and reference materials. Many of the tools and techniques used to create these can also be applied to courseware development.

MULTIMEDIA COURSEWARE DEVELOPMENT AND USE

Authoring tools and presentation vehicles

Unlike commercial software packages, multimedia courseware is often created by non-computer scientists who are amateur programmers, at best. Since most developers have similar needs with regards to the structure of their programs (for example, they all require button objects and the ability to place picture files on the screen), a number of authoring tools are being marketed to make courseware creation easier and speedier. (Note that these are not only applicable to courseware creation; they are also used to author software demonstration packages, information kiosks, home library CD-ROMs, etc.) Most of them have simple drag and drop graphical interfaces. By working with an authoring tool, a developer can make use of a large number of predefined functions to create a professional looking product, without needing to understand the programming code that resides at its core. In short, authoring is programming for non-program-

mers. Although not necessarily always the case, all three components of courseware, the educational software, the learning motivation, and the instructional support, can be authored in multimedia format and then distributed electronically. The material presented below is equally applicable to the development of all three.

Some of the most widely used authoring tools are: Macromedia Director and Authorware by Macromedia, Multimedia Toolbook by Asymetrix, and Apple's HyperCard. (A list of companies whose products are mentioned is included at the end of the paper.) Many of the authoring tools have their own scripting language that advanced users can employ to enhance or change the capabilities of standard objects. Others have been developed to make programming with an already existing language possible for non-programmers. Microsoft's Visual Basic, which provides a graphical environment for writing Basic programs, and Adobe's PageMill, which is a graphical authoring tool for HTML-based Web pages, are two such examples. (A list of acronyms and their meanings is presented at the end of the paper.)

Most courseware that is developed with an authoring tool cannot be executed without a presentation vehicle being resident on the user's machine. In many cases, the presentation vehicle is a run-time version of the authoring package and developers are often allowed to freely distribute such an attenuated version of the package together with their product. For example, folders created with SuperLink (by Washington Computer Services) must be packaged with a copy of the SuperLink run-time version. Alternatively, files created with Macromedia Director have an executable module embedded in their code. If a World Wide Web page is authored using a tool such as PageMill (by Adobe), the resulting file is written in HTML and requires a presentation vehicle such as a Web browser (e.g., Netscape Navigator) and all of its "plug-ins" and "helper applications" in order to be viewed.

Digital media

A multimedia application can be composed of any number of digital media types. A good understanding of their formats is, however, necessary in order to use and incorporate them successfully into a courseware product. A brief description of each is given below.

Text A plain text file is the simplest of all media types. The standard cross-platform format follows the 7-bit ASCII character set specification. Such a file can be created and viewed using almost any editor or word processor. Text may also be contained in more complex file formats such as those generated by word processors (e.g., WordPerfect or Microsoft Word), or by Adobe Acrobat software (PDF files). In these instances, either a "viewer" application that can interpret the given file format, or the application that was used to create the file, is required to read it. Generally, text files are small and do not require compression.

Graphics (computer-generated drawings, scanned images, digital photos) There are many sources of graphics files, the most common of which are computer-generated drawings, scanned images, and digital photos. A graphic artist may create pictures using a combination of these sources. There are a number of common graphic file formats in which an image may be saved: TIFF, JPEG, GIF, EPS,

PCX, BMP, PICT, etc. In some of these formats (e.g., JPEG) the description of the image is compressed to reduce the file size. In the raster-based formats, each image is created with a particular resolution (expressed as the number of pixels in both horizontal and vertical directions, or as dots per inch - dpi), and a colour depth which may range from black and white (1-bit), through various gray scales (2-bit to 8-bit), through 256 colours (8-bit), through thousands of colours (16-bit), to millions of colours (24-bit). The most photo-realistic graphics are created using 24-bit colour technology. Generally, the desired resolution depends upon the intended use of the picture: 72 dpi is sufficient for screen display, but printing requires at least 300 dpi for good results. Using high resolution and colour depth for an image can result in very large file sizes.

3D objects High quality three-dimensional graphics are fairly new to the desktop computer. Objects defined using 3D descriptions can be animated and rotated on a screen, literally adding a whole new dimension to multimedia applications. The display of 3D objects is computationally intensive, since the computer must constantly render and calculate each view as an object is rotated, translated, or zoomed. Most 3D objects are created with specialized modeling and animation software packages such as Pixar's RenderMan or AutoDesk's 3D Studio, each of which has its own "standard" file format; at present, there is no cross-platform standard. Objects can be modeled entirely from scratch, or else aids such as space digitizers can be used to create 3D surface models in the computer by touching a wand to key points on a physical object. On the Macintosh platform, the system software comes equipped with a standard library of 3D object drawing and animation functions (QuickDraw 3D) that can be used by graphics applications to create and display 3DMF files.

Sound Digital sound can be generated synthetically using specialized computer software, or it can be obtained by capturing signals from external devices such as audio CDs, video players, or microphones. When a digital audio signal is recorded, it may be sampled as mono or stereo, at one of several sampling rates (e.g., 11, 22.5, or 44.4 kHz). Also, the resolution of the signal can be set anywhere between 4-bit and 16-bit. In combination, these three factors determine the sound quality and file size. Sound can be stored digitally in a number of standard file formats, the most common of which are AIFF and WAV. Sound compression is difficult, due to the high sensitivity of the human ear to noise and distortion. For this reason, most sound file formats are uncompressed.

Alternatively, sound can be stored symbolically in a format such as MIDI. In this case, the file does not contain digitally sampled sounds, but rather, a series of control messages that can be interpreted by sound producing hardware. Playback of a MIDI file, therefore, requires a compatible device that can reproduce the sounds described (i.e., a synthesizer).

Movies Movies reside in composite files that may contain a video track, a sound track, and a text track, bundled together. The most common movie file formats are QuickTime, Video for Windows (AVI), and MPEG. The video track is a collection of frames that is played sequentially, ideally at a rate of

30 fps (frames per second) in order to achieve smooth motion. A video track can be obtained from an external video player or a camcorder, or it may be a computer-generated animation. Each frame is equivalent to a graphic image, so that the file of even a fairly brief video track becomes rather large. For this reason, the video track in a movie file is usually compressed. In the QuickTime and AVI formats, a variety of compression schemes can be used, the most common of which is Cinepak. MPEG movies are always compressed to some degree. Of the three formats, MPEG achieves the highest compression ratio, but playback requires special hardware and/or a very powerful main processor. The sound and text tracks in a movie file are generally stored in one of the formats discussed above. When a movie is played, all three tracks must be executed simultaneously by the computer.

Animation Animation is a combination of graphics and movie technologies. Each frame of an animation is a computer-generated image. Animations may be used to illustrate the results of a simulation, to show "fly-throughs" of 3D architectural plans, to depict stories, etc. FLI is the most common animation file format on DOS and Windows platforms. An animation file can be used as the video track for a movie file.

Virtual Reality Virtual reality (VR) is defined by the Interactive Multimedia Association as "the art/science of creating worlds that are totally rendered by computers in which the user can immerse themselves and take 360-degree perspectives" (from the online IMA Glossary of Multimedia Terms, see Web Sites of Interest to Multimedia Developers). One way to achieve this effect is by using Apple's QuickTime VR technology to create navigable movies; that is, frames of a panoramic scene may be "stitched together" and then viewed in a sequence determined by the user. Movements of the computer's mouse are interpreted by a viewer application, such as the QuickTime VR Player, to display images of the scene corresponding to the user's perceived location in space. True VR worlds are collections of 3D objects arranged in space that can be explored by a user who moves about via a mouse-driven interface. (On non-desktop computers the interface may consist of more sophisticated hardware such as gloves, a mask, a moving podium, etc.) Virtual Reality Modeling Language (VRML) is the most common platform-independent VR object description method. VRML files contain ASCII text that must be interpreted by an appropriate viewer application. The latest version of the language (VRML 2.0) is based on Apple's 3DMF format.

Simulations and other programs Although not strictly a form of multimedia, often a key component of educational software is a simulation or other program that may be launched directly from the courseware. Simulations are extremely useful in illustrating the dynamics of processes such as, for example, population growth, turbulent flow, or gas exchange. Students may be allowed to adjust certain parameters and then observe the effects thereof. Simulation programs are often written in one of the many common programming languages (e.g., C, Fortran, Visual Basic) although the use of third party software can considerably ease the developer's burden, especially if the software is scrip-

table (e.g., MATLAB or Excel). In this case, the developer needs to author only a script or a spreadsheet with macros. When the student clicks on a button in the main courseware shell, the software is launched and executes the script.

Hardware considerations

There is no question that courseware should be authored using the fastest and most powerful computer available, equipped with special features geared towards multimedia work. Ultimately, however, courseware is going to be run by a user on his or her own computer, and its success will depend considerably on its compatibility with the hardware available to that individual. For example, playback of a full-screen (640x480 pixels) 24-bit colour MPEG movie requires a machine with a sound card, an MPEG decompression chip, as well as sufficient processor speed and memory capacity to manage the signal. At present, this is a tall order for most home computers. Thus, when developing a courseware product, it is important to be aware of the hardware requirements that will result for the user, especially with respect to screen resolution (640X480; 1024X768, etc.), color depth (8, 16 or 24-bit), sound capabilities, and extra graphic or video cards. There is, obviously, always a trade-off to be made between a product's quality and sophistication, and the number of users who will be able to run it.

METHODS OF DISTRIBUTING A COURSEWARE PRODUCT

There are many methods available to distribute courseware to users and different ones may be appropriate for each of the various components. For the distribution of educational software, its size and operating requirements will usually determine which methods are the most applicable. For the electronic delivery of instructional support and learning motivation, interactivity requirements will largely determine the method of choice. Some of the more common approaches are described below, along with their respective advantages and disadvantages.

Internet-based distribution

Placement on an FTP site Courseware files can be placed on a computer that has been set up as an FTP server. A student who wishes to access the files must log onto the FTP server with a local machine and download the files from the remote directory. Once the files have been copied to his or her machine, the student is responsible for their installation and execution. Retrieval of the files from the FTP site is a one-time event; the software itself runs locally and is completely independent from any Internet connection. This procedure is an excellent way to transfer a file of any size and is robust. Once the files have been transferred, however, the developer has no control over their subsequent reproduction and distribution, which may be of concern in some cases. An additional drawback of this approach, from the perspective of an educator, is that it is left to the student to check the FTP site for software updates or patches and to initiate contact (via electronic mail, for example) with the instructor/courseware developer should there be any problems. This method of electronic distribution is applicable to all three courseware components although, if used exclusively, there is no direct

contact at all between teacher and student.

Telnet sessions A telnet connection between two computers allows a user to execute a program on a remote machine. In this case, courseware can be run entirely on a remote computer and no files have to be transferred to the student's local machine. To access courseware in this manner, a student must run a telnet program on his or her computer in order to connect to a server on which the software is located. The telnet program acts as an intermediary between the two computers, allowing the student to control the remote machine using a local keyboard, mouse, etc. The display from the remote computer is directed to the student's screen, creating an almost transparent interface. A major drawback of the telnet approach is that the remote machine is limited with regards to the number of sessions it can operate concurrently at a reasonable speed. In addition, because of communication limitations due to a lack of bandwidth, telnet programs usually only operate in text mode, eliminating the inclusion of graphics or other multimedia components. Again, all three courseware components may be delivered this way but, because the student remains logged onto a remote machine during courseware use, contact for support and motivation is somewhat easier to achieve than with the FTP method.

World Wide Web The World Wide Web is currently the most popular method of accessing the Internet. In courseware authored in HTML, most of the elements of multimedia (text, graphics, movie, and sound) can be combined in a standard manner so that it is accessible to all users. HTML is used to write "pages" that may be formed from a combination of these media and which usually contain hypertext links to other pages on the Web. The appeal of this approach is that it is platform independent, allowing the same files to be accessed via UNIX, PC, and Macintosh type computers. The file is interpreted by a browser program (e.g., AIR Mosaic, Netscape Navigator, Internet Explorer) which is run locally on the user's machine. To display the different digital media types, browsers make extensive use of "plug-ins" and "helper applications." Plug-ins extend the capability of the browser so that it can display media such as movies and animations directly. If a browser does not have a suitable plug-in, it may start-up another application (called a "helper application") which will be used to display the media type in question. It is the user's responsibility to install any required plug-ins and to configure his or her browser to use the appropriate applications as external viewers when necessary. Recent browsers can also interpret software authored in the Java language.

Anyone, from anywhere in the world, may sign on to a courseware Web page using his or her browser and view the information that is placed there. At present, however, distribution via the World Wide Web faces severe speed and bandwidth limitations so that, in practice, HTML pages must be kept relatively simple. The slow rate of data transfer over the Internet makes the access of large movie or picture files especially cumbersome. In the near future, the installation of high speed communication lines will significantly impact the nature of World Wide Web content, enabling the use of multimedia intensive software in real-time.

Direct contact Contact between instructor and student, although not absolutely crucial, is usually deemed desirable in

the educational process and is generally considered to facilitate learning. Of the three distribution methods mentioned above, the World Wide Web is the most accommodating in this regard because within HTML it is possible to author objects that collect user data, comments, etc. that can then be forwarded to the instructor. Such communication does not, however, constitute a dialogue in any proper sense of the word and it is bi-directional dialogue that is most beneficial. The above methods are therefore best suited for the distribution of the educational software component of courseware. The delivery of support and motivation may be better accomplished with direct contact methods. Direct contact can be supplied by a local instructor, i.e., someone present at the same physical location and time as the student, or by a remote instructor who might be separated from the student in either time or location, or both. The simplest (and still most common) delivery method of this type is electronic mail (Email), with which a reasonable dialogue can be maintained, even if the back-and-forth communications must be highly asynchronous due to time-zone separation of the instructor and student(s). With Email, a group of students can also hold a class discussion via a Notice Board, even though they are geographically and chronologically separated. In this case all messages are posted to a shared directory, usually on the instructor's file server.

A number of more sophisticated approaches to electronic dialogue are presently under development. These are variously oriented to one-to-one, one-to-many, or many-to-many communication. The MBone, for example, is an organizational structure superimposed on the Internet that accommodates a variety of applications for the delivery of direct contact multimedia. These include voice conferencing, video conferencing, shared applications, as well as Shared WhiteBoards. The latter is quite similar to the Notice Board referred to above, except that the interaction is synchronous and happens in a graphical environment. Video conferencing (in which, in this case, all the conference participants can see one another on their respective screens) coupled with WhiteBoarding can be an effective method to distribute the support and motivation components of courseware. Most users will, however, connect to the Internet by a modem coupled to a voice grade telephone line, or via a LAN. In most cases neither technology can supply sufficient bandwidth to make video conferencing an enjoyable experience and further MBone development for general courseware distribution will depend largely on bandwidth increase. Many other video and voice conferencing systems are under development as well, a number of them running on the Internet, and others over dedicated lines. In some cases they are used to distribute all three courseware components, e.g., as video broadcasts. The considerations presented herein concerning the electronic distribution of the support and motivation components of courseware apply equally whether the educational software component is distributed via the Internet or via other media.

Portable media (CD-ROM, diskette)

In many instances, the size of a courseware product makes its publication on the Internet unfeasible due to slow transfer rates. In such circumstances, the software may be distributed on diskettes or CD-ROMs. In fact, until networking speeds

are improved, portable media is likely to maintain its position as the leading software distribution format. Unlike Internet access where files are usually shared, with this approach each student must obtain a personal copy of the courseware. In this case, the Internet may still be used to provide services to the student such as software updates and technical advice. In distance education programs support and motivation may be distributed by any of the methods mentioned above such as Email, WhiteBoarding, or MBone video conferencing.

Local network server

The delivery of courseware over a LAN is an intermediate approach that eliminates some of the drawbacks of Internet distribution. In this case, software is installed on a local network server and is then used on personal computers that are directly connected to that network. This is an excellent approach for students who have access to a computer laboratory since high transfer rates can be maintained and the instructor is able to keep control of the configuration and setup of the software. Also, if security is a concern, courseware that is resident on a local server can be reasonably protected.

An intermediate alternative

After having weighed the advantages and disadvantages of the various distribution methods, the authors have developed an intermediate alternative that is a combination of them. In this approach, the educational software component is authored with the developer's tool of choice (e.g., PageMill, Macromedia Director, SuperLink, etc.) and written onto a CD-ROM. The software can then be distributed on portable media to students who wish to purchase a personal copy. In addition, the instructor may place a copy of the CD-ROM in a computer in his or her own office. This machine can then be configured as a network server, an FTP server, or a Web server, depending on the nature of the presentation vehicle and the intended audience. In this manner, the software component can be delivered at high speed to on-campus students via a LAN and can simultaneously be distributed more widely over the Internet. The support and motivation components can then be delivered via direct contact to on-campus students by a local instructor in a tutorial setting, and to off-campus students through electronic mail or some other, more sophisticated method. The direct contact approach is favoured because it is felt that, except for extremely motivated learners, it is difficult to deliver support and motivation electronically, i.e., without human-to-human interaction. The distribution approach described here is flexible and robust, and will enable instructors to continuously adopt new technology as it arises. The authors are presently developing a demonstration of this technique using a package written with SuperLink.

WEB SITES OF INTEREST TO MULTIMEDIA COURSEWARE DEVELOPERS

Listed below are the addresses of some of the sites that contain tips and advice from developers who wish to share their experience. Only a few are shown, since all of them contain links that can be followed to hundreds of others.

Interactive Multimedia Association
<http://www.ima.org/>

Glossary of Multimedia Terms (from IMA)
<http://www.ima.org/tools/glossary.html>

Maricopa Center for Learning and Instruction
<http://www.mcli.dist.maricopa.edu/>

Virtual Courses on the Web
<http://lenti.med.umn.edu/~mwd/courses.html>

SUMMARY AND CONCLUSIONS

The creation of good quality courseware requires more than just expertise in the subject matter of the course. If computer-based instruction is to be successful as a teaching method, courseware developers must consider the instructional support and learning motivation needs of students, as well as supply the educational software. The products they create should be based on a number of media types and they must have comfortable human interfaces. This requires experience in software design, as well as a fairly comprehensive understanding of multimedia technology.

Today's software cannot replace the support and motivation provided by a teacher, but it does provide a whole new array of tools that can be used to illustrate concepts in novel and exciting ways. In a classroom setting, software can be used as a supplement to regular lectures, so as to invoke student participation and render the teaching situation more dynamic. Beyond that, it can also be employed as an effective approach to transmit the bulk of course material traditionally presented as lectures, leaving the instructor with much more time to interact with students in a tutorial atmosphere. The use of multimedia is advantageous because of the quality of presentation that this allows.

Courseware is likely to become a strong force especially in distance education, due to the ease with which it can be marketed and distributed. Although the Internet is a popular method of distribution, it does have severe limitations with regards to transmission speed. Courseware to be distributed in this manner should be written accordingly. Alternative approaches such as that recommended by the authors may be more viable at the present time. Ultimately, technological advancements and the degree to which they become accessible to the student will dictate the future of courseware and multimedia use in the classroom.

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COMPANY REFERENCES

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PCX is a copyrighted file format by ZSoft Corporation, 450 Franklin Rd., Suite 100, Marietta, GA, 30067, USA.

LIST OF ACRONYMS

3DMF	3D MetaFile (Apple Computer, Inc.)
AIFF	Audio Interchange File Format (Apple Computer, Inc./Silicon Graphics Inc.)
ASCII	American Standard Code for Information Interchange
AVI	Audio/Visual Interleaved data

BMP	Shortened form of bitmap; most commonly refers to Microsoft Windows Bitmap files (Microsoft Corporation)
EPS	Encapsulated PostScript (Adobe Systems Inc.)
FLI	Shortened form of Flic (Autodesk)
FTP	File Transfer Protocol
GIF	Graphics Interchange Format (CompuServe Inc.)
HTML	HyperText Markup Language
JPEG	Joint Photographic Experts Group file interchange format (C-Cube Microsystems)
LAN	Local Area Network
MIDI	Musical Instrument Digital Interface (International MIDI Association)
MPEG	Motion Pictures Experts Group of the ISO
PCX	PC Paintbrush File Format (ZSoft Corporation)
PDF	Portable Document Format (Adobe Systems Inc.)
PICT	Macintosh Picture (Apple Computer, Inc.)
TIFF	Tag Image File Format
VR	Virtual Reality
VRML	Virtual Reality Modeling Language
WAV	Waveform data

SUGGESTED READING

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