Apple CD-ROM Handbook

A guide to planning, creating, and producing a CD-ROM

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Contents

Figures

PART ONE

Consider CD-ROM

Once a new technology survives the overstated optimism—and pessimism—of its earliest days, people begin discovering whether it has real promise.

CD-ROM has survived. Its value in a wide range of applications is clear, and its potential for still other purposes is being explored.

Now a practical handbook on CD-ROM product development can be drawn from experience rather than expectation. This book takes a first step in that direction. It's intended to help Macintosh developers approach their first CD-ROM project with the benefit of what has already been done.

This first part of the book surveys CD-ROM product development. It assesses the technology, compares it to the alternatives available for the mass distribution of data, and outlines the resources that go into a CD-ROM project.

- Chapter 1, "Why Use CD-ROM?," covers the attributes of the medium.
- Chapter 2, "The Competitive Edge in Distribution," considers three applications for which CD-ROM is especially well suited.
- Chapter 3, "Do You Have What It Takes?," treats the resource requirements of CD-ROM product development.
- Chapter 4, "Choices That Define Your Disc," discusses the decisions that shape a CD-ROM product.
- Chapter 5, "Everything Your Disc Delivers," reflects on some general issues concerning the content of disc products.

Why Use CD-ROM?

It used to take 18 floppy disks and 14 pounds worth of shipping charges to put Pixar's Showplace and MacRenderMan product bundle in the hands of a user. "Cost of goods was the reason we first looked at [distributing on] compact disc," says Pam Kerwin, Vice President of Marketing and Sales. "Even with a consultant to help on the first disc, we reduced our cost of goods by two-thirds. And we'll save more than 90 percent on the next one."

For years, KPMG Peat Marwick relied on magnetic media to get their specialized accounting software out to offices around the world. Now it's switched to CD-ROM. "We used to be fearful of making any kind of change in the software because that meant thousands of sets of floppies to distribute, sometimes with multiple disks in a set. Now we just put it on the next CD," says Mario Dell'Aera, Senior Manager of Audit Technology and Research. "Cost was one reason we did it. It cut duplication and distribution costs substantially. But timeliness was another. They can look at the date and know it has to be the most current information. It's a hard disk on a disc and it comes four or five times a year."

The Compact Disc for Your Computer

Compact discs are a handy, affordable way to distribute large amounts of information. The familiar audio CDs are devoted to digital recordings. But other kinds of information can also be captured on compact disc. When that information is meant for computer use, the compact disc is called a **CD-ROM** (compact disc read-only memory).

CD-ROM discs play in a special device, called a **CD-ROM drive,** attached to the computer. CD-ROM drives are much like home CD players; in fact they play audio CDs as well as CD-ROM data discs. They usually cost more than CD players. This reflects the extra electronics that make digital information available to the computer and the added durability and reliability needed for data applications.

Like audio CDs, CD-ROM discs are molded from *polycarbonate.* This is the plastic of bulletproof windows and safety lenses for eyeglasses. It makes them tough, resilient, and long-lasting with reasonable care.

CD-ROM discs use the same technology as audio CDs. Hundreds of millions of tiny dimples are pressed into the surface of a 4¾-inch plastic platter. They form a long, thin spiral out to the edge from the hub. Digital information is represented in this succession of dimples (called *pits*) and the spaces between them (called *lands*).

A CD-ROM player spins the disc to read it. A laser focused through the thickness of the plastic bounces from a mirror-like coating on the dimpled side and passes back through the disc. As the disc spins, the laser follows the spiral track. Sensitive electronics detect a difference between the reflections from the pits and from the lands. The signal from this detector is decoded into digital information.

Compact disc players convert the signal to audio for playback. CD-ROM drives can tell the difference between audio information and other data. They play the audio but pass the other data to the computer for processing.

Advantages of CD-ROM

CD-ROM discs combine several valuable characteristics for data distribution. They are

- high-capacity
- convenient
- affordable
- durable
- standardized
- read-only

Very Large

CD-ROM discs accommodate hundreds of megabytes of data, as much as very large hard disks, but on drives costing a fraction of the price.

A CD-ROM disc isn't much larger than a floppy disk, but it holds from 400 to 800 times more information, depending on the design of the CD-ROM and the type of floppy. That can mean tremendous savings in duplicating and shipping costs.

You'll see many different figures cited for the capacity of a CD-ROM disc. It's really a function of the way the disc is mastered—how much space separates the coils of the spiral track, a measurement called the *track pitch.* Smaller track pitch means a tighter spiral and more capacity—over 650 megabytes (MB). But not all CD-ROM drives can read discs mastered for more than about 580 MB. If your product needs to play on every kind of CD-ROM drive, 580 MB seems to be the practical limit at present.

The ability to put so many files on a single, removable, low-cost disc means users keep more programs and documents at their fingertips than they could previously afford the equipment or the space to store. It also makes all those files easy to access.

Convenient

Having many files together in a single collection makes it easier to locate information when you want it.

Often there's room on CD-ROM discs for an exhaustive index, plus the software tools to navigate the contents or search them. *Navigation* tools help you find your way around. They are like the headings in a book or its table of contents. *Searching* tools work more like a book's index; they point out every place certain words appear.

Affordable

The cost of CD-ROM manufacturing continues to go down. One thousand CD-ROM discs can be pressed for less than $3000, with delivery in 10 days. And the more you make, the less each one costs, because the setup charge, called a mastering fee, is the same whether you order a few discs or many. So the cost per disc goes down rapidly as quantities increase.

For a breakdown of CD-ROM manufacturing costs see "Manufacturing" on page 28.

Durable

CD-ROM discs are read by laser. There's no physical contact and no wear. Information on the disc doesn't degrade with use.

Minor scratches on the play side do no harm. The laser beam is tightly focused on the mirror inside but not at the plastic surface. It takes a sizable gouge to block it.

Unlike floppies and magnetic tape, CD-ROM discs are immune to magnetic fields.

Standardized

CD-ROM discs are standardized to ensure compatibility between machines of different kinds and make data exchange possible.

The physical format of CD-ROM discs is specified by an international standard sometimes called the **Yellow Book.** This ensures that CD-ROM discs can be played in drives from many different manufacturers. A particular computer system may be required to interpret the file structure used on the disc, because developers can organize their CD-ROM by
any file system they choose (such as the Macintosh hierarchical file system, HFS).

A basic CD-ROM file structure has also been adopted. Published by the International Standards Organization in 1988, the standard is commonly known as **ISO 9660.** Files on a disc organized according to ISO 9660 are recognized by any computer that understands this format. All Macintosh computers, for example, recognize ISO 9660 files. For more information see "ISO 9660" on page 36.

Read-Only

Because the information is embedded in polycarbonate it can't be changed. To users a CD-ROM disc looks like a large, locked hard disk. They cannot save their own data on it.

At first glance a drawback, the read-only nature of CD-ROM is an advantage in several ways. It prevents tampering and accidental erasure, it makes CD-ROM discs virus resistant, and it ensures that copies of data distributed to multiple sites remain consistent.

The Other Side of the Disc

Some of the strengths discussed in the preceding sections must be managed thoughtfully, or they can prove to be weaknesses.

Read-Only

The fact that new data cannot be recorded on a CD-ROM disc may frustrate users. They may want to add their own notes to documents, comments to a particular file, or leave bookmarks. A well-designed interface for a CD-ROM product provides these features by using files on the hard disk, or on a floppy.

High-Capacity

The ability to hold a very large number of files becomes a drawback if users can't understand how the files are arranged. Careful disc organization will help you avoid this problem. A human interface that makes navigating easy and intuitive is important. Tools to search for files will reduce user frustration with large collections.

Durable

Even the durability of CD-ROM discs can work against them at times. Because users are reluctant to discard "perfectly good" compact discs, old versions of software may linger, creating confusion. Or they may be passed along to others, creating inconsistency.

The trade-in approach is one solution. Some CD manufacturers have pioneered methods of recycling polycarbonate, and incentives to return obsolete discs would be a move in the right direction.

The Competitive Edge in Distribution

CD-ROM discs combine a number of strengths unavailable in other distribution media. As a result CD-ROM is more and more widely used to distribute

- software
- information
- multimedia

Software products include computer programs like word processors or spreadsheet applications. Information products contain the many kinds of data files produced and used by computer programs. Some CD-ROM products carry programs and data files. Multimedia products, for example, inform, persuade, and entertain by using audio, images, animations, and video, as well as the software to present them.

CD-ROM has been selected to distribute these products because it offers significant advantages over the other media available.

NOTE
In this book the word *product* denotes the work of commercial as well as corporate in-house developers. ◆

Distributing Software on CD-ROM

Most of the costs associated with developing software are identical whatever distribution format you choose.

In the past, software products have been distributed on floppy disk. For large products this takes many floppies. As software products grow, so does the expense and inconvenience of distributing floppies. But removable tape and disk cartridges are generally too expensive to use for more than a few copies. Convenience and cost are two of the reasons developers are discovering CD-ROM discs as a distribution medium.

Advantages of CD-ROM

There are several advantages to CD-ROM for software distribution. CD-ROM discs are

- *less expensive* than multiple floppies, even for relatively small products
- *convenient*
- big enough to provide disc *space for added value,* such as
  - new data types, like audio and video
  - enhancements
  - multiple versions
- *virus resistant*
- *easy to distribute*

Less Expensive

The one-time setup fee for mastering means the cost of CD-ROM discs goes down rapidly as the number made increases. Floppy disk duplication is different. There's usually no setup fee, but the cost per disk remains relatively constant.

If you need 100 copies, CD-ROM discs are less expensive than floppies for products of about 14 MB or more.

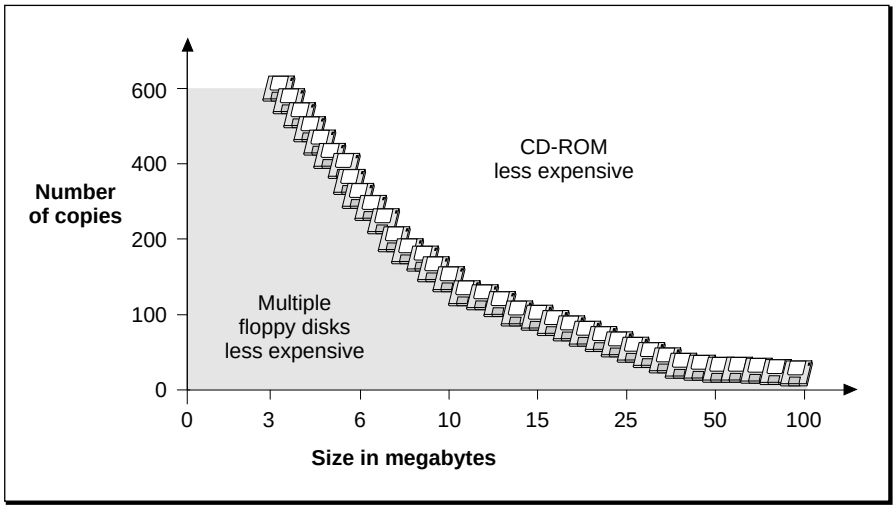
If you need 250 copies, CD-ROM discs are less expensive than floppies for products of about 7 MB or more.

If you need 500 copies, CD-ROM discs are less expensive than floppies for products of about 4 MB or more.

If you need 1000 copies, CD-ROM discs are less expensive than floppies for products of about 3 MB or more.

These conclusions reflect floppy duplication at $1 a disk, CD-ROM mastering at $1200, and $2 per CD-ROM disc for pressing. Figure 2-1 shows the cost comparison of distribution on floppy disk and CD-ROM.

Figure 2-1 When CD-ROM is less expensive than floppy disks



Convenient

Everything needed arrives on a single CD-ROM disc. It's compact, easy to handle, and easy to store.

Software is easier to install from a CD-ROM than from multiple floppy disks where a defect on any single floppy can thwart the installation.

All parts of the product are secure from erasure. They stay together for convenient access.

Space for Added Value

CD-ROM discs have room for developers to add value through

- *new types of data.* Audio, video, animation, and high-quality graphics are easily accommodated on a CD-ROM disc.
- *enhancements.* Additions to the product bundle "ride for free" on most CD-ROM discs. Online documentation, multimedia help or training, templates, audio notes, product demonstrations, and "Question and Answer" files of frequently asked questions are examples of additions that repay the extra development effort. All contribute to user satisfaction and reduce customer support.

- *multiple versions.* On a CD-ROM disc you have space to provide multiple versions for different users. You might include images digitized in color, monochrome, and gray scale; sound files or resources in a choice of languages; and CD audio tracks for those with audio playback equipment and sound file versions of the same tracks for those without. Refinements like these bring each user the most sophisticated presentation his or her machine will support.

Virus Resistant

CD-ROM discs are inherently virus resistant. Many viruses spread by writing foreign code into healthy programs. This cannot be done to programs on a CD-ROM disc. If programs on a hard disk become infected, virus-free replacements can be loaded with confidence from the CD-ROM on which they were distributed.

When meticulously checked for contamination during production, CD-ROM discs ensure the integrity of data and code.

Easy to Distribute

A CD-ROM disc weighs less than a single floppy. How you package the product has greater impact on shipping cost than the disc weight if only a single disc of either type is needed. But the weight of additional floppies quickly becomes a significant factor.

The cost of collating disk sets is also eliminated by shipping one CD-ROM in place of multiple floppies.

Shining Examples of Software Distribution on CD-ROM

Beyond dramatic savings, Pixar has realized other benefits from distributing Showplace and MacRenderMan on CD-ROM. “We added a library of appearances and one of objects that don’t come on the floppies. There are extra textures, too, and a collection of examples to help you see what can be done. You just don’t have that opportunity on floppy,” says Pam Kerwin. “We've also used it as a way to help dealers. Animation is new to many of them. So we include a large section on RenderMan, also one on Pixar, to help them understand and sell our products.”

A/UX, a version of the industry-standard UNIX® operating system for Apple Macintosh computers is distributed on CD-ROM. The product disc includes hundreds of executable programs, numerous utilities and object files, and more than 6000 pages of documentation. One CD-ROM replaces the 26 floppy disks otherwise required and eliminates a 3-foot shelf of manuals.

Adobe Systems found that CD-ROM discs can open additional distribution channels. Type On Call is a Macintosh CD-ROM product containing the entire Adobe™ Type Library. At purchase, users have access to Adobe Type Manager, the PostScript™ version of 13 standard Adobe typefaces, and their choice of 2 additional fonts from 8 popular typeface groups. But access to nearly 1000 typefaces encrypted on the disc can be purchased instantly with a call to Adobe. Each is released for use by entering its individual code into selective access control software called The Vendor (AND Group).

Distributing Information on CD-ROM

Most of the costs of developing information content are identical no matter what distribution format you choose. More and more, the content is being prepared on computers and converted to other forms. Desktop computers, for instance, are now handling the prepress activities in addition to text and graphics preparation for printing. It's now the steps to convert content out of the digital domain that add cost and time. This trend makes direct digital distribution, such as CD-ROM discs provide, the most affordable and convenient choice.

Other relevant comparisons with older distribution alternatives include

- *quality,* the range of data types each medium can deliver and how well it does so
- *cost,* the expense of production, including data conversion
- *ease of use,* the quality of the user's experience and the features that make a product easier to use
- *ease of update,* the time and effort involved in releasing new versions

Advantages of CD-ROM

There are many options for information distribution. Comparisons of CD-ROM with paper, micrographics, online services, and magnetic media are representative.

Paper

Printed material can convey two types of data: text and images. On paper the information can only be read. The contents of a CD-ROM disc, on the other hand, are readily imported to programs for editing, layout, transmission, easy search and retrieval, or any other purpose—even printing on paper.

Printing has setup costs. These include data conversions (the camera work, screens, photostats, and color separations) and plate making.
The expense of printing varies widely depending on the number of colors. For distributing information to computers, the cost of reentering data makes print an expensive choice, although improvements in **OCR** (optical character recognition) software are making this more feasible when it does become necessary.

Printed material is handy, portable, and easy to browse when it's small. Weight grows rapidly with the amount of information, however. So
does the difficulty of finding things. Up to 250,000 pages of text can be distributed on a 2-ounce CD-ROM disc. The same information consumes 1250 pounds of typical copier paper, printed on both sides.

Paper documentation is independent of the computer system. It takes no screen space and remains available while you do other things with the computer. But it also wears out and can get misplaced, marked up, or soiled. Printing on demand from a CD-ROM offers independence plus unlimited replacement copies as needed.

Paper can't be searched in the same way as a CD-ROM disc. Printed materials are often indexed, but only a small proportion of the words typically appears. A full inverted index is often possible on CD-ROM products. This includes all words except those deliberately excluded.

Micrographics

Much of the information published as *micrographics* (microfilm, microfiche, or aperture cards) is developed on computers and "printed" directly to film, a process called COM (computer output microfiche).

COM is used extensively for text and to some extent for images. High-resolution color imagery is now possible but not widely used.

Micrographics are not easily browsed but can be indexed for random access.

Micrographic products are fairly quick and relatively inexpensive to produce and update. They are efficient for distributing text data to a limited number of users. But for more than about 50 MB, going to 100 users, a CD-ROM disc costs less.

CD-ROM also accommodates data of many other types and conveys the information in a form the computer can readily use for other purposes.

Online Information Services

The value of online distribution is limited by the rate at which data can be transmitted. A CD-ROM drive costs about the same as most 9600 baud modems. But the CD-ROM drive delivers data at least 15 times faster! Even ISDN service, where available, is from 3 to 12 times slower than a CD-ROM drive.

Data of all types can be distributed online, but only the most desperate or wealthy download files as big as many digitized images, video clips, and animations. None of these data types can actually be presented in real time by an online service.

Most services charge by the minute for the time you are connected to their system (connect fees) and in some cases for the telephone network to reach it (line charges). Freeing users from the time pressure associated with online services has a positive effect on productivity. Information on the disc is already “paid for” so there is a tendency to browse it more freely and search it more thoroughly when using a CD-ROM disc.

As the number of users receiving your information grows, the cost of online delivery (connect fees and line charges) quickly exceeds the expense of manufacturing and distributing CD-ROM discs.

Online information services are navigated by browsing or by command, the equivalent of random access. They are usually not as easily searched as a CD-ROM disc, however, often requiring the user to endure a sequence of redundant menus and prompts, which increases frustration and cost.

Anything downloaded from an online service requires storage media at the user site, a distribution cost that is easily overlooked.

The greatest strength of online distribution is the exceptional speed of updates. This makes online services and CD-ROM distribution natural complements to one another. CD-ROM discs put audio, graphics, images, and animations (all too large for online services to deliver in real time) on the desktop. Processing load is shifted from the host to the local system. But the host can control delivery of the elements on CD-ROM, if desired.

The most volatile information is always up-to-date online, reducing the frequency of disc revisions. For online service providers, publishing some information or interface elements on CD-ROM offers a comfortable, low-cost means of attracting new users and encouraging current users to explore. This can also be an effective way to promote new services and impart to users the skills needed to sift through huge quantities of information.

Magnetic Media

Floppy disks are the only viable magnetic media for mass distribution in many cases. The cost of removable tape and disk cartridges discourages their use for more than a few copies.

The limited capacity of floppies makes them less useful for types of data that require large files.

All CD-ROM discs are physical replicas of the master, while floppy disks are copies. Each copy is a different recording of the master being played. Variations occur from pass to pass, and as the master wears with use.

CD-ROM discs employ three levels of error correction. Floppy disks do not.

For cost comparisons of floppy disk distribution see Figure 2-1.

Floppy disks afford the same access and search opportunities as CD-ROM discs, but without the convenience and speed of searching large collections on a single volume.

Floppy disks are quicker to revise and do permit partial updates. CD-ROM discs must be replaced and do not afford partial updates.

Floppy disks are an awkward solution if more than a few are required. They don't lend themselves to indexing, browsing, or searching. The user must keep track of content spread over many disks.

Shining Examples of Information Distribution on CD-ROM

Outstanding CD-ROM information products have appeared in many categories, including

- professional databases
- general reference works
- catalogs
- product presentations and demonstrations
- maintenance manuals

MEDLINE, ERIC, and AGRICOLA are large bibliographic databases that were available only online before CD-ROM. Now doctors, educators, agriculturalists, and many other professionals save line charges and connect fees by searching the literature of their field on CD-ROM discs.

Reference works are a natural match for CD-ROM. *The Electronic Encyclopedia* from Grolier is one good example. *The World Almanac and Book of Facts* is another. Merriam-Webster's *Ninth New Collegiate Dictionary* on CD-ROM includes digitally recorded pronunciations of more than 160,000 entries.

The California School Board Association publishes policy manuals for the state's public school districts. Before CD-ROM the districts received a pair of fat three-ring binders, plus hundreds of pages of quarterly updates to collate into them during the year. GAMUT is the quarterly CD-ROM product that replaces the old system. It offers quick and easy access to the more than 800 policies included in the manuals and eliminates laborious manual updating. Plus there was enough room on GAMUT to include the entire California State Education Code, Title V, and other federal documents, and a keyword topical index to everything on the disc.

Distributing Multimedia on CD-ROM

Multimedia products do more than contain information; they present it, using audio, video, and graphics to enhance communications.

CD-ROM discs offer as much room for large multimedia presentations as any other mass distribution medium. The cost per megabyte is very favorable if you need more than a small number of copies.

Since the introduction of CD-ROM, multimedia products have been introduced in a wide range of areas including

- education
- entertainment
- training
- sales and promotion
- reference

Advantages of CD-ROM

The comparable media for distributing multimedia are videocassette and videodisc. CD-ROM compares quite favorably in several ways:

- digital signal processing
- random access
- searchability
- branching
- ease of update

Digital Signal Processing

Videocassettes and videodiscs store video in analog form. Multimedia files such as QuickTime movies store audio, video, and other images in digital form. This method permits application programs to do more powerful and flexible signal processing. It also takes advantage of CD-ROM error correction to improve quality.

Random Access

One strength of CD-ROM is its ability to access data from any location on the disc fairly quickly. It requires nothing like the rewind or fast-forward operations of a VCR. Videodisc users can jump also but only to numbered frames or chapter stops. This process resembles finding a file on CD-ROM; however, the user must know the desired frame or chapter number
in advance.

Searchability

You can search CD-ROM discs for files of possible interest, either by name or (sometimes) content. Videodisc players under computer control offer a kind of search capability if there is a keyword database describing the disc contents. Videocassettes lack this ability.

Branching

When the selection of material presented or the order of its presentation depend on user choices, a product is said to support *branching*. This capability is especially important to training programs and other interactive products. CD-ROM products

support branching, as do
some videodisc systems. Videocassettes provide no branching.

Ease of Update

Multimedia CD-ROM products can be produced entirely on the desktop by using a Macintosh computer. Powerful yet easy-to-use production tools are available and require less technical expertise than conventional video production does.

Shining Examples of Multimedia Distribution on CD-ROM

Spaceship Warlock from Reactor, Inc. combines elements of a comic book, a science fiction movie, and an arcade game in one interactive animated adventure unlike anything that's gone before.

Exotic Japan by The Voyager Company harnesses multimedia to put language instruction in a rich cultural context. The disc introduces innovative practice facilities for mastering pronunciation by using the Macintosh audio input device.

Desert Storm: The War in the Persian Gulf by Warner New Media explores the potential of multimedia CD-ROM products to capture the sweep of current affairs. Here the brinksmanship, maneuvering, and lightning strike to liberate Kuwait unfold again through the unvarnished text of on-the-spot reports by *Time* war correspondents and through hundreds of full-color photos.

Do You Have What It Takes?

If you develop software or publish information, you probably already have everything you need to create a CD-ROM product.

A project doesn't have to be complicated or use hundreds of megabytes to be worth distributing on CD-ROM. It can be as simple as duplicating the contents of a hard disk for use by others. Whether you stay close to what you know best or stretch in new directions, it takes the same things to create successful CD-ROM products:

- a plan
- content
- a project team
- tools
- suppliers

Not one of these is unique to a CD-ROM project. In many cases you will already have what's required or know where to obtain it. All the resources mentioned in this book are listed in the Appendix.

A Plan

You will follow the same justification procedure for a CD-ROM product as any other. Still, a glimpse behind-the-scenes of one established CD-ROM may give you some ideas.

Facing a Challenge

In 1987 three separate internal studies by Apple USA Sales and Marketing identified a cluster of basic operational problems:

- It was difficult and costly to deliver timely information on Apple products to resellers and the field sales force.
- A confusing array of product information was being mailed from multiple, uncoordinated sources within the company.
- Sales personnel spent a great deal of time preparing their own presentation materials from this information.
- The quality of these presentations varied with the ability of the individuals generating them. Results were inconsistent and did not always meet the company's standards.
- Presentations had no benefit of review to protect Apple copyrights and trademark interests.
- Despite frequent mailings, the field personnel remained unaware of many support materials available to them.

Formulating a Solution

Apple investigated a number of solutions. A single sales and marketing information source seemed to be needed, one which could be easily updated and distributed on a regular basis.

The choice of delivery medium was eventually narrowed to CD-ROM and data cassette. CD-ROM promised ease of production, but the installed base of drives was small. Cassettes were more widely established but expensive to duplicate. The decision was taken to try CD-ROM.

In July 1988 the first *Apple Reference and Presentations Library* (ARPL) CD was delivered to 250 field representatives. Containing a scant 7 MB of unformatted slide presentations, it had no interface, no search engine, and no online help.

While quite limited, this first edition generated invaluable experience and led to the solution of assorted technical difficulties.

Interviews with the first ARPL users confirmed that significant time savings were realized through the use of this new tool. They reported spending less time preparing to sell and more time selling. Those using ARPL also said that the quality of their presentations had improved.

The response of real users became the basis of a business plan.

Presenting a Plan

The *Apple Reference and Presentations Library* was proposed to management as a quarterly information channel to the Apple field sales force.

Material for distribution would be collected throughout the company.

Everything would have appropriate review by the legal department. Everything would be graphically formatted for a consistent “look and feel.”

Two Apple employees would be responsible for developing the product. Many roles, such as interface design, programming, and testing, would be entrusted to contractors.

The key to success, it was felt, lay in making Apple CD-ROM drives widely available to the field personnel. Without this investment ARPL could not deliver the benefits identified to a large enough audience.

The plan was adopted.

Reaping the Benefits

Today over 20,000 copies of the *Apple Reference and Presentations Library* CD are delivered every 3 months. Separate editions meet the needs of Apple employees and Apple Partners.

Each edition contains hundreds of megabytes—over 130 slide presentations comprising over 5000 slides. Every slide has a consistent look and feel; slides from different groups can be combined into custom presentations without additional graphics work. In many cases, speaker’s notes are included to ensure that the most important messages are put forward in presentations.

HyperCard® is used as a front end for navigation, search, and retrieval functions.

Content gathering has been automated so that only one Apple employee is dedicated to continuing the project.

Follow-up research has shown that

- the average sales representative uses ARPL over five times per month
- the average ARPL user saves 9 hours per month in the time needed to prepare sales calls—a savings of more than $675 a month each
- the average ARPL user makes three more sales calls every month than an average nonuser

The *Apple Reference and Presentations Library* CD has saved Apple Computer millions of dollars in labor and distribution costs, increased the effectiveness and productivity of the sales force, and ensured a consistently high standard of quality in presentation materials.

Content

Something is going to ship on the disc. You may be creating the content from scratch. You may be licensing it from others. Either way it will resemble print or video products in one respect—you're likely to spend more on developing, assembling, and formatting the content than on any other phase of the project. Yet most of this expense is not specific to CD-ROM. It would exist no matter what distribution medium you chose.

Creating Content

Creating original content involves pretty much the same things whatever the distribution format. If you already develop or publish products, these procedures and costs are familiar. One advantage of writing, designing, and producing original content with CD-ROM distribution in mind is that no conversion to an analog format is required.

The tools and procedures involved in creating content for a CD-ROM product are treated by data type in the chapters of Part Two.

Clearing Content

Unless you develop absolutely everything that ships on your CD-ROM disc, you will be obtaining the rights to works that are the property of others.

Plenty of good material is available for publishing, either as a CD-ROM product or to supplement your product. Some is out of copyright or otherwise cost-free, but most must be purchased or licensed.

Licensing typically involves a fee, royalty payments, or both. Licensing contracts can be complicated. You may need to hire an attorney to help you negotiate terms and fees.

Sometimes the owner will be satisfied with credit. Get a written agreement saying so, and put it in your files with all other permissions and licenses. People change their minds.

The section "Legal Considerations" on page 43 discusses copyright issues in more detail.

Preparing Content

Whether you create it, own it, or license it, content must be in digital form. Some things already in digital form will need additional formatting to meet the requirements of your product.

Detail on preparing materials for CD-ROM appears by data type in the chapters of Part Two.

A Project Team

Unless you're creating your first product or launching a product different from any you've done before, the skilled people you need are probably already available, as members of your own organization or among your suppliers.

Every CD-ROM product takes

- project management
- production

The roles of project manager and producer may be combined.

Depending on the nature of the project, you may also require skills in

- content
- design and performance
- programming

Individuals may bring more than one of these skills to the team. Roles can also be shared. Using outside resources can work well. Flexibility and a collaborative spirit are more important than rigid job descriptions.

These skills may all be available in your organization. All can be obtained from outside suppliers if necessary.

Project Management

Every project needs a leader to manage the team, develop the schedule, mind the budget, guide the work, and have final approval at each phase. The leader also serves, or designates someone to serve, as the contact with suppliers.

Project manager may be your role, or one of them. It's the responsibility most difficult to delegate to outside resources.

Production

The production role involves preparing and assembling the elements of the CD-ROM disc. Working both with the content and the product packaging, this may require knowledge of

- *data conversion*, such as keying and scanning, or supervising those who do
- *data organization*, to assemble the content efficiently
- *packaging*, to arrange design, printing, and fabrication services
- *coordination*, of equipment, services, suppliers, and schedule

The production role is sometimes combined with a specialty dictated by your product's content. These special skills are also readily available from outside resources.

Content

You and members of your team may be experts in the product content. Or others may provide

- *content expertise* in both subject matter and market
- *writing and editing*, to craft copy for the product and printed materials
- *research*, especially the ability to locate suitable material
- *legal assistance*, to handle licensing and copyright issues
- *testing knowledge* of how the product should perform

Design and Performance

You may engage various others with special talents in

- *graphics* to design screens and printed materials
- *human interface design*, to give the product the look and feel it needs
- *audio production*, to record, mix, edit, and digitize sound elements
- *video production*, to create, edit, record, digitize, and compress video
- *performance*, that is, narrators, musicians, models, and actors to lend professional polish, especially for multimedia presentations

Programming

Programmers who specialize in particular tools may be needed to write or specify code for

- *search engine development*, to link the user interface with the search engine
- *HyperCard*, *scripting* to produce stacks for the product, or the interface if HyperCard is used for navigation
- *multimedia*, if Authorware, MacroMind Director, SuperCard, or other multimedia tools are used

Tools

You probably own the equipment and software to produce a CD-ROM product, at least from the types of data with which you normally work.

If you plan a product including types of data that are new to you, you may need new hardware or software. The production environment assembled from these tools has a profound impact on product development.

Hardware

A Macintosh computer with a hard disk is all the equipment needed to develop a CD-ROM. Strictly speaking you don't even need a CD-ROM drive; but you'll probably want one, especially for testing your product before final production.

Any computer in the Macintosh family can support a CD-ROM drive. Some of the software you select may require a certain amount of memory. Multimedia production, in particular, is easier if you use one of the faster Macintosh computers for development. Always test your finished disc on as many models as possible to be sure all users will be able to enjoy it.

Some additional items of equipment make the job easier. Consider acquiring a

- *large external hard disk.* You can assemble data on an internal hard disk, but an external one is more convenient. Choose one with capacity as large as any CD-ROM disc you plan.
- *color monitor.* You can check your screen designs in monochrome by setting the Monitors control panel to black-and-white.
- *backup device.* A second large hard disk, or other backup device is good "insurance," provided you use it. If you select backup media that your mastering facility accepts, you can also avoid sending them your hard disk.

Depending on the type of product, you might also consider

- an audio digitizer (or a Macintosh with this capability)
- an audio tape recorder
- a video digitizer
- a videotape recorder
- a scanner

For discussion of the hardware tools associated with different data types, see the individual chapters of Part Two.

Software

Creating a CD-ROM product can require software tools for preparing the content, such as digitizing and editing programs or utilities for converting between data

formats. Other programs will actually ship on your disc, such as the interface tools, access tools, and player utilities.

Digitizing and Editing

New production software will be required to work with data types for which you're not already equipped. But you may also decide to replace tools you have been using. You may, for example, want to move to programs that read and write files in the most interchangeable formats or have versions on other computer systems for interoperability.

The chapters of Part Two discuss the file formats for different types of data and tools for handling each type.

Human Interface

You will want the human interface of your product to help users navigate the product. Navigation is finding your way through the structure of a file system or a body of knowledge to locate the things that interest you.

HyperCard is one tool for providing a human interface. Authorware, MacroMind Director, and SuperCard are other possibilities. Chapter 13, "Every Product Has a Human Interface," discusses issues involved in navigation and the human interface.

Access Tools

Search engines are programs that speed access to some kinds of data. Some are optimized for CD-ROM discs.

For more on access tools consult Chapter 14, "Giving Users the Tools to Find Things."

Other Software

Plan to include on your disc all the software needed to use the contents. This means licensing the programs or sometimes players, either in full-featured or run-time versions.

Production Environment

The combination of hardware and software that you employ creates a production environment. The power of this environment, its flexibility, and its ease-of-use will all affect the time, expense, and effort required to develop your CD-ROM products.

Most production environments are adequate for products confined to text. But interest in data of other types is steadily growing. Products distributed on CD-ROM can include audio, high-resolution images, and multimedia. The best production environments for CD-ROM product development provide powerful facilities for handling these data types.

Facilities for audio, high-resolution graphics, and multimedia are built in to every Macintosh computer. A large selection of powerful programs for these data types has reached maturity on the Macintosh family of computers. These combine in a range of Macintosh production environments more powerful, more flexible, and easier to use than can be assembled for other computer platforms.

Suppliers

Most CD-ROM projects make use of outside suppliers during some phase of production. Some of the most common are

- data conversion
- testing
- packaging
- manufacturing

Data Conversion

You can contract for

- keyboarding
- scanning
- digitizing

For text, keyboarding is more accurate than scanning with OCR (optical character recognition) software. Service bureaus charge from $1 to $5 per page for keyboarding, depending on the accuracy required and the average text per page.

Scanning to convert drawings and photographs is also available from outside suppliers. Estimate from $.50 to $5 per page. Line art is the least expensive to scan, and color photography is the most expensive. The better your original, the lower the rate, because less cleanup is required.

Sound materials are converted by digitizing. Sound digitizing is a feature of the newest Macintosh computers and may be added inexpensively to most others. Digitizing is available from service bureaus, too.

Video is also converted by digitizing. A source (camera, LaserDisc, or VCR) supplies video to a digitizer card in one of the Macintosh expansion slots.

The chapters of Part Two provide more information on converting each of the data types for use on CD-ROM.

Testing

You will want to test your CD-ROM product extensively. You can also hire a service bureau to do it. Special discs are used for testing your product before manufacturing. These cost from $100 to $700 each, depending on how quickly you need them, and you may need more than one.

Test discs can also be handy (and less expensive) when you need only one or two copies. In the next few years expect to see the equipment for making these discs widely available in local service companies offering quick printing, slide preparation, and other short-order services for business. You will be able to walk in with your hard disk or other appropriate storage media, and walk out with a single CD-ROM at a reasonable price.

See “Testing” on page 104 for details.

Packaging

CD-ROM products can take advantage of packaging materials developed for CD audio products. Most require some printed material as well.

Jewel boxes are the hinged polystyrene cases in which most Americans store audio CDs. They are also the most common way to store CD-ROM discs. As a rule of thumb, allow at least $2 per unit for a minimum package in the jewel box style. This covers the box and simple printed materials to accompany your disc.

Other kinds of packaging may be better for your product. See “Packaging the Disc” on page 115 for information on alternatives.

Manufacturing

Whatever other suppliers you use in creating your product, you will certainly need a CD-ROM manufacturer. Manufacturers offer premastering, mastering, and replication as well as other services.

At **premastering** all the individual files of your product are combined into a single huge file for the mastering machine. Some developers buy their own premastering equipment, and some use a service bureau, but all disc manufacturers offer the service. Allow from $250 to $500 for premastering, depending on the number of files on the disc.

CD audio tracks can be added to CD-ROM discs at this stage. The resulting **mixed mode disc** makes compact disc audio available to your product.

Testing and disc optimization services are also available during premastering. For more information see “Premastering” on page 110.

The **mastering** process converts your data into a stamping pattern for the presses. A more detailed description is found in “How Mastering Works” on page 123.

All manufacturers charge a **mastering fee.** It ranges from $500 for ten-day turnaround to $3000 for same-day service, and it does not depend on the number of discs being produced from the master.

The process of pressing discs is called **replication.** The cost of replication is less than $2 per disc, with modest price breaks at higher quantities.
A more significant reduction in price per disc comes from more discs sharing the cost of mastering. The larger the number of CD-ROM discs you press from a master, the lower the cost per disc. For example,
100 discs with same-day service cost over $30 apiece when mastering
is added to replication, but 10,000 discs with 10-day turnaround cost under $2 each, including their share of the mastering fee.

Price quotations usually include a two-color label printed on the disc. Manufacturers insist on having the art for this label, plus all your packaging materials (if they are doing package assembly), on hand before production can begin.

For more information see “How Replication Works” on page 124.

Shipping is the last stage in the manufacturer’s service. Manufacturers will ship discs directly to your customers or users (for a price, of course) or send them to you in bulk, packaged or unpackaged, at your expense. But you must also budget for other shipping charges, such as freight on your packaging materials from the printer to the manufacturer.

For more on shipping, see “Other Services” on page 124.

CHAPTER 4

Choices That Define Your Disc

In most ways a CD-ROM product is like any other. The product development and project management skills needed to create products are not discussed here. But there are choices about content and format that define your product and affect the steps you take in preparing it for distribution on CD-ROM disc:

- deciding what you're doing
- choosing the most appropriate form for content

Deciding What You're Doing

The objective in going to CD-ROM distribution need not be grand, only clear. Four questions clarify your objective:

- What do you have?
- Who wants it?
- How will it work?
- How much value do you want to add in the process of bringing it to them?

What You Have

What will you put on the disc? This decision comes first and affects most decisions that follow.

Anything that can be digitized can be distributed on CD-ROM. Knowing what will have the most value to users can be as simple as asking them. According to Mario Dell'Aera of KPMG Peat Marwick, "What we do is survey the field: 'What do you want on it?' Some things are licensed; some of it we developed in-house. They get our Industry Letters, all the templates, standard correspondence, and worksheets, a complete set of procedures, manuals, and forms, all things that they wanted. We call it *The KPMG Informant* and it's over 500 megabytes now."

Commercial products apply the same principle once the potential users have been identified.

Who Wants It

Learn everything you can about the prospective users.

Knowing who will use your disc means more than simply identifying them. What do they want to do with what you provide? How would they like to do it, and what tools do they have for the purpose? The data types you employ and formats you choose both depend on this understanding.

You may discover different goals among the users. For example, some may incorporate graphs and charts into presentations, while others build the underlying data into financial models. This knowledge provides an opportunity to add value. Save them steps by providing the information in ready-to-use images as well as spreadsheet files.

Not everyone will have the same tools. Some types of data are more accessible and some file formats more readily exchanged between programs and platforms. The surest way to achieve compatibility is to provide on your disc the basic tools needed to use what you distribute.

How It Works

People use products for what those products do. But what they do can be accomplished in more than one way. With content in mind and a notion of who wants it, the stage is set for developing your vision of how the two will meet in a compelling product.

Put yourself in the user's position. What does the material being offered call to mind? Is it a mountain to be climbed? A voyage to be charted? A museum to be explored? An interview to be conducted?

These real-life analogs are more than metaphors for the process. They contain clues to how a user might want to do things. They contain the seed of a product you can deliver and point in the direction of how it
can work.

This vision may come in a flash, or it may take weeks. Take the time required. There's not much basis for a compelling product without it. There may not be a product at all.

How Much Value to Add

Just bringing a large number of things together in one place adds value. Making them easy to access and use enhances the product tremendously. But it may be desirable to differentiate your product even more. There are a number of ways to do this by using the capacity of CD-ROM discs to

- increase the amount of content
- provide product documentation and training on the disc
- bundle supplemental materials, such as templates and clip content
- supply more powerful navigation tools
- offer resources at different resolution levels

Delivering more for the money is one way of increasing value, but it also increases the burden on your interface. A CD-ROM disc doesn't have to be full to offer advantages over other distribution media.

Documentation and tutorial files for your CD-ROM product are powerful value-added features to include on the disc, especially in an application software bundle.

Including supplemental material, such as templates, clip libraries, and QuickTime "help" movies is another way of using the space available to add value.

You can also add value by using the extra space for digitized sound clips about each element of the disc. Played from your interface, audio notes help the user understand what's available and how to use it. Implementing similar support through the Help Manager is another way of adding value.

One of the most powerful ways to add value to a CD-ROM product is by making every resource on the disc available in multiple versions. For example, provide graphics for each of the different screens users may have, in monochrome, gray scale, and each level of color. This makes your product seem custom-made for the machine running it. Have your program check the type of Macintosh computer and call the versions of the appropriate size, geometry, type, and resolution.

Choosing the Most Appropriate Form

In choosing the forms of data to distribute you reconcile the nature of your content with the needs of those who want it and the investment you are willing to make.

The same data can be distributed in many forms. Consider data from a presentation, for example. To those who couldn't attend you might send transcripts, copies of the

overheads, audio recordings of the event, all the data files to repeat it (given the right software), or a QuickTime movie of the presentation itself. Perhaps you'd distribute more than one form.

Within each form are a variety of possible formats. Should transcripts be text files, for instance, files for a particular word processor, or files for a page layout program?

It's tempting to simply distribute things in the form and the format you have them in. Certainly this minimizes production expense and effort. But it also overlooks tremendous leverage. Any conversion of form or format likely to be done by users is better performed just once in production than hundreds or thousands of times later. (The data should also be available in unconverted form for those with different needs.) For in-house discs the result is significant cost savings. For commercial products it's added value. And when specialized software or expertise play a role in the conversion, this leverage is multiplied.

Some things work best in print form; others are more effective as audio. The form in which information presently exists is a consideration, but the form in which it accomplishes the most is equally important. The chapters of Part Two look at the different forms data can take and what each offers your product.

The desire to simplify the choice of formats is steadily leading to standards. This is a trend with great promise for making it easier to develop products, move information between programs and machines, and handle that information with a variety of tools.

Don't expect a single standard for everything. As long as different markets respond to different needs, more than one standard will be necessary. But count on the market to weed out developers who use proprietary formats to "lock in" their users. Competing "standards" of this sort proliferate at everyone's expense.

You make the choice of standards for your CD-ROM product and those who use it. Not one but three different decisions are involved:

- data file format
- file system
- compact disc format

Computers save information as files on storage media. Some storage media, including floppy disks and hard disks, use magnetic techniques to record the information (magnetic media) and others, like CD-ROM, use optical techniques (optical media).

Data File Format

On either media, identical information can be saved in a number of different **file formats.** The file format describes how information is organized inside the file. The program that creates the file determines its format. Some programs can create files in more than one format; others create only one format but can read data from files of different formats. Some utility programs have been developed solely to convert files from one format to another.

Using a particular file format means you can exchange information with others using the same computer and program. Often you can also exchange information between different programs on the same computer by finding a file format they both

understand. Sometimes files can be exchanged between different computers running the same program and occasionally even between different programs on different computers through a file format known to both.

You will choose the file formats for your CD-ROM disc. You want formats for which all users are likely to be equipped. Yet you may not know the kinds of programs your users have. One solution already mentioned is to provide player software on the CD-ROM disc itself. Another approach takes advantage of the disc's large capacity by providing all files in multiple formats.

Some files formats are more widely recognized than others. These formats can be the best choice for files on a CD-ROM product. They afford the best interchange between different products of the same type (for example, competing word processors); between programs of different types, like a database and a spreadsheet; and between programs in either category running on different computer platforms. Against their usefulness in this regard you must weigh the fact that these formats sometimes embody the lowest common denominator in terms of the richness of information stored.

The most interchangeable file formats at present are

- TEXT for document files and field-oriented data
- TIFF for bitmapped graphics
- EPS for object graphics
- AIFF for sound files
- PICT for animation frames
- RIB for animation models
- PICS for animation sequences

Multimedia file formats have yet to evolve to a meaningful level of interchange. The efforts of the Interactive Multimedia Association are bent toward bypassing ad hoc file compatibility in favor of a more dependable approach.

The common file formats for different types of data are discussed in the chapters of Part Two.

File System

The Yellow Book standard specifies only the physical arrangement for data on a CD-ROM disc. How the directory and file structure are organized is your choice. The file structure you choose is imposed during the step called premastering.

You have at least three options in this regard:

- ISO 9660
- HFS
- hybrid HFS-ISO

ISO 9660

The ISO 9660 specification reflects the effort among manufacturers and developers to arrive at some lowest common denominator in the area of file systems. The files of discs in the ISO 9660 format can be read by any computer with software to recognize this file structure. All Macintosh computers recognize ISO discs. This makes the file contents accessible. Still, the right programs must be on hand to use the data in the files. Some cross-platform CD-ROM products count on programs of the type needed being available on each different computer.

ISO 9660 discs forfeit important features of the Macintosh user interface. ISO 9660 offers no icons, so files appear on a Macintosh desktop with default icons supplied by the Finder.

The files on an ISO 9660 disc are limited to eight directory levels—eight levels of folders within folders. This sounds ample, but can seriously hamper efforts to organize a large number of files for easy location on a CD-ROM.

Another disadvantage is limited filenames. ISO 9660 filenames are confined to

- eight-dot-three format—a maximum of eight characters in a filename, with the option of a period followed by three more characters (for example, OLDTHINK.EXE)
- the characters A through Z, 0 through 9, and underscore ($5F)

ISO 9660 offers compatibility at a low level. It can be used by a Macintosh computer, but it is oriented more toward a simple command-line environment.

For those who must use the ISO 9660 format Apple has developed extensions that add some basic Finder information, such as file and creator types, while maintaining ISO compatibility.

HFS

A CD-ROM disc can be premastered with the HFS (hierarchical file system) structure. It will be accessible to any Macintosh computer and support all the features of the Macintosh interface.

A CD-ROM premastered in HFS offers full 31-character file names and custom icons, plus many other features that are not supported by ISO 9660.

Comments, for example, enable users to attach their own notes to files, identifying the contents for later reference or the benefit of co-workers. Labels provide a powerful, convenient way to quickly organize and reorganize access to files using categories that make sense for your application. Both of these features are made even stronger when used as the basis of a search using the Find command.

HFS discs are not limited to eight levels of directory structure. This flexibility can be essential when organizing a CD-ROM disc to deliver thousands of individual files. HFS allows the structure of your disc to be determined by its content rather than the limitations of an operating system.

HFS discs can be used only by Macintosh computers, unless premastered in the hybrid HFS-ISO format.

Hybrid HFS-ISO

CD-ROM products can be premastered to run under HFS and still provide ISO 9660 compatibility. On a Macintosh computer the files appear with full filenames and custom icons. On other ISO 9660 computers, the files appear with eight-dot-three filenames in the limited character set.

Not all premastering suppliers offer this option. The procedure is proprietary but is available from various service bureaus and manufacturers. Hybrid discs offer the best of both file structures and preserve the savings of producing only one disc for multiple platforms.

Some Macintosh tools such as MacroMind Director have play-only programs that run under other operating systems. Providing these programs on a hybrid HFS-ISO disc allows users on a variety of different computers to display Director files.

The disadvantage of a hybrid disc is that you get only half as much space for each version.

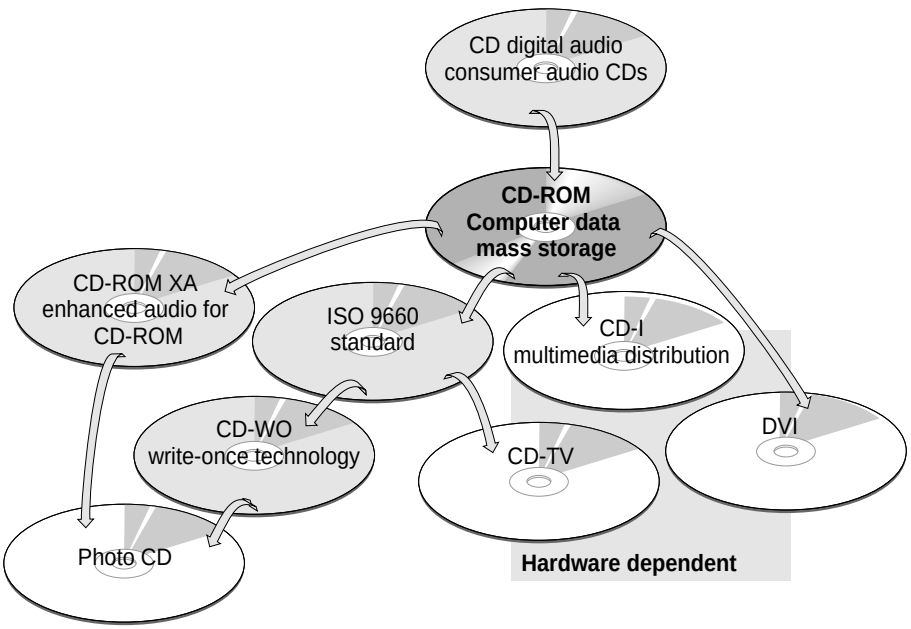
Compact Disc Format

A compact disc can be formatted in several ways. Some advantages described for CD-ROM apply to the other formats, too. But which disc format you choose determines whether your disc will play in all players.

The information on compact discs is divided into chunks of uniform size called *sectors*. Adjoining sectors are grouped to form *tracks*. Tracks are listed in the table of contents, a special unnumbered track that plays first.

Different formats use the space within disc sectors differently. Figure 4-1 shows some of the formats derived from CD-ROM.

Figure 4-1 The CD family tree



CD audio discs use the space for digitally recorded sound and error correction data. They follow what's called the **Red Book** format, developed by Philips and Sony.

Standard CD-ROM discs use the space within sectors for computer data rather than audio but retain the error correction. Part of the space that CD audio tracks use for music, CD-ROM tracks devote to synchronization data and a header. Headers identify each sector individually.

The Yellow Book standard for CD-ROM lets developers devise their own ways of using the space in a sector. If they do so, however, only specially equipped computers can interpret their discs. **CD-I** (short for Compact Disc Interactive) is a system of this kind.

CD-I discs shift some space left blank in a normal CD-ROM sector and use it for a subheader. The subheader passes information about the data in the sector to the player. This is for **interleaving** (sector-by-sector alternation between data types within a file). Interleaving permits different types of data to be routed to different hardware or software as a file is playing. But shifting this space within the sector makes CD-I tracks unplayable on normal CD-ROM drives. In fact, these discs play only under a particular operating system built into special players. They also omit the extra level of error correction included in the CD-ROM standard to ensure program data integrity.

CD-ROM/XA (short for CD-ROM Extended Architecture) tracks are identical to CD-I tracks. A CD-ROM/XA disc lists these data tracks in its table of contents, while a CD-I disc does not, to make them “invisible” to audio CD players. CD-ROM/XA discs play only in specially equipped CD-ROM drives.

Sometimes compact discs are described by the product being distributed rather than the disc format used. *DVI* (Digital Video Interactive), for example, is not a disc format but a video compression technology developed by RCA. DVI requires special compression and decompression boards, which are available for the Macintosh computer as well as for several other systems. DVI files are often distributed on CD-ROM discs because of their size, and these are sometimes called DVI discs.

Photo CD is Eastman Kodak’s digital image storage and distribution system. Photofinishers equipped with a Photo CD workstation can scan images from film and record them directly to compact disc. The disc format is that of CD-ROM/XA discs. Photo CD discs are recorded individually on CD write-once discs.

CDTV is not a disc format but a product name under which Commodore Computer markets a stand-alone compact disc player as a television peripheral. The disc for CDTV is a CD-ROM disc, and its file structure conforms to the ISO 9660 definition.

The terms *MPC* (for multimedia PC) and *Ultimedia* refer to computer hardware configurations, not disc formats. There are no MPC or Ultimedia discs as such; both configurations include a standard CD-ROM drive. Discs for these systems can follow the ISO 9660 specification or other formats. Ultimedia, established by IBM, also includes a DVI board.

Advantages of CD-ROM

Standard CD-ROM enjoys much wider use than any of the formats derived from it.

CD-ROM shares substantial elements with each of the other formats. There are tools to convert information from CD-ROM to CD-ROM/XA, CD-I, and other formats, but no tools to convert in the other direction. Producing for CD-ROM keeps all your options open.

The Other Side of the Disc

CD-ROM/XA and CD-I offer interleaving of multimedia data, sector by sector. CD-ROM discs don’t support this method, but other approaches are available. QuickTime from Apple, for example, provides interleaving by using software rather than special-purpose add-on hardware.

Everything Your Disc Delivers

Everything has to be in digital form for use on a CD-ROM disc. Getting it there is often the biggest cost in developing a CD-ROM product. Once this has been accomplished, however, the investment pays dividends. Material prepared for use on a disc is easy to adapt for other purposes. Images and QuickTime movies, for example, are easily incorporated in documents or presentations. Text files prepared for CD-ROM can be imported by a variety of programs to become part of a brochure or press release. And it's easy to search what you have assembled.

Different types of data are digitized in different ways with different tools and procedures. The chapters of Part Two look at different data types distributed on CD-ROM disc and their special characteristics. But some principles apply to all forms of data being prepared for CD-ROM distribution.

Quality Issues

Acquire the content for your product at the highest level of quality possible. This provides the greatest flexibility and can improve disc performance.

High-quality data can be converted to formats of lower resolution. The reverse is not true.

Data gets degraded as you prepare it for distribution. Information is lost outright during some types of compression and conversion. New information (not part of the original) is sometimes added by *interpolation* (calculating probable values from adjacent ones). This occurs, for instance, when an image is stretched or scaled to a larger size.

Another kind of degradation is **noise,** meaningless information in a signal. The amount of noise is measured by comparing it to the amount of meaningful information it accompanies. This is called the **signal-to-noise ratio.** The higher the ratio, the better the quality of the signal.

Noise is introduced every time analog signals are copied. The effect is cumulative when copies are made from copies. Yet such copying is part of many analog audio and video production techniques. If many of these steps are involved in your project, it's even more important to start with the best quality possible. Get your data into digital form as early as possible in the production process.

The signal-to-noise ratio of analog data on magnetic tape declines from wear in normal use. Save your master tapes for digitizing; work only from copies for all other purposes.

Signals that pass through a series of analog devices are only as good as the poorest component. If you're buying equipment, the key is balance. Choose devices with about the same technical characteristics. If this sounds mystifying, an audio or video engineer can help you make selections that match.

Content with a high signal-to-noise ratio can do more than improve the perception of your product. It can also improve the performance. Noise is hard to compress because it lacks cohesive structure. Signals with less noise tend to compress more efficiently, which is especially desirable for CD-ROM products.

Compression Options

The term **compression** covers all the ways to minimize the number of bytes required to transmit or store data and recover it (**decompression**) with acceptable accuracy. Compression helps CD-ROM products in four ways:

- It reduces the time required to transfer data to memory from the disc.
- It reduces the amount of RAM required to store data transferred from the disc.
- It improves the playing performance of data types being decompressed in real time from the disc.
- It makes possible the distribution of video data.

The efficiency of compression is expressed as the **compression ratio**, the relation of the original size of the data to the compressed size. For example, data with an uncompressed size of 5 MB has undergone 50:1 (fifty-to-one) compression if it now occupies 100 KB. The compression ratio possible depends very much on the data being compressed.

In general the higher the compression ratio attained, the lower the quality of the data recovered on decompression.

Legal Considerations

Creating any product has legal implications. Of particular importance for CD-ROM products are the issues of property rights and copyright. There are many books on these subjects and related issues. Attorneys who specialize in these matters can help you understand their implications.

Property Rights

You are responsible for what you distribute on a CD-ROM disc. One way or another you must have the right to publish everything included in your product. You can obtain these rights by

- creating the content
- contracting for the content to be created
- licensing the content from its owner
- obtaining permission to use the content from its owner
- using only content in the public domain

Whether you contract to have content created, license it, or obtain permission to use it, get the agreement in writing. Your attorney can help you develop documents for this. Companies that regularly license their software or information already have documents for this purpose that they will want to use. It is prudent to review these with your attorney.

Creating Content

You own what you create, unless you have made other arrangements about the rights to your work. One such arrangement is employment. In some places, the law sees your employment as a transfer to your employer of all rights in work you do, unless your employment contract has different provisions. This idea is called *work-for-hire*. Generally it covers only the things produced to fulfill assigned tasks or responsibilities. An attorney can explain how work-for-hire applies to you, to those hired for your team, and to those with whom you contract as suppliers.

Contracting for Content

You want the rights to anything you pay others to create for your product. This applies to software, data of all kinds, and design work, in fact just about everything you might obtain from an outside resource. Your attorney can prepare agreements that secure those rights. Use them with your contractors.

Licensing Content

By licensing you can arrange to include almost anything in your product—software, images, music, text, and other sorts of copyrighted materials. Sometimes this saves a

great deal of time. It can be the most affordable way to “buy” skills you don’t have in your own organization.

Licensing fees vary depending on the type of property. They also depend on whether you are obtaining an exclusive or a nonexclusive license. If you obtain an exclusive license, for a specified period of time the owner will not license anyone else to use the material in the same way you are being permitted to use it. Whether an exclusive license is even possible depends on the type of property. Some properties, such as recordings of popular songs, are almost never licensed exclusively and so appear in many different “oldies” collections. Other properties, such as rights to use the title and characters of a popular movie as the basis for a computer game, are almost never licensed any other way. This assures the licensee a reasonable chance of marketing a profitable product for the benefit of both parties to the agreement.

If the property you want to license has never before appeared in computer form, it may make a difference whether you ask for all computer rights or only the rights to distribute for a particular computer platform. Rights for a single operating system are sometimes easier to obtain. If you want rights for all operating systems, the owner may require you to release all the versions within some period of time, perhaps as short as a year.

Using Content by Permission

Even if an owner doesn’t ask for compensation, obtain written permission for use. CD-ROM discs last for a long time and people sometimes forget what they’ve said.

Using Content in the Public Domain

The law recognizes a special category called the **public domain.** Materials in the public domain are not protected by copyright or patent, and anyone may use them. Things come to be in the public domain in different ways. Works created by the government are generally in the public domain. Sometimes owners place their work in the public domain. When all copyright or patent protection has expired, a work passes into the public domain. If you are not sure whether something is in the public domain, it’s a good idea to consult your attorney before including it in your product.

Copyright

Because CD-ROM discs are considered a form of publication, you are obligated to acknowledge the copyrights and trademarks of others as you would in a publication. The arrangements you make to obtain rights from others may also impose requirements for crediting materials to those who own them.

CD-ROM products are a new development. It's not universally clear which provisions of the copyright law apply and which, if any, do not. Most companies producing CD-ROM products seem to observe the copyright provisions for recordings by including a notice of copyright on the label of the compact disc itself. In most cases this notice is repeated somewhere in the content of the disc, as well as on the product packaging.

Programs you develop for your CD-ROM product are entitled to copyright protection, like any other software. Copyright protection gives you the exclusive right to reproduce and distribute the work and to create other works derived from it. This protection becomes yours as soon as the program is created. Nothing beyond the act of creating it is necessary, although registering your copyright to the program has some advantages. Your attorney can advise you about this.

As already noted, when a program is created by an employee in the course of employment, the employer is sometimes considered the author for copyright purposes.

Even if all the things you distribute on CD-ROM have been obtained by licensing or permission, the law entitles you to what is called a *compilation copyright* on your product as a unique collection of material. This same protection applies to products that others have produced entirely from licensed materials or materials in the public domain. That may affect your ability to use things from such collections.

The decision of the Supreme Court in Feist Publications Inc. versus Rural Telephone Service Co. (1991) suggests that if your disc contains only publicly available information, you may need to do something creative or original in the way you select or arrange material to merit copyright protection. Consult your attorney for more information on this aspect of the law.

Patents

Patents are granted to protect inventions. For a specified period of time patent holders have an exclusive right to make, use, or sell things that include their inventions.

Your CD-ROM product, or the software you develop for it, may qualify for patent protection. To be patentable your invention must be truly new and not something obvious to a skilled person with access to what was known at the time you developed it. For example, simply distributing your programs on CD-ROM instead of floppy is likely to be regarded as obvious and so disqualified for patent protection. A patent attorney can help you understand how the Patent Office applies these two tests to applications.

For some time it was widely believed that inventions in computer software were unpatentable. But many patents for software-related inventions have now been granted. A patent can offer more protection than a copyright because it prohibits not only copying but also "knockoffs" that do the same thing as your invention, even if the way
is not identical.

But securing patent protection is more complicated than registering your copyright, less certain, and more expensive. It may take several years to complete and has some potential drawbacks.

As part of the application process the applicant describes how the invention can be duplicated. This *disclosure* means that all protection as a trade secret is lost if your invention receives a patent.

Unless you apply for patent protection within one year after first showing your invention or offering it for sale, it may be ruled unpatentable. So seeking a patent can also slow commercialization of your product.

It's a very good idea to seek legal counsel if you are interested in patents. Your attorney can explain these and the other implications of seeking patent protection.

The Right of Privacy

A final legal consideration in creating your CD-ROM product is the area of privacy.

Reproducing a "likeness" of someone on your disc may violate their right to privacy. Even the parody or imitation of a well-known person can violate their rights. Broadcasters and publishers routinely obtain a signed release from anyone who appears in their "product." The rules do not apply to "public figures" or to crowds photographed in public, but you may need legal counsel to decide what's prudent.

PART TWO

Working With the Contents

Many different kinds of information can be expressed in digital form. All can be distributed on a CD-ROM disc. But some may be more effective for one purpose than another, and some require special hardware or software tools.

Each type of data can be stored in one of several formats. The tools you have may determine which formats you use for production. The programs that users have may determine which formats are distributed on your disc. And sometimes you will want the same information in more than one form or format to be available on your disc.

Some types of data place unusual demands on the CD-ROM disc. The characteristics of CD-ROM impose some requirements on the way certain data is prepared for distribution.

The individual chapters of Part Two examine the possible forms of data, the formats in which they are distributed, the tools they require, and the techniques involved in preparing them for distribution on a CD-ROM disc.

- Chapter 6, “Programs”
- Chapter 7, “Text”
- Chapter 8, “Images”
- Chapter 9, “Audio”
- Chapter 10, “Animation”
- Chapter 11, “Video”
- Chapter 12, “QuickTime”

Programs

Application programs represent a type of data only in the sense that they all contain instructions for the computer's microprocessor. Your CD-ROM product is likely to include programs of some sort. For example, a program will provide the user interface, and another program will perform the search functions if you offer them. In fact the whole point
of your CD-ROM product may be to distribute programs, whether you've written them or obtained them from others.

Program Fundamentals

Programs that run on the Macintosh family of computers all have the same file format, designated by the file type APPL.

You may intend users to run a program from the CD-ROM disc. In that case, some precautions are necessary. See "Including Programs on CD-ROM" on page 51 for details.

If a program is not meant to be run from your disc, it's generally a good idea to put it in the form of a *self-extracting archive*. This is a compressed file that saves the expanded version of its data to disk when double-clicked. By using a self-extracting archive you ensure that the program will be transferred to writable media before execution, whether users copy the archive file or attempt to run it from CD-ROM.

Program Tools

Be careful not to make assumptions about the software tools available to users. Provide on your disc the tools to use all the data your disc contains, unless you can be certain that users will have everything required. Some programs that have been included on CD-ROM discs for this purpose are

- TeachText
- HyperCard
- DiskPaper Reader
- MacroMind Player

TeachText is a system utility from Apple that displays and prints files. TeachText 1.2 will open any TEXT file and will run under System 6 or System 7. TeachText 7.0 runs only under System 7, but opens all TEXT, PICT, and QuickTime files. In fact, System 7 offers to open files of these types using TeachText if they are double-clicked when the applications that created them are unavailable. TeachText displays and prints text only in 12-point Geneva plain. Both versions can be licensed for use in CD-ROM products. Contact Software Licensing in the Legal Department at Apple Computer for more information.

HyperCard, the unique hypermedia component of system software for the Macintosh computer, is often included on CD-ROM products. This both adds value and means stacks on the disc can use all the newest features even if users don’t have a current version before receiving your disc. Including HyperCard on your disc makes it possible to use a HyperCard stack for navigation or as an interface. For information on licensing HyperCard for your disc call the Legal Department of Claris Corporation.

Farallon’s DiskPaper Reader is an alternative to TeachText. It can make available documents created by any Macintosh application program. DiskPaper files are “printed” to disk from the program and become freestanding. Users do not need the programs, or even the fonts used,
in their own systems. Documents can be set up to permit users to copy text to the clipboard or to prevent this. Ask for Software Licensing at Farallon Computing for more information.

MacroMind Player is a run-time utility that plays scenes created with MacroMind Director. There is no licensing fee for including this program on your CD-ROM disc, if you are a registered user of Director 3.0.

Including Programs on CD-ROM

Most well-designed Macintosh programs run without difficulty from a CD-ROM disc. Observing a few precautions helps you ensure this.

Give users the choice of running programs from the CD-ROM disc or their own hard disk whenever possible. That means your program must use full pathnames to any data files on the CD-ROM disc.

Programs that create temporary files without letting the user decide where to put them can sometimes fail to run from CD-ROM discs since files can’t be created on a locked volume.

The access and data transfer rates of CD-ROM make it undesirable to rely heavily on the segment loader for paging either code or data into memory.

Think carefully about the application memory size to set for each program on your disc. Setting it too high on the locked volume is a mistake. While users can transfer the software to hard disk and change this setting, it can prevent some users from running the program from the CD-ROM disc.

CHAPTER 7

Text

Text is a very compact form of information. It already has two levels of encoding: words are small symbols for real or imaginary objects or actions, and words are encoded as text by using a still smaller set of symbols called letters. Text can convey large amounts of information in a minimal amount of data. Nothing beats it when size is the key consideration, either for transfer speed or for storage space.

But some things are difficult to capture in words. The effectiveness of text can be enhanced by the way it's presented, whether on paper or screen. Different typefaces and styles contribute to this enhancement. It is especially important to consider the design of text when you intend it for use from the computer screen.

Text has the distinct advantage of supporting indexing. Using text as a jumping-off point into other data forms through hypertext links in programs like HyperCard and SuperCard takes advantage of this strength in collaboration with the strengths of other data media.

Text Fundamentals

Text files contain the printable ASCII characters, and sometimes other characters that control how the text is displayed or printed, such as

- style codes
- markup codes
- formatting information

Style codes are nonprinting characters embedded in the text of a document file to control what font, size, and style are used to display or print the text. They are preserved when a word processor saves documents in *native format*, the proprietary file structure unique to that program. They are not preserved when a file is saved as "text only."

Markup codes are short strings of printing characters such as <*ti*> included in the text of some documents. They serve as *tags*, or markers that designate parts of the text for typesetting in a predefined fashion. Because they include characters that also occur naturally in text documents, tags are sometimes difficult to remove from files and typesetting tapes that contain them.

Some programs, such as outliners and spreadsheets, also sprinkle the text of their files with special characters. These control formatting, mark the fields for indexing, or indicate something else to the program. They are preserved when the program saves files in native format but may also survive when text is saved in other ways or copied to the clipboard. They can cause problems for other programs.

If all text files on your disc are stored in TEXT format, any word processor the user happens to have will probably open them. TeachText will also open them. If the file itself is double-clicked, the Finder launches the application that created it. If the application is not available, System 7 offers to open the file with TeachText.

Another advantage of TEXT format is the large number of programs of different kinds, on both Macintosh computers and other platforms, that can open, read, and write to TEXT files. Using this format can increase the ways and places a user can put your product to work.

Files in TEXT format may require the least preparation before indexing. Refer to "Search Engine Installation" on page 101 for more information about indexing.

The primary disadvantage of TEXT format is the absence of typefaces and style codes.

Text Tools

Text is put into digital form by typing it in from a keyboard (called *keying* or *keyboarding*). The programs used are most often word processors. No special equipment beyond a computer is required. Text digitized this way is called a *text file* or *word processor file*.

Text can also be digitized by using a device called a scanner. Scanners convert the visual pattern of printed materials into an electronic pattern of information. The programs used to digitize text with a scanner are called *OCR* (optical character recognition) programs. Text digitized this way is also called a text file (sometimes an OCR file).

A third way to digitize text, called **document imaging,** also uses the scanner. Each page of text is captured as an image and stored in the way described for other images. See Chapter 8, "Images."

Text Data Formats

A file in TEXT format contains only ASCII characters, no embedded characters for style, markup, or other reasons. Such files can be exchanged freely between a wide range of different programs for the Macintosh computer, and programs operating on many different computers.

You will also encounter the native formats of different word processors. Some programs can open, import text from, or export text to files in formats other than their own. Some file formats are recognized only by the programs that create them. Among the native file formats of word processors are

- WORD, the original MacWrite® format
- MW2D, the MacWrite II format
- WDBN, Microsoft Word
- WPDC, WordPerfect

Native format text files can often be exchanged freely between versions of the same product running on different computer platforms.

You may also encounter the acronym **SGML.** This is not a file format; it stands for Standard Generalized Markup Language. SGML is an international standard (ISO 8879) for defining markup codes. As noted earlier in the chapter, these describe the structure of information, by means of tags embedded in the data itself.

Including Text on CD-ROM

How to approach the task of text input for your CD-ROM product depends on how much text you have to digitize, how accurate the results must be, and how well your source documents work with OCR programs.

It takes longer to “train” OCR software to work with unusual fonts than common ones. After that, however, the accuracy with distinctive fonts can actually be higher.

Test any OCR software you consider using. Try it on your own documents, not just those provided by the software publisher. With simple documents you may get error rates as low as 1 percent. However, since an average page of type has 2000 characters, that's still 20 errors per page, and the error rate for complicated documents may be five times higher, averaging one or two errors per line.

Compare that with keyboarding, where the average error rate is only .025 percent or one error every two pages on average. If accuracy is important, keying can be a better choice.

But keying is also time consuming. The cost must be weighed against the cost of correcting the errors from OCR.

Members of the team might be able to keyboard a small number of documents. For large numbers of documents, many teams contract with a data entry or conversion company. Some teams hire temporaries. At least one has donated Macintosh computers to the local high school typing class in exchange for keyboarding.

Document imaging, scanning your documents as pictures, is the simplest way to capture large amounts of text. It may be the best if users only need to view things. It won't be possible for them to search for words in the contents or clip text for other use.

The figure of 2 KB per printed page is frequently used to estimate the space required by text documents. The actual amount required varies with the type size, style, and formatting. Storing your documents as pictures rather than text files can take up to 20 times more space. Compression sometimes improves this, but the picture always takes more space.

CHAPTER 8

Images

Images have a unique ability to communicate. One of the strengths of CD-ROM is its ability to deliver large numbers of images at a low cost.

Imaging Fundamentals

Computer images are created by drawing, paint, and illustration programs or by scanner software. Some programs save images as *bitmaps*. A bitmap describes the color assigned to every **pixel,** or picture element—the smallest unit of the display you can control. Other programs save images as a collection of *objects*, each a shape described by a mathematical expression. These images are called *object-oriented graphics*. **QuickDraw** is the part of Macintosh system software that displays both bitmapped and object-oriented images.

Images are also described in terms of their dimensions in pixels. For example, an image exactly the size of the 9-inch Macintosh screen is 512 pixels wide and 342 pixels high (512 by 342); while the screen of a Macintosh 12-inch color monitor is 512 by 384; and a Macintosh 13-inch RGB monitor is 640 by 480.

In the simplest representation of an image, pixels are either black or white. Black-and-white images have a **bit depth**—the number of bits describing each pixel—of 1.

When more than one bit is used to describe each pixel, the new values made possible can stand for shades of gray (*gray scale*) or for colors. Pixel depths of 2, 4, 8, 16, and 32 are possible with QuickDraw. Thirty-two-bit color images can include millions of distinct colors and achieve striking realism. The price is size: a 640 by 480 image in 32-bit color occupies about 1.2 MB of RAM or disc. When compressed without any loss of
data by the QuickTime photo compressor this image still requires about 120 kilobytes (KB).

Imaging Tools

Digital images can be created with three types of products: paint programs, drawing programs, and illustration software. The distinction is based on the way the products store data. Paint products use a bitmapped format. Drawing programs, including computer-aided design (CAD) products, use an object-oriented format. Illustration software generates files of PostScript code. No special equipment is required, but some people like to use a bit pad or graphics tablet with these products. A digital image prepared this way is called an *image file*, a *paint file*,
a *drawing file*, or a *PostScript file*.

Digital images can also be captured by using a scanner. Scanners convert the visual pattern of pictures into an electronic pattern of information. The programs that digitize images with a scanner are called *image-processing* programs or just *scanner software*. An image digitized
in this way is also called an *image file*, or a *scanned image*.

Image files, especially scanned image files, tend to be very large. The higher the quality, the larger the file. Size is the reason CD-ROM is such an attractive medium for images. Size is also the reason that image files are often compressed. Operations of any kind on large image files are likely to be very time-consuming.

Kodak ColorSqueeze is a JPEG software compressor for the Macintosh. QuickTime's photo compressor also provides software compression of images to the JPEG standard. It achieves compression ratios between
5:1 and 100:1, depending on the nature of the image.

Image Data Formats

There are various formats for bitmapped images and others for object-oriented graphics. Several terms are common:

- *PICT,* the system file format for QuickDraw images on Macintosh computers, stores object-oriented data or bitmaps. This format originally supported only eight colors. The upgraded version, PICT2 (now also commonly called PICT) supports as many colors as your monitor will display.
- *TIFF,* short for Tagged Image File Format, was developed specifically for high-resolution scanned images in gray scale or color. TIFF is used by programs in many different computer environments, but there are several different and potentially incompatible implementations of the standard.
- *DRWG,* the native format of MacDraw®, contains object-oriented data.
- *EPS,* short for Encapsulated PostScript, is a format that combines an object-oriented version of an image (a PostScript description) with a bit-mapped version of the same image for preview purposes.
- *GIF,* the Graphics Interchange Format, is a compressed format introduced by CompuServe in 1987 to speed downloading of images.
- *JPEG,* short for Joint Photographic Expert Group, is not a data file format, but an ISO standard for compressed images. As the standard is adopted, JPEG may become one of the most universal formats for image interchange.

Including Images on CD-ROM

As image size increases and color is added, images become quite large. RAM is likely to be affected before CD-ROM disc capacity. The increased time to load large graphic files from disc can also be a problem.

There are several variables in scanning, and the choices are somewhat a matter of taste, especially with photographs. To maintain control of the results some teams choose to handle scanning in-house, although the time and expense can be greater.

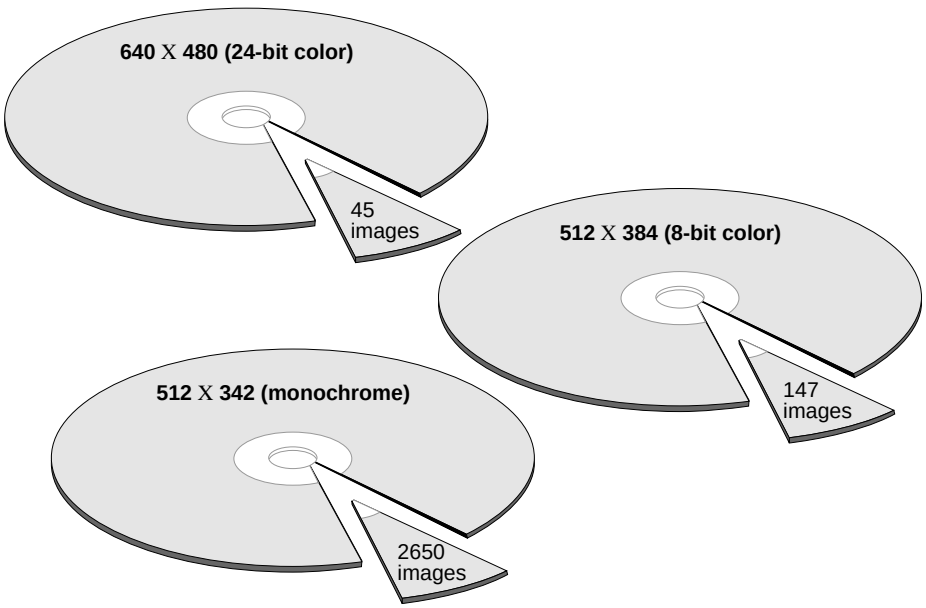
Images

It is recommended that you use image compression with bitmapped images. This reduces not only the amount of disc space required but also the time to retrieve images, which can be more important in CD-ROM applications.

Object-oriented graphics are already stored in a highly efficient form, as mathematical expressions. Do not plan to gain much space by compressing them.

The bit depth and image size determine how many images will fit on your disc. If for instance you have budgeted 10 percent of the disc for images, then choosing 24-bit color limits you to 45 images, each 640 by 480. The same space would hold 147 images in 8-bit color at the 512 by 384 size. Figure 8-1 illustrates this.

Figure 8-1 How many images fill one-tenth of a CD-ROM?



Audio

Sound results from vibration. It travels through the air as variations in pressure, spreading out in waves from its source, like ripples around a pebble dropped into a pool.

Sound waves have some familiar properties. Their strength (amplitude) is sometimes called volume.

Their tone (or pitch) results from the frequency (speed) of the vibration responsible. This is expressed in hertz (abbreviated Hz) a measure of the cycles each second. For sound, a cycle consists of one wave of high pressure and the trough of low pressure preceding or following it. The average human ear detects sounds with frequencies between 16 Hz and 20,000 Hz (typically shown as 20 kHz).

Electronic means of recording, modifying, and reproducing sound are often referred to as *audio*. Audio can add an extra dimension to the user's experience of a computer program, which is why audio has always been an integral part of Macintosh computers.

Audio Fundamentals

Audio is put into digital form by a process called **sampling.** A sample is a snapshot of sound pressure at one instant in time. If samples are taken quickly enough, and recreated in sequence, the result is a kind of audio animation, the impression of an actual sound. The quality of this impression depends in part on how frequently the sampling occurs
(the *sampling frequency* or **sampling rate**). The higher the sampling rate the greater the range of pitches accurately recorded.

At least two samples must be taken during the cycle of a sound wave to describe it accurately. This means the sampling rate must be at least twice the frequency of the highest pitch you want to reproduce. The sampling rate used on CD audio discs is 44.1 kHz so that sounds over the whole range of human hearing are reproduced accurately.

Sampling rates below 40 kHz do not accurately capture the highest audible pitches. But this is sometimes acceptable. Sampling at 22 kHz captures the same range of frequencies as a typical FM stereo broadcast. Most of the frequencies to which the ear is most sensitive (1 kHz to 6 kHz) are captured accurately even by sampling at 11 kHz. The result is comparable to AM radio in frequency content.

The accuracy of an individual sample depends on the digitizer's *resolution:* the number of different values available to represent a sample's amplitude. This depends on how many bits of data are used to record the sample. Audio on your CD-ROM product can have 8-bit or 16-bit resolution.

Audio Tools

Depending on what you want to do with audio, you may need special hardware and software.

The most common audio source is an analog tape recorder, but other possibilities include microphones, CD players, DAT (digital audiotape) machines, or a mixer combining signals from several of these sources.

Audio digitizers range from the MacRecorder, which samples at 5.5, 11, or 22 kHz in 8 bits, to the Audiomedia card, offering up to 44.1 kHz sampling at 16-bit resolution. MacRecorder plugs into a Macintosh serial port. The Audiomedia board requires a NuBus™ slot.

An editing program is used to trim, fade, mix, and modify sound samples. Some programs like SoundEdit (the software for MacRecorder), also control the digitizing hardware.

Audio Data Formats

The different formats for digitized sound that can be used with Macintosh CD-ROM discs include:

- *Red Book*, the digital tracks distributed on CD audio discs with a sampling frequency of 44.1 kHz.
- *sound resources*, the way sound is stored within a Macintosh program.

- *SoundEdit files*, sometimes called simply *sound files*. This is the native file format of SoundEdit. It differs only slightly from AIFF, defined next, and SoundEdit will convert files between the two formats.
- *AIFF* (short for Audio Interchange File Format), a format for exchange of sounds between different programs and different computer platforms. Some Macintosh programs store sound in this format. A more complete description of AIFF is available from APDA, Apple's source for developer tools.
- *QuickTime* movies are a convenient form in which to distribute audio. See *SoundToMovie* in "Conversion Tools" on page 77.

For more information on Macintosh sound refer to the Sound Manager chapter of *Inside Macintosh.*

Including Audio on CD-ROM

Your CD-ROM product can include both system audio and CD audio. But not all users will have a CD-ROM drive with audio output, and those with audio output may not be hooked up for playback. It's a good idea, when you have room, to provide audio in both formats and let the user choose.

The sampling rate and resolution have a profound effect on the amount of disc space audio requires. Figure 9-1 shows how these factors affect the amount of disc space needed to store a minute of audio.

Figure 9-1 How much space does a minute of audio take?

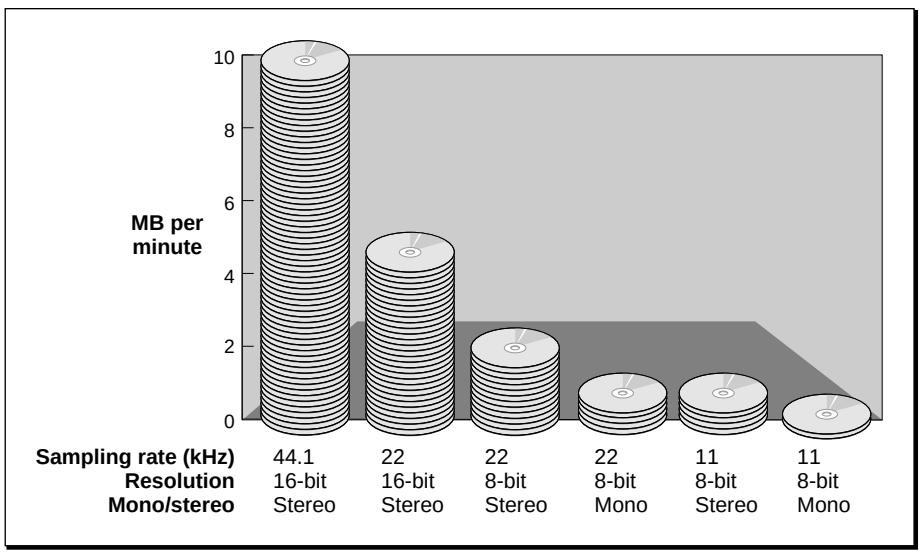
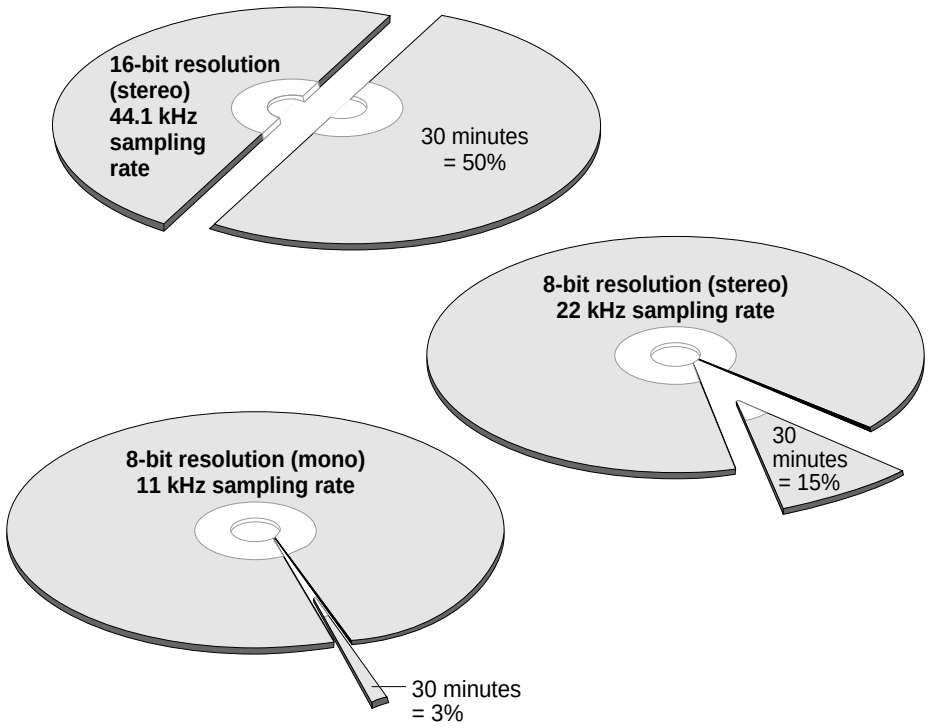


Figure 9-2 shows this relationship in another way. If you have 30 minutes of audio content, it fills about half of your disc when stored as Red Book tracks (stereo at 44.1 kHz sampling in 16 bits) but much less at a lower sampling rate and resolution.

Figure 9-2 How much audio fits on a CD-ROM?



Remember that no access to the CD-ROM is possible while Red Book audio is playing. Any data required by your product during CD audio playback must be loaded into memory beforehand.

Fading the volume level to zero at the end of samples when you're digitizing, even if it's done quickly, prevents a speaker click.

If you decide on an 11 kHz sampling rate to save space, actually record the material at 22 kHz. This is called *oversampling*. Then copy the data and paste it into an 11 kHz sound file using, for example, SoundEdit. This often produces better-sounding results than 11 kHz sampling.

Audio is very personal; some users will prefer to turn it off altogether. Others will find it inappropriate on some occasions. Provide users that choice as well as the ability to control volume levels.

CHAPTER 10

Animation

The word *animate* means “to give life.” Presented in rapid succession, a series of individual images is perceived as one image with the attribute of motion. This phenomenon brings pictures to life and forms the basis for all animations.

There are several ways to create animations. The results of most, in digital form, can be distributed on CD-ROM disc.

Animation Fundamentals

The traditional cel animation technique developed by the film industry is still in use. Hand-painted images are photographed frame by frame for projection as a motion picture. These animations can be digitized, either frame by frame or from video, for computer display.

Animations are now often assembled from computer-generated images. Animators can prepare the individual images in two ways. They can use any of the drawing, painting, illustrating, and scanning programs, or they can generate images with the appearance of three dimensions by defining data *models* of objects. Images of these objects are generated by a process called *rendering.*

Rendering software is like a movie studio for setting imaginary scenes. The user imports computer-generated models and backdrop images created in advance; defines and positions imaginary lights and cameras; and describes the motion of the objects, lights, and camera. Then the program produces, image by image, a rendering: how the object appears to the camera, under those lights and against that backdrop. Each image requires many calculations. These determine, for example, what is visible to the camera and what is hidden; which surfaces are lighted and which are in shadow; what reflections are created and how they appear.

Animation Tools

Animation tools range from very simple to very complex. Which is best depends on the application. They fall into rough categories:

- *Imaging tools*, such as those discussed in Chapter 8, create images one by one.
- *2-D animation programs*, for example FilmMaker (distributed by Macromedia) and Animation Works (Gold Disk Inc.), provide tools for image creation and presentation of the animated sequence.
- *CAD* (computer-aided design) software can be used to define data models for objects in three dimensions.
- *Modeling programs*, such as Swivel 3D (part of the SwivelMan bundle from Macromedia) and Ray Dream Designer (Ray Dream Inc.), create models for 3-D animation. Some combine this with rendering but not presentation of the finished sequence.
- *Rendering tools*, such as Showplace and MacRenderMan from Pixar, accept models created by other programs and produce images to be combined as an animation. Some, like MacroMind Three-D from Macromedia, also provide the tools to present the animated sequence.
- *3-D animation programs*, such as Infini-D (Specular International) provide tools for all three operations: modeling, rendering, and presentation.

Other tools may be needed, including

- *hypermedia tools.* Images stored on cards by HyperCard or SuperCard can be animated by using the facilities of those programs.
- *sequencing software* like MacroMind Director can present animations in combination with other forms of data, such as music or narration.
- *authoring software*, such as AuthorWare, handle sequencing of animations along with other material and also permit programming so that the material presented depends on interaction with the user.
- *animation players.* These are run-time versions of the animation programs and authoring tools that make it possible to view animations on a computer of a different kind without the software that created them.
- *QuickTime*. Movies can be prepared from any set of images by using the animation compressor. In movie form, animation data can be used by a wide variety of different programs. See “QuickTime Fundamentals” on page 73 for more information.

No special hardware is required to produce animations, although some teams find it useful to make videotape recordings of their work. This takes both a VCR and a video card with output acceptable to the recorder.

The more complicated the animation, the longer it takes to build the sequence of images. A math coprocessor or accelerator card can speed the operation of animation programs.

Animation Data Formats

There are several file formats in which animation programs commonly exchange data:

- *RIB,* short for RenderMan Interface Bytestream, is the proprietary input format developed by Pixar for its RenderMan rendering product.
- *DXF* stands for Data Exchange Format. It's the native file format of AutoDesk's computer-aided design product, AutoCAD, and a de facto standard among CAD packages. Since models for 3-D animation are often built using CAD software, most animation programs recognize it.
- *PICS* is the format for a sequence of PICT images arranged as an animation, the form in which MacroMind Director and other multimedia tools produce animations.

Including Animation on CD-ROM

Animations can take a lot of space. Color or gray-scale sequences take more space than monochrome. The longer the sequence, the larger the file, too. This matters because most animation players move a sequence into RAM before playing it. This can mean an unacceptably long delay while loading the animation. It can also limit which users will be able to view an animation. You may have plenty of space on the CD-ROM disc to distribute animations so large that some users will lack the RAM to display them.

One solution is to provide a QuickTime movie of every animation, along with whatever other formats you distribute. This makes the animated sequence available on every Macintosh computer with QuickTime installed. Which machine a user has will affect the way the movie looks but not whether it plays. Those with enough RAM to load the animation can use a different program to display it if they choose.

Distributing the animation data in compressed form reduces the loading delay, but expansion time must also be considered.

CHAPTER 11

Video

Video is television without the broadcaster, combining sound with moving pictures. The amount of data required to produce full-motion video exceeds what present CD-ROM drives can deliver without compression. By storing video data in compressed form, however, it can be distributed on CD-ROM discs.

Video Fundamentals

Like animation, video is actually a sequence of individual images (frames), each of which may be slightly different from the one preceding it. Viewed in rapid succession these produce the illusion of smooth, continuous action.

Video data is encoded as an analog signal, but there are several methods. One, two, or three channels of information may be employed. These three types are called

- composite video
- S-video
- component video

Composite video is a single channel of information. This is the most common signal type but the lowest in quality. It has the additional disadvantage of being "standardized" at least three different ways.

Better pictures result when the signal has two separate channels: one for brightness information and another for color. This describes *S-video*, a signal standard among video equipment manufacturers. S-video is available from S-VHS and Hi8 equipment. Handling the signal as S-video can make a noticeable difference in quality.

Component video is a signal format with three information channels. Component video offers the highest quality, but be aware that there are two kinds (RGB and YUV). These use the three channels differently, so conversion between them is

required. In addition, some manufacturers implement RGB and YUV slightly differently than others.

Video Tools

No matter what you want to do with video, you'll need special hardware components. Outside resources have this equipment, but you may want some of it in-house. The tools needed to capture and digitize video, process it in various ways, compress it for distribution on your disc,
and, in some cases, play it are

- recorders
- digitizers
- compression and decompression boards

Video Recorders

VCRs are the video source most commonly used. In selecting a video deck, consider its resolution and its video output formats.

Videotape formats vary in their ability to capture picture detail. This characteristic is measured as *lines of resolution*. On the low end, with
200 to 240 lines, is VHS at normal play speeds (the use of extended play further reduces picture quality). At the top, digital broadcast tape machines produce 480 lines of resolution. In many applications, the S-VHS and Hi8 formats, with 360 to 400 lines, produce good results
at a reasonable cost.

You want a VCR with output in the highest-quality signal format your video digitizer accepts. This improves not only appearance but also performance from a CD-ROM disc.

Source video can also be obtained from cameras, LaserDisc players,
or any other video device, including video boards in other computers.

Video Digitizers

Video digitizers convert analog video signals into digitized images compatible with the graphics system of a computer. Some can digitize video at *frame rate* (30 frames per second) for storage in RAM or on hard disk, in compressed or uncompressed form. The WTI-*Moonraker* from Workstation Technologies and Quickview Studio from E-Machines are examples of frame-rate video digitizers.

When choosing a video digitizer find out whether it supports clipping. This is a requirement for doing graphics overlay or blending and for displaying video in regions of arbitrary shape. Performing these operations with your video card sometimes eliminates the need to use analog editing methods that increase noise.

Video Compressors

Video compressors convert digitized video to one of the several widely used formats described later in this chapter. Some, like Kodak's ColorSqueeze and the QuickTime video compressor, do this entirely with software. PicturePress from Storm Technology is compression software with a dedicated accelerator card. Others products like the QuickPak expansion adapter for a RasterOps 24STV video board are hardware compressors. Some hardware compression schemes, such as DVI, also require a decompression board for video playback.

Video Data Formats

There are different video-encoding schemes, different standards within some of those schemes, and different compression formats in use. You may encounter some or all of them when working with CD-ROM products.

Video is encoded as component video, S-video, or composite video.

Composite video has been formulated differently in different parts of the world. The varieties in use include

- *SECAM,* in France and most of Eastern Europe
- *PAL,* in Australia, most of Western Europe, and part of South America
- *NTSC,* in North America, Japan, and part of South America

Consumer equipment is typically designed for use with only one of these systems. However, VCRs that accept input in multiple video formats and produce output in multiple formats are available.

In addition to the other ways to make video incompatible, there are several different ways to compress video signals:

- *QuickTime* is the Macintosh system extension for time-based data. Video is one of several data types that can be compressed for use from a CD-ROM disc by using QuickTime. For detailed information on this see Chapter 12, "QuickTime."
- *MPEG* stands for Motion Picture Experts Group and describes a video compression standard that has been adopted by the International Standards Organization. Both hardware and software compressors based on this standard are available.

- *DVI* (Digital Video Interactive) is a video compression technology originally developed by RCA, now owned and being developed by Intel Corporation. DVI requires special compression and decompression boards, which are available for the Macintosh computer as well as several other systems.
- *CCITT H.261* (also known as P*64) is a standard of the Consultative Committee on International Telephone and Telegraph for bitmapped graphics. While designed for facsimile transmission (fax) of still images, this format is also used for video teleconferencing.

There are tools for using each of these compression schemes with Macintosh computers. The performance tradeoffs embodied in each of these systems are quite different, and which is best for delivering video on a CD-ROM product depends on the product's application.

Including Video on CD-ROM

Even in compressed form, video data places heavy demands on the capacity and performance of CD-ROM discs. You can improve the quality of video on your CD-ROM substantially by paying careful attention to the issue of noise. Noise is random information that compresses poorly. Poor compression means larger data files and more time to load from the disc. Avoid noise at every opportunity.

Higher tape speeds record and play video with better resolution and lower noise. Don't be tempted to economize by using extended play speeds.

For lowest noise, use the highest-quality video signal your VCR provides and your video digitizer accepts. Simply handling the signal as S-video can make a noticeable difference in quality.

Do editing and effects after digitizing whenever possible (unless you have all-digital postproduction). In the analog realm, these operations involve making a copy, even when using digital effects. Analog copies lose quality and suffer from higher noise levels. For this reason, digitize from the master tape, not a copy. But otherwise use masters sparingly to limit wear. Wear makes tape noisier because magnetic material is lost with every play. Use copies for review when selecting the sequences you will use.

Digitize video at high-contrast settings. This also improves the results of compression.

QuickTime

QuickTime is an extension of the Macintosh system software. It provides facilities for managing **time-based data**—data that can be stored as samples taken over time, such as audio, video, and animations—in the same transparent way that QuickDraw manages still images.

QuickTime includes tools to capture, edit, and display time-based information in a form called a *movie*. The ability to use movies becomes part of every Macintosh computer with QuickTime installed, so they can be cut, copied, and pasted just like other forms of data. A movie clip copied from a presentation, for example, can be pasted into the summary memo for those who couldn't attend. On a Macintosh system with QuickTime, the recipient views, reviews, pauses, and sometimes even edits the movie right in the memo.

Documents of many kinds can include QuickTime movies. No additional hardware or software is required. Because QuickTime is an integral part of the system, applications don't need to know anything about the internal structure of movie resources or movie files. And users get the benefits of time-based data like audio and video without any special effort.

QuickTime Fundamentals

QuickTime works on any color Macintosh running system software version 6.0.7 or later. Users simply drag the QuickTime extension into their System Folders and restart to make QuickTime movies available.

A QuickTime movie can contain several tracks, each one a stream of time-based data. The data for each track can be stored in the QuickTime movie, a separate data file, or both. Movies may draw data from more than one file, and more than one movie may use the same files.

QuickTime movies can be captured from an analog source, like a VCR, either in real time (a process called *live capture* or *continuous capture*) or more slowly (*controlled capture*).

Movies can also be generated from digital materials. One way is by conversion of a group of PICT files, a PICS file, or a Scrapbook file. The other is by **transcoding** an existing QuickTime movie to another format (changing the way it's compressed).

QuickTime movies are compressed to reduce storage space and the time required to transfer them from a hard disk or CD-ROM. Third-party compression cards or software can be used with QuickTime, but four software compressors are provided, each optimized for a particular kind of data:

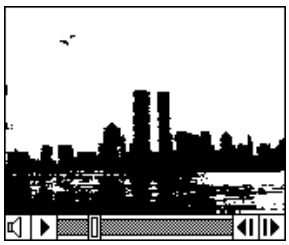
- The *animation compressor* is best for compressing images created in digital form, such as a sequence of PICT drawings to be combined as an animation.
- The *video compressor* is best suited to capture analog video. It provides high-quality playback from hard disk and moderate- to high-quality results played from a CD-ROM disc. Movies compressed with this tool suffer very little degradation from recompression, which makes them a good format for editing and digital effects.
- The *graphics compressor* is optimized for images meant to be displayed at 8 bits per pixel.
- The *photo compressor* provides JPEG compression of still images. This produces the highest-quality images at the best compression ratios, but decompresses too slowly for motion sequences with any but the smallest images. It's an excellent format for reducing size when archiving video movies and very useful for data interchange with other computer platforms. See "Image Data Formats" on page 59 for more information on the JPEG format.

Time-based data can be compressed in two ways, and the QuickTime compressors use both. *Temporal compression* addresses the changes in information from frame to frame, while *spatial compression* is applied to the information within a single frame. One of the advantages of QuickTime is that you can compress and play back much bigger images than will fit in main memory.

On the faster machines, QuickTime can record digitized video directly to a high-performance hard disk, without applying any compression. This method consumes large amounts of disk space (about 24 MB per minute) but is very useful for capturing a high-quality sequence that will play well from CD-ROM after transcoding.

Users view movies with a *movie controller*, a component of the Macintosh system that provides the user interface. It can provide controls for various playback functions, or even editing. Figure 12-1 shows a simple movie controller.

Figure 12-1 A movie controller



With QuickTime installed, the user dialog for opening files displays a *poster* when a movie file is selected. This PICT image is a frame selected by the movie's author to give users an idea of the contents.

QuickTime Tools

You need no special tools to include QuickTime movies prepared by others in your CD-ROM product. To prepare movies yourself you need one or more software tools and perhaps some hardware.

Software

Five kinds of application software tools can be involved in developing QuickTime movies:

- live capture tools
- controlled capture tools
- movie-editing tools
- conversion tools
- utilities

Live Capture Tools

Live capture tools control the compression of QuickTime movies from analog sources playing in real time. These have the advantage of speed when compared to controlled capture, but may not produce images of high enough quality for some CD-ROM products.

There are several live capture tools available:

- *MovieRecorder* provides live capture to RAM or fast hard disk with the fastest color Macintosh computers. MovieRecorder requires a video digitizer card and audio-digitizing capability.
- *VideoSpigot* is a live capture system from SuperMac Inc. It works with all color Macintosh systems and requires only audio-digitizing capability. VideoSpigot applies its own compression during capture but allows any compressor to be selected for transcoding.
- DiVA *VideoShop* works with a video digitizer to perform live capture to a hard disk. It also offers movie editing. See “Movie-Editing Tools” on page 77.

Movies captured live must be transcoded to a more compressed format before they play well directly from present CD-ROM drives.

Controlled Capture Tools

Controlled capture generally produces higher image quality than live capture. A wider range of compression tools can be used with the compression settings adjusted for best results on different sections
of the movie.

Controlled capture takes longer than live capture—how much longer depends on the compressor used and the compression settings. Acquisition using the controlled capture tools described here typically takes between 10 and 30 times longer than live capture.

Among the available controlled capture tools are:

- *MovieTime*, by Light Source Inc. It currently supports controlled capture from S-VHS videotape on the NEC PC-VCR and works with most color Macintosh machines. Because MovieTime provides the facilities for transcoding both temporal and spatial compression, movies that play well directly from a CD-ROM disc can be prepared without additional compression tools.
- *GrabGuy*, for controlled capture from Sony video decks with serial port control. It works with most color Macintosh machines and any of the QuickTime compressors. Movies captured with GrabGuy won’t play directly from a CD-ROM disc but can be transcoded for this purpose.

- *MovieMaker,* for serial-controlled laser disc systems. It is intended for use only with content that developers have put in video disc form, not copyrighted material owned by others. MovieMaker works with any color Macintosh.

All the controlled capture tools described here require a video digitizer and audio digitizing capability. Video-digitizing cards are discussed later in this chapter, as well as in “Video Digitizers” on page 70. For background on audio digitizing see “Audio Fundamentals” on page 61.

Movie-Editing Tools

The elements of a QuickTime movie can be acquired separately and combined by using movie-editing tools.

- *Adobe Premiere™* from Adobe Systems offers QuickTime movie editing with a metaphor that’s easy to understand and use. The images and soundtracks of movies appear frame by frame across the editing window and can be positioned for cuts and other transitions under mouse control. Adobe Premiere will integrate text, graphics, audio, and animation with QuickTime movies to compose multimedia presentations.
- *VideoShop* brings together the tools to manage your collection of QuickTime clips and edit segments into sequences with a variety of transitions and effects. It also handles text, graphics, audio, and animation and can control a video digitizer for live capture of QuickTime movies.

Conversion Tools

QuickTime movies are prepared from digital source materials by conversion. If the source is an existing QuickTime movie, the process is called transcoding. Tools for these operations include:

- *ConvertToMovie,* for creating QuickTime movies from digital data in other forms, such as PICT images, PICS files, and Scrapbook files. It can also be used to modify the characteristics of existing QuickTime movies. ConvertToMovie has the advantage of letting you preview the effect of the recompression settings.
- *SoundToMovie,* for adding sound to existing QuickTime movies. It can also be used to create movies containing only audio. SoundToMovie accepts input from Macintosh ' snd ' resources and from sound files in AIFF format. (For detail on these audio formats see “Audio Data Formats” on page 62.)
- *MovieShop,* especially for making movies that play well from CD-ROM. It offers one-button automatic optimization for CD-ROM playback. An expert user mode is also provided for “tweaking” performance. This tool is highly recommended for CD-ROM product development.

Utilities

One of the most versatile utilities during the transition to QuickTime is Wild Magic. This control panel makes QuickTime features available in most existing applications that support PICT files. Wild Magic lets you copy a movie with MoviePlayer and then paste it wherever you like. Once you paste it into a document, the QuickTime movie displays its poster with one button, called a *badge*, on top of it. When you click the badge, the movie controller appears, and the movie plays as it would in a QuickTime-aware application. Wild Magic requires System 7.

Hardware

No hardware is required to use QuickTime, but you will want a videotape player and video digitizer for preparing movies.

Videotape Player

The first hardware tool many teams mention is a VCR from which to capture video. Consider three factors in selecting a VCR:

- resolution
- computer control
- video output formats

Resolution

Videotape formats vary in their ability to capture picture detail. This characteristic is measured as *lines of resolution*. On the low end, with
200 to 240 lines, is VHS at normal play speeds (the use of extended play further reduces picture quality.) At the top, digital broadcast tape machines produce 480 lines of resolution. The better the source video, the better the resulting movie will be. But for most QuickTime applications, the S-VHS and Hi8 formats, with 360 to 400 lines, produce good results at a reasonable cost.

Computer Control

Live capture from video is adequate for many purposes, but movies intended for distribution on CD-ROM often warrant the extra time for controlled capture. These methods require computer-controlled video decks that can be positioned with single-frame accuracy. All newer professional video machines provide for this serial port control, as do some S-VHS and Hi8 decks.

Video Output Formats

For best results, use the highest-quality video signal your VCR provides and your video digitizer accepts. This improves not only appearance but also performance from a CD-ROM disc. Composite video is the most common but the lowest in quality. S-video, available from S-VHS and Hi8 equipment, is better. Component video offers the highest quality. For more on these video formats see “Video Fundamentals” on page 69.

Video Digitizers

A video digitizer is required for either live or controlled capture. General information on video digitizers appears on page 70. There are three special characteristics to consider when you select one for making QuickTime movies:

- digitizing speed
- filtered downsampling
- video input formats

Digitizing Speed

Digitizers vary in speed. One capable of capturing 30 frames per second is recommended for capturing QuickTime movies. This will speed production and offer greater flexibility. Products that cannot digitize at least 15 frames per second may not be capable of live capture at all.

Filtered Downsampling

How a digitizer resizes video pictures has a serious effect on image quality. Some video digitizers offer *filtered downsampling*. This means that when pixels or lines are eliminated to create small images from large ones, the digitizer will average the values of adjacent picture elements to eliminate undesirable picture artifacts.

Video Input Formats

Some digitizers accept video in the higher-quality signal formats. Using these inputs will improve your results provided matching outputs are available from your player.

Audio Digitizer

You need audio digitizing capability for both live and controlled capture (except to produce movies with no sound).

Choose an audio digitizer with input level control. Without one it can prove impossible to obtain distortion-free recordings from some sound sources.

QuickTime Data Formats

QuickTime movies have the file type MooV.

Data for movies can be stored in other files, including

- AIFF files and Macintosh ' snd ' resources for audio
- PICT and Scrapbook files for images
- PICS files for animation

QuickTime movies (and single PICT images) produced by the photo compressor adhere to the JPEG standard. This is presently the most interchangeable format for data of this type.

For information on exchanging QuickTime movie data with other computers, see the Appendix, “QuickTime Movie Resource Format,” in *Programmers Guide to QuickTime,* available from APDA.

Including QuickTime on CD-ROM

QuickTime is designed to make movies that play directly from a CD-ROM disc. But these movies must be prepared with the characteristics of CD-ROM in mind.

CD-ROM drives are slower than hard disks, both in average **seek time** and in **data transfer rate.** (Seek time is how long it takes to reposition the head to read from a different sector of the disc, and data transfer rate is how quickly data flows to the computer from the drive.)

Both characteristics can affect the performance of movies played directly from disc. Tools and techniques for minimizing the effects of both characteristics are discussed in concept here.

Tools

Transcoding recompresses a movie to reduce the data transfer rate it requires. This is an essential step in preparing QuickTime movies that play well from a CD-ROM disc.

The *peak bandwidth* (best data transfer rate) of the first CD-ROM drives was 150 KB per second. Some models now available offer bandwidths of 300 KB or more. In practice, movies that need data at 120 KB per second or more won’t play acceptably in the drives rated at 150 KB. This reflects the seek time required by the drive and time delays imposed by audio synchronization.

MovieShop is a transcoding tool specifically for CD-ROM movies. It accepts a target bandwidth from the user and recompresses the movie to produce that playback rate. For best overall performance select a value in the range of 80 to 90 KB per second for

most material. Or use the “one button” make function to produce movies in this range automatically.

Techniques

There are also production techniques that optimize movie performance from disc. These involve

- source quality
- source content
- image size
- audio
- flattening

Source Quality

When possible, acquire movies meant to play from CD-ROM by controlled capture rather than live capture. The difference in quality will repay the time investment in most cases.

To improve the sharpness of movies made by controlled capture, shoot the source video with a shuttered camera.

Source Content

The efficiency of temporal compression depends on the amount of change from frame to frame. Motion created by *panning* (when the camera turns right or left) and *tilting* (when the camera tips up or down) results in large differences from frame to frame and in video that compresses poorly. Sequences with objects in motion against a static background will compress more efficiently. Be aware, however, that limiting motion to improve image compression can result in very boring movies.

The bandwidth required can also be reduced by limiting the color bit depth of the movie. Limiting your movie to 8-bit color, for example, often makes a tremendous difference in performance.

Some transcoding tools provide *color dithering*. *Color dithering* uses the interaction between colors of adjoining pixels to fool the eye into seeing shades that aren’t there. It can make a lower bit-depth less noticeable in the final product.

Image Size

Reducing image size is another way to improve performance. The larger an image, the greater the bandwidth it requires at any given frame rate. Almost all video movies play well, even from CD-ROM drives with
150 KB bandwidth, at an image size of ¹⁄₁₆ screen and at rates of 8 to 10 frames per second.

Audio

The audio sampling rate can be traded off for bandwidth. Both 22 kHz and 11 kHz audio are processed in real time by the Apple Sound Chip. But 22 kHz sound requires almost twice as much data to be moved from the CD-ROM disc to the system, so 11 kHz improves performance.

Images playing from the disc can be synchronized with sound playing from RAM. If the time needed to move the sound to memory is not objectionable and RAM is available, this makes more bandwidth available for the image data.

Movies without synchronization to a soundtrack achieve the highest data rates of all when played from a CD-ROM disc.

Flattening

Flattening a movie moves all the data required into the movie file itself and optimizes its layout there for best performance. All movies meant to be played from a CD-ROM disc should be flattened. Movie-editing tools offer this operation, as do some utilities.

Flattening movies also makes them easier to exchange with other computers.

PART THREE

Putting It All Together

The content of a CD-ROM disc accounts for only part of its value. The way things are assembled, the tools provided for finding and using content, and the performance of the finished product are equally important.

This part treats the stages of production beyond content acquisition:

- Chapter 13, “Every Product Has a Human Interface,” is about developing the human interface.
- Chapter 14, “Giving Users the Tools to Find Things,” covers the topic of search engines.
- Chapter 15, “Pulling a Disc Together,” concerns the preparations for manufacturing.
- Chapter 16, “Packaging and Pressing,” looks at the manufacturing stage, where CD-ROM products become reality.

Every Product Has a Human Interface

The more things you collect in one place, the harder it is to find what you want. Still, bringing together a large number of things has real value. It reduces the number of places you have to look for them, for instance. And it lets you bring powerful tools to bear on the items in your collection.

However, CD-ROM products sometimes contain thousands of files and programs. Users can wander through them, but that's different from navigating the structure of the disc. Navigation implies a destination and a course charted to reach it. It's hard to form a mental "map" of something so complex, unless it's very well organized. Most CD-ROM products over a few megabytes in size need a human interface to help users navigate and use the contents.

You may choose to develop additional human interface programs for your product. Still, you should invest the time to make sure your program takes full advantage of everything the Finder offers.

The Finder is an Interface

The Finder provides the first level of human interface for your product. With it, users browse through folders and locate things of interest. To help them, you provide clues such as file names, icons, labels, comments, and the hierarchy of folders.

Users will always want the option of using the Finder to locate things on your disc. There are things you can do to make this method of navigating powerful for them:

- Have the most helpful windows open when the disc is mounted.
- Organize by folders thoughtfully.
- Name files and folders well.
- Invest in custom icons that capture key product concepts visually.
- Harness labels and comments.
- Build Balloon Help.
- Add aliases.
- Design the Desktop arrangement.

Open the Most Helpful Windows

The windows left open on the desktop of the assembly hard disk when it goes for premastering are the windows the user will see every time the CD-ROM disc is mounted. Give careful thought to which windows will be most helpful and to how they should be arranged. Remember that this arrangement is permanent. Once you've decided what it should be, check to be sure that it isn't changed during premastering.

Organize by Folders

Every method of organizing a disc into folders represents someone's idea of the important distinctions between files. For example, one set of files is yours and another belongs to a colleague, or one group of files was created last year and another group this year.

Those distinctions might be the best ones to make on a file server, or while you collect the pieces for your disc. But are they the most important distinctions for people who use your disc?

How files are divided among folders is more important than it may appear. Putting yourself in the place of your product's user is essential in organizing your folders (in every step of getting your human interface right for that matter). The better you know the users, the more likely you are to make the distinctions that matter most to them. The best organization will reflect their concepts and priorities rather than yours.

The distinction you've chosen should be obvious at a glance. Assigning folder names carefully is one good way. For example, a folder named Pacific Region Sales says more at a glance than one called simply Far East.

Name Files and Folders Well

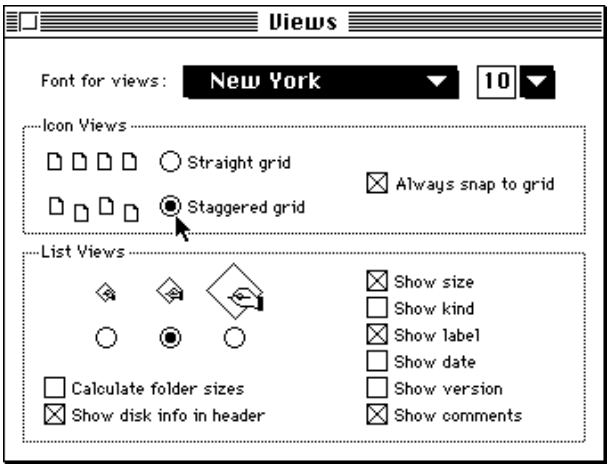
You can't always choose new names for documents or programs. But often you can choose names for the folders that hold them. Choose thoughtfully. Avoid really long names and avoid using abbreviations or symbols. It's best not to use the word *folder* in a folder name. That only encourages users not to read the name completely.

Use the vocabulary of the users where that's different from your own. Remember to confirm the appropriateness of these names with users when you are testing.

Names are more than addresses where things are found. They're also landmarks for navigators remembering the way to things at other levels. Names you recognize at a glance and names that call something to mind make the best landmarks. Remember, however, that names with meaning to you may mean something quite different or nothing at all to your audience.

Depending on the length of the names you assign, the names of adjacent files or folders may overlap when "by Icon" or "by Small Icon" are chosen from the View menu. This can make them hard to understand. The solution is selecting Staggered grid from the Views control panel (see Figure 13-1).

Figure 13-1 Selecting "Staggered grid" from the Views control panel



Invest in Custom Icons

Custom icons are excellent landmarks. And they're especially good at drawing attention to a particular type of file. Use them to set apart certain files, like Summary files and ReadMe files, that occur all over the disc but that have particular significance.

Careful use of color can heighten the impact of custom icons, but some users will have monochrome monitors. Design effective black-and-white icons, then colorize them. The effort may not seem justified until you understand the role of the desktop as a part of your product and a place to add real value.

Harness Labels and Comments

System 7 introduced labels. Labels permit files and folders to be tagged for convenient retrieval and grouping. A label is assigned by choosing it from the Label menu while a file or folder is selected.

Don't overlook the many ways labels can enhance the performance of the Finder for your product. Users cannot permanently alter the labels of files on a CD-ROM disc. So you can create and apply lasting labels for their benefit.

Labels are not obvious on monochrome monitors, so they make undependable landmarks. But labels are a wonderful way to find every example of a type of document, even when they're scattered across the CD-ROM disc. To search by labels, the user chooses Find from the File menu of the Finder. ("Show label" must be selected in the List Views portion of the Views control panel for label searches to be possible.) Searches are quick because only the desktop of the disc is searched. It is also quick and easy to apply labels if you do it at the right stage of production.

To add more value and further enhance the Finder interface of your product, create comments for files and folders by typing in their Info windows.

Comments are more time-consuming to add than labels but also more powerful. Comments can be used for keyword searching from the Finder. ("Show comments" must be selected in the List Views portion of the Views control panel for comment searches to be possible.)

Comments can also be displayed in a List View of folder contents to give the user valuable information about files. Note that the Finder displays only the first several characters from the comments. How many characters depends on the font and size selected in the Views control panel. With planning you can provide both About information and keywords through comments. Because the CD-ROM desktop is locked in plastic, your investment in comments is not at risk of accidental destruction.

NOTE
The steps for preparing your assembly hard disk described in “Procedure for 6.0 / 7.0 Compatibility” on page 109 will rebuild the desktop and wipe out comment information. To protect comments, add them after using this procedure. ◆

Build Balloon Help

Balloon Help is another way System 7 has to make information about programs and documents available to users when they desire it. Providing a Help message for every file can be a large investment, but these messages make the Finder much more powerful as an interface for your CD-ROM product.

Add Aliases

An alias is a representation in System 7 of a program, a folder, or a document. It’s not a copy but it “points” to the original file that it represents in System 7. When you open an alias you’re actually opening the original file.

Aliases for the most important programs and documents on your CD-ROM product can be a big help to users exploring the disc through the Finder.

Locate an alias anywhere the user is likely to look for a key file. Put yourself in the place of the user. Consider where an alias would help you the most.

Design the Desktop

How the desktop is arranged is part of your human interface and deserves careful attention. Good choices help users navigate, and bad choices can impede or frustrate them. Details enhance the human interface of your CD-ROM disc. Take time to

- select the most meaningful type of view for each window
- arrange icons to emphasize significant files
- size and position windows to work on all monitors
- align windows, or tile them where appropriate

The Art of Human Interface Design

The Finder can provide a powerful human interface for your product, especially if you invest the time to take full advantage of its features.
But many CD-ROM products will be enhanced by the addition of a custom human interface.

This is increasingly true as products grow in size and the number of constituent elements. Imagine a dictionary that's not alphabetized. Everything is there, but you'll need good luck to find it.

No matter how much thought goes into arranging the files and folders,
the organization represents an assumption about the way users see the contents. The more closely the assumption matches the users' concept,
the more easily they gain a picture of where things are on your disc.
But those with a different outlook have more difficulty getting that picture, and the more numerous the files, the more difficult it becomes
to keep the picture in their heads. A human interface takes over this job. To do the job well, the human interface should be memorable, effective, and powerful.

From the interface, users discover where they are and where they can go. You provide tools to get them where they're going and to help them remember how they got there.

Through the interface you supply tools for users to run programs and tools to find, open, display, or print things. Having these choices is what makes an interface powerful.

The interface is where the user lives in your product. From their perspective, the interface is your product.

For an insightful and often entertaining introduction to the subject
of human interface you may wish to read *Tog on Interface*, by
Bruce Tognazzini (Addison-Wesley, 1992).

The Role of Screen Design

Screen design that really works is essential to a good human interface. The impressions created by screens are something that users live with

for a long time. Good impressions are worth investing time and money to cultivate.

Screen design and print design are not the same art. You need both, and some designers do both very well. If you must choose between them, however, invest in screen design.

It's worth taking the time to find a designer who has produced screens your users would enjoy working with every day. And it's worth taking the time for you and the screen designer you hire to study the users carefully.

Human Interface Guidelines

Make sure you really understand the *Human Interface Guidelines: The Apple Desktop Interface,* called the *Human Interface Guidelines.* It provides developers with the philosophy behind the Macintosh computer and tells developers how to develop the human interface of their products for best results.

If you create an interface, use the *Human Interface Guidelines* as your textbook and template. The closer you stay to it, the better your human interface will be. Study how others have applied the principles of human interface design. Work with a number of Macintosh application programs and keep at it until you've gained an intuitive feel for what works and what doesn't.

If you are having an interface created for you, use the *Human Interface Guidelines* as the specification and yardstick by which to measure results. Don't accept an interface that doesn't follow it.

Pay special attention to the design philosophy discussed in the guidelines. Ask yourself whether your interface

- feels responsive, permissive, and consistent in use
- builds on skills people have rather than forcing them to learn new ones
- gives users the feeling that they're in control
- provides feedback so users can tell they're doing something

This may sound like religion, but it's serious computer science with hours of user testing behind it. Taking it seriously pays off.

What the User Wants

The interface exists to make possible what the user wants. You must anticipate what that includes. Human interface features frequently requested for CD-ROM products include the ability to

- browse easily through the contents
- print any document or file on the disc
- copy any program or file on the CD-ROM to a hard disk
- copy text or images from files on the CD-ROM to the clipboard
- open any program or document on the CD-ROM disc
- retrace or undo a number of the most recent navigational steps quickly
- save your “place” in the interface and return to it later
- annotate files or programs stored on the CD-ROM disc in some “indelible” fashion
- keep user notes and comments in a notepad associated with the disc
- generate reports about the contents of the CD-ROM disc that can be viewed on the screen, printed, or saved in a file
- search the contents of the CD-ROM disc or selected folders

Some of these requests are met by including programs like TeachText on the disc; some may require a search engine or other tools; and others can be provided by existing XCMDs (external commands) if you build your disc interface with HyperCard.

Building the Human Interface

The cost of building an interface depends on what it needs to do and whether you build it yourself or contract with outside resources. Some contract designers specialize in custom development of user interfaces.

The interface design grows out of your vision for the product, discussed in “How It Works” on page 32. Your vision may suggest a metaphor that suits the audience and the content. Or some other metaphor may be more suitable. If no metaphor seems to fit, don’t force one.

Design a way for users to navigate and search the disc content. Provide the structure, but allow users to choose the pathways. Design ways for users to use what they find to do what they want. Put the users in control.

Build a prototype of your interface. The prototype is just a glimpse of your vision that can reveal whether you're on track and whether the track you're on goes anywhere. If you're unable to capture at least this glimpse for other people, it may not be possible to embody the vision in a full-scale product.

The prototype can be developed by using a high-level programming language, a visual programming environment like Prograph or Serius Programmer, or authoring tools such Authorware and MacroMind Director Interactive.

HyperCard is another possibility. It's remarkably flexible and has a short learning curve for developers. It provides a number of useful facilities for your interface automatically. One example is a built-in review of steps for the ability to return to any recent point directly. Its search capabilities are limited, but techniques such as precompiling an index of card IDs can improve search performance dramatically.

Test the prototype on users by watching them interact with it. What they do tells you at least as much as what they say. If users have to struggle to use the prototype, they don't catch your vision. Either your vision or your prototype needs work.

Put what you learn into a new version of the prototype.

Test the revised version and continue this cycle of revising and testing until users understand and use your prototype intuitively. Then you're ready to select and configure a search engine for your product if it's going to have one.

Giving Users the Tools to Find Things

One important feature for your interface to offer is the ability to search. Searching takes place at two levels: finding particular files and finding information within files. The first is useful no matter what you distribute on a CD-ROM disc. The second pertains most to information products but can add value to the on-disc documentation of software products or any data bundled into a CD-ROM title.

The clues for finding particular files may be in their names, their types, or their creation dates, or in the comments you provide about them. Macintosh computers keep track of this information in two places. One is a set of invisible files, together called the *Desktop file,* or often just the *Desktop.* The other is a list (called the *catalog*) of the files and folders stored on each volume (floppy disk, hard disk, or CD-ROM), which is kept on the disk it represents. Users search the information in both places by choosing Find from the File menu of the Finder.

Sometimes the only way to locate what you want is to look in the files themselves. Doing this one file at a time can be extremely time-consuming as well as frustrating. So, if searching within files is important for your product, you'll want to make the contents more valuable by making them more accessible. This means putting them in the form to be searched by a special access tool. Which tool depends on the kind of data and what you want to do with what you find.

If your data files are similar to one another and have a consistent structure—that is, they can be broken into separate elements, whether or not they're always present or appear in any order—a *record-oriented search engine* may offer the best access. Otherwise a *full-text search engine* may be more appropriate.

Search Engine Fundamentals

The task of a search engine is to locate where particular words or phrases occur in a group of files. A search engine can help users hunting for a document they recall by contents but not by name. Or it can help them see if your disc has anything on a specific topic. Instructions to a search engine, called a *query,* include the words to locate and sometimes special conditions about how these relate to each other or the document.

Search engines range from very simple to very powerful. The most sophisticated offer advantages in performance, advanced search tools,
and integration into your user interface.

On your disc with the search engine will be

- the documents to be searched
- an index to those files
- a list of words you don't want indexed, called the **stopword list**

Documents

Search engines do not search your document files directly; they search an index of your files. The documents themselves are present so that users can access them in other ways once they know which ones they want. And some search engines will open your documents to show where the search words were found.

Index

The index is a file that records the location of every word in a collection of documents. You create this file for your documents by using an indexing tool supplied with the search engine. Most search engine products well suited to CD-ROM build what is called a **full inverted index.** This means that every word in your documents is indexed unless you specifically choose to skip it. This type of index can be very large, sometimes nearly
as big as all the documents it indexes combined.

Without an index, every document file would have to be searched individually for the words in the query. That could take the computer more than an hour on a full CD-ROM disc. A search engine looks for query words in the alphabetized index instead, a much quicker process.
It reports to the user which documents contain *hits,* or occurrences of the word specified, and where within the documents the hits are found.

Any word not included in the index will not be found by a search engine, even if it occurs in one of your documents. Controlling which words get indexed and which do not is the function of the stopword list.

Stopword List

To keep a word from being indexed, you put it in the stopword list. A number of words like *and* and *the* occur so often in typical English text that they're meaningless for search purposes. Making them stopwords saves indexing time. More importantly, it means a smaller index, which means faster searches. A default stopword list is supplied with most indexing programs. You should review it carefully before indexing (see "Prepare the Stopword List" on page 102).

Search Engine Options

Search products vary in their query features and the extent to which you can integrate them into products. The most powerful may have everything you need but also many things you do not need.

Query Features

The query features you want to include are the ones users will need to find information on your disc most effectively. Some of the features available include

- word searches
- phrase searches
- Boolean searches
- field searches
- proximity searches
- wildcard searches

A *word search* locates every occurrence of the single word supplied by the user. Word processors usually offer this kind of query.

A *phrase search* is similar to a word search but finds multiple words when they occur together in the order specified. Some search engines can ignore punctuation or stopwords in a phrase; others cannot.

Most search engines permit *Boolean searches,* that is, queries that use the Boolean operators AND, OR, and NOT to control more precisely what will be found. This is a powerful tool, but it confuses some users. If you include Boolean searching, you may want to build it into your interface in a way that makes it easy to use. If Boolean searching is very important to your product consider a program that also offers relevance ranking (described later in this section).

Some programs let you designate as *fields* certain sections within your documents and then perform searches limited to the text within those fields.

A *proximity search* locates two or more words, in any order, if they occur in the same sentence or the same paragraph.

In a *wildcard search,* special symbols such as the asterisk (*) in the query stand for any single character or string of characters. For example, the query "grow*" would

find the words *grown*, *grows*, and *growth* plus any others that start with the letters *grow.*

Other features available in some search engines might also benefit your product. These include

- relevance ranking
- relevance feedback
- back references
- query by example

Some search engines attempt to present hits in order of interest to the user. This is called *relevance ranking*, and it relies on such clues as how frequently the search terms occur in a document. It's especially useful when combined with Boolean searching, which can otherwise tend to retrieve many useless documents. For example, the Boolean query "NEW OR (MULTI-FAMILY) OR HOUSING" retrieves all documents containing any of the words. With relevance ranking, the engine looks at statistical information about the documents to decide which are likely to be the most useful, and the user sees those first.

Giving the program feedback on its success at estimating relevance (*relevance feedback*) is a way of refining queries in some products. The user says, in effect, "This document was a good choice for my last query."

The best results are sometimes achieved by refining a query gradually. To construct complicated searches in this way, it helps to refer to the results of previous queries in the present query. Some search engines permit such *back references.*

If a search engine offers *query by example*, users supply a sample document and the search engine locates the available files most similar to it.

Interface Features

Some search engines provide an *application programming interface* (API). This is a set of commands you can include in a program to drive the search engine. By using these commands your interface incorporates search tools, but the searching is actually done by a product you have licensed. Writing the program to link a search engine to your product through its API is a task for which you can retain contract programmers.

Some search engines do not offer an API but provide their own user interface for queries. It may or may not be one you can modify. To search with these products, users open the search engine product as they would any other program.

When you consider query interfaces, remember the following:

- Briefly describing each document found helps users recognize which hits matter.
- Searching can take a long time. Visual indications of progress are important to the user.
- Results should be made available as a search progresses. This tells the user something is happening and lets them begin to consider the results.
- Users may want to manipulate old queries as the basis of new ones. The ability to save queries as well as their results is often valuable.

Search Engine Selection

Two of the most versatile search engines for use on CD-ROM are:

- *Personal Librarian* from Personal Library Software.
- *Ful/Text* by Fulcrum Technologies Inc.

Both have versions for the Macintosh family of computers and a wide variety of other computing platforms. Selecting the right search engine for your product involves finances, as well as questions of features and integration with your interface.

Examine the Financial Arrangements

Using someone else's search engine involves compensating them somehow.

Some products include a license for unlimited, royalty-free distribution of discs incorporating the engine (but not the indexing tools). Some require a one-time license fee plus a royalty on every unit of your product sold. Others charge separate licensing fees for each product that includes their engine, plus royalties.

Understand fully the financial implications of any search engine you consider.

Evaluate the Match

The best engine has only the features you need, accepts files in exactly the format you have them, and integrates seamlessly with your interface. Until someone writes it, however, consider how well the products available match your product:

- Does the search engine provide the query features your users need?
- Can the engine search the kinds of documents you have without conversion?
- What formatting codes are required or forbidden by the program; are your documents formatted that way?
- Does the product have versions available for the platforms you want to reach?
- Can the interface provided accomplish what you need?
- Does the product offer acceptable performance?

Features your users don't need or your interface won't harness are costly extra baggage. The best feature set has only what you'll use.

Find out what form documents must take for the indexing tools. Some products will index only TEXT files. Others also accept documents created by popular programs. Some files may have to be converted before the product can index them.

Embedded codes such as markup language and text styles are tolerated by some products but must be removed for others. Some products require special codes in the text to mark fields. It takes time and costs money to put codes in or take them out.

Some search engines have versions for a variety of computing environments. Choosing one of these may make possible a single CD-ROM that runs on any platform you need to reach.

If the product has no API, you must use the query interface it provides. Even if it has an API, you may decide to save programming and use the product's query interface. But some products don't offer an interface, so you will have to create one. Your schedule, budget, and programming skills may be the deciding factors.

Experiment With Performance

Not all search engines work well with CD-ROM discs. It is well worth the effort to experiment with the search engine you are considering.

Any search engine that accesses its own program code frequently from the disc would be a poor choice to run directly from a CD-ROM product. You can check this. Put the search engine program on a floppy disk by itself (index and documents elsewhere). Run this copy of the program and note how often the floppy drive runs as you perform searches.

If possible, get a copy of some other CD-ROM product that uses this engine. If searches seems to cause frequent CD-ROM access, especially in short bursts rather than longer reading intervals, the product may not be a good choice for CD-ROM.

Search Engine Installation

Products vary, and you should follow the installation and operation directions provided with the program you select. In general, though, harnessing the search engine involves only a few basic activities:

- preparing the documents
- preparing the stopword list
- building the index

Prepare the Documents

If the indexing tools expect codes in the text to mark certain parts, such as the title, you will need to add them. These marker codes are called *tags.* Some products allow multiple documents combined in a single file with tags in the text to mark where each one ends. The product documentation will tell you what tags are permitted, which ones are required, and what they mean.

Remove other embedded codes if they interfere. The import filters of some products do this for you. Typesetting tapes and other files that use embedded characters in special ways may need extensive modification before they can be used with a search engine. Some programmers specialize in the creation of filters to handle this problem.

The indexing tool may accept only documents created by certain programs. Convert your documents to TEXT files or to one of the types the program recognizes.

If you use style codes in text to format screen displays or printing, you may be able to index from copies saved as plain text but still provide the formatted version on the disc for users.

NOTE
The document viewer in some search engines may not work with formatted files. If it doesn't skip over embedded codes when counting characters to display hits, the user may be shown the wrong section of text. ◆

Prepare the Stopword List

The stopword list includes all the words that will be skipped when indexing. Most search engines provide a default stopword list of the most common stopwords such as *a, and, the,* and *that.* Examine this default list carefully. Be prepared to edit it before you index.

There may be words you can add to the stopword list. Don't do this lightly. A search engine finds only the words included in the index. Any word you add to the stopword list will not be found.

Still, certain words may play no meaningful role in any search you can imagine users performing. Make these stopwords to reduce the size of the index and improve the search performance of your product.

On the other hand, study the default stopwords. The list provided may contain words that must not be excluded from your index. For example, the word *a* appears in many stopword lists. That's appropriate in many cases, but wrong for a product about human nutrition, where searching for "VITAMIN A" could be expected.

Build your index completely once. Review it carefully for high frequency words that don't contribute anything. Consider adding these to the stopword list.

Build the Index

All the documents to be indexed must be present and designated in some way for processing. Different products handle this differently.

It may take a long time to create the index. There's no way to predict exactly how long or how large the resulting file will be. Experiment with a limited number of files to gauge how much time and disc space to reserve for the index.

The indexing process often generates more than one file. Be sure to include all of them on your CD-ROM disc unless the documentation provides other instructions.

Pulling a Disc Together

Production begins when you create or convert the first thing that will someday ship on your CD-ROM disc. It ends when your project leaves premastering for manufacturing. In between are six activities:

- collecting content
- assembling data
- testing
- preparing the assembly hard disk
- premastering
- final testing

Collecting begins first and continues in parallel with assembly and testing. Some contents are created, others acquired. Some need changes before they can be used on a CD-ROM disc. The steps involved depend on the type of data involved. For details see the individual chapters of Part Two.

Whatever their source, your disc's contents must be assembled in a system of folders as they will appear on the final product.

Everything is tested, first alone, then in groups, and finally all together.

When everything has been assembled and tested, the assembly hard disk gets prepared in special ways.

Finally, premastering puts the contents of your disc in a special form for the manufacturer. Some developers do premastering themselves, but most have it done by the pressing plant or a service bureau.

Assembling Data

Everything going on the CD-ROM disc is assembled on a large hard disk. Other mass storage devices could be used, but most CD-ROM producers favor big, fast hard disks. Other devices are sometimes used for backup and transfer.

The drive is usually mounted as a network server so everyone on the team can work as the pieces come together.

Only those things going on the CD-ROM disc are stored on the assembly disk (sometimes a partition of a disk). Keeping things being created, modified, or converted in a staging area prevents anything from slipping through unfinished. With thousands of pieces going into some CD-ROM products, systems are essential to keep track of what's been done.

Some people abandon the prototype at this stage and start programming from scratch. Others rework their prototype until it becomes the finished product. In either case, the features of the product are finalized, and the emphasis moves to stability and performance.

Before leaving this stage, give your product the ability to check what model of Macintosh computer it's running on and set monitor color and bit depth appropriately. See that it performs routine housekeeping chores, such as resetting the color look-up table, when it quits.

Give serious thought to a beta release of the product on CD-ROM at this point. It serves as a proof disc for you while generating invaluable feedback from real users.

Testing

Test, then test again, throughout the production process. You can start testing some of the parts early, including

- your interface
- the search engine, if you have one
- the programs you're putting on the disc

The interface gets tested from prototype to premastering. You're refining the design at first, then working on performance, and finally making sure it works with everything else on the disc.

If a search engine is being programmed to work from your interface, test that early, maybe even before the interface features are finished. Only a few documents have to be indexed at this stage.

As more documents become available, build a bigger index and start testing to improve performance and refine the stopword list.

Test the programs that will go on the disc on a locked volume. Modify or replace those that won't run.

When everything is finally assembled, test the human interface and the search engine against the assembly hard disk as if it were the CD-ROM. Don't evaluate speed issues at this stage. Seek times and data rates will be slower with most CD-ROM drives. Check to see whether timings are being determined by program operations that read data from the disk. Such a dependency may be undesirable because performance varies between the new, faster CD-ROM drives and older, slower ones.

Make sure that everything is where it's expected to be and is properly linked to the human interface application.

More testing takes place on the actual disc image prepared by premastering. This is described in "Final Testing" on page 113.

Preparing the Assembly Hard Disk

Everything is together, but there are five things to be done to the assembly hard disk before you send it for premastering:

- Clear the boot block and DDM.
- Clean up the desktop.
- Take performance improvement measures.
- Check for viruses . . . twice!
- Follow the procedure for 6.0 / 7.0 compatibility.

Clear the Boot Block and DDM

The *boot block* is a small area on any HFS volume that is used for startup. Data here points to the location of the system file for the computer to load. The Macintosh automatically creates a boot block on any volume that contains a system file. If your assembly hard disk contains a system file, or has had one in the past, it has a boot block. This must be removed so that it won't be transferred to the CD-ROM disc.

At startup the Macintosh looks for boot blocks on SCSI devices like CD-ROM drives. When it finds one, it tries to start from that volume.
This is not yet possible from a CD-ROM disc, so the startup fails.

A good premastering service or disc manufacturer will check for this condition and rectify it. Or you can clear the boot block yourself in
two ways:

- If you have a second large hard disk, reformat it and copy everything (with the exception of the System Folder) from the assembly hard disk to the reformatted disk. If no system file is copied onto the second disk, no boot block will be created.
- With a disk-editing utility, you can overwrite the boot block with nulls ($00). For the location of the boot block and other details see the SCSI Manager information in *Inside Macintosh.*

▲ **WARNING**
Back up your assembly hard disk before attempting to edit the boot block manually. If you are not certain about the editing procedure, seek qualified help. ▲

The *DDM* (Driver Descriptor Map) is located in the first physical sector of a disk (as opposed to the first logical sector of the volume, since there can be more than one volume on some disks). On a CD, the first driver descriptor in the DDM should be zeroed out to prevent any driver from being loaded from the CD. The DDM affects only discs that are present in the CD-ROM drive at system startup time.

The DDM can be cleared in two ways:

- Some premastering systems offer this operation. Your service bureau or pressing plant may be equipped to handle it. If you premaster in house, consult the equipment manufacturer's documentation for proper procedures.
- With a disk-editing utility, you can overwrite the DDM with nulls ($00). For the location of the DDM and other details, see the SCSI Manager information in *Inside Macintosh.*

▲ **WARNING**
Back up your assembly hard disk before attempting to edit the DDM manually. If you are not certain about the editing procedure, seek qualified help. ▲

Clean Up

The way you last leave the desktop of the assembly volume is exactly what the user will always see on the CD-ROM disc. They can modify things temporarily, but each time the disc is mounted the arrangement you leave for them will be restored. Take the time to clean up the desktop carefully. Pay attention to

- appearance
- consistent layout
- consistent window size and placement

Choose Clean Up Window from the Special menu of the Finder to align icons. You may want to adjust manually if filenames overlap.

Consider how windows should overlap when more than one is open. Tiling, where possible, makes it easy for users to select a background window. Use a consistent approach.

Be consistent about window size as well. Keep in mind the smallest screens on which your product may be viewed when you position and size windows.

Take Performance Improvement Measures

There are two things to do at this stage to make your CD-ROM disc load and run faster:

- *Defragment* the assembly hard disk.
- *Unmount* the assembly hard disk before removing it.

Defragment

Hard disks get *fragmented* when they are written and erased frequently, as the assembly volume will be. Files are stored in many bits and pieces wherever there’s room. Fragmented disks operate more slowly because of the frequency with which the heads must seek a new track to continue reading.

A CD-ROM disc produced from a fragmented hard disk will also be fragmented. Because the seek-time performance of CD-ROM drives is not as good as that of hard drives, impaired performance that may not be frustrating on a hard disk can become so on a CD-ROM. The fragmentation problem can be corrected in two ways.

Copying your assembly volume to a freshly formatted disk, as described for removing boot blocks, handles the problem by writing each file in a succession of adjacent sectors on the fresh disk. Backing up your assembly volume to tape and reformatting the disk before you restore your data will do the same thing.

If you have no second hard disk or tape backup, utility packages such as The Norton Utilities and DiskExpress II include tools for defragmenting hard disks. Be aware, however, that some tools regroup files by type when defragmenting. That can mean increased seek times for a CD-ROM product. Whenever possible, transfer folder by folder from your assembly hard disk to a freshly formatted hard drive for best results.

Unmount

Always unmount the assembly hard disk before removing it from the computer. You can do this in two ways: drag the hard disk icon to the Trash or choose Shutdown from the Special menu (which unmounts all drives). If the assembly drive is removed without being unmounted, a flag meant to detect system crashes will remain set and be transferred that way to the CD-ROM. Every time such a CD-ROM disc is loaded, the computer runs tedious and unnecessary diagnostics.

Check for Viruses

The importance of taking appropriate precautions against virus contamination during CD-ROM production can hardly be overstated. A contaminated disc is scrap; it cannot be recovered. With as many discrete files as may be assembled in the preparation of a CD-ROM even isolating a virus problem can prove formidable.

You will want to introduce each file into the assembly system through a routine virus-checking procedure. Some production teams even forgo the convenience of being networked to the assembly hard disk to minimize the risk of contamination. Every machine involved with production should run a battery of virus-checking software, updated to the most current versions. A final check of the assembly volume before premastering is also highly recommended.

Maintain a list of the invisible files you know belong on the CD-ROM disc and double-check it before premastering.

Keep a record of correct file sizes for each program that will ship on the disc and double-check that before premastering. Don’t use the sizes that appear if you’ve selected a view including size information. That number refers to the amount of disk space allocated rather than the actual file size. Instead choose “Get info” from the File menu for each file and record the number marked “bytes used” that appears in parentheses.

Perform these same checks against the proof disc after premastering. Infection of a disc image during premastering is rare but not impossible or without precedent.

Procedure for 6.0 / 7.0 Compatibility

Differences between System 6 and System 7 software create some behavioral quirks for CD-ROM discs. The problems are not serious, but they can confuse or annoy users:

- If a disc made under System 7 is run under System 6, certain hidden files used by System 7 will appear.
- If a disc made under System 6 is run under System 7, the system rebuilds the desktop file the first time the disc is mounted. This process is time-consuming but can be canceled without ill effect, although users may not realize this.

The following procedure eliminates both problems:

1. **Use the latest released version of System 7 software while developing your CD-ROM disc.**
2. **Restart from System 6 (preferably version 6.0.7), holding down Command-Option to rebuild the desktop file.**
3. **Restart from System 7 and allow the system to rebuild the desktop.**
4. **Restart from System 6 again.**
5. **Drag the following icons to the Trash icon. If you don't find them all, don't worry—they are not always created.**
   - Desktop Folder
   - Trash folder
   - Move & Rename folder
   - AppleShare PDS file
6. **Choose Empty Trash from the Special menu to empty the Trash.**
7. **Drag your disk to the Trash icon to unmount the disk.**
8. **Switch off and disconnect the disk drive.**

The disk is ready for premastering. If you make changes to it later (other than adding comments), repeat these steps.

Premastering

Premastering creates a single huge file from everything that will make up your CD-ROM product. The process is sometimes called building the image or simply a *build.* The result is called an *image.* It contains everything that will appear on your disc.

During the build, the premastering equipment adds things required by the mastering machine. One is the *VTOC* (Volume Table of Contents) for your disc. This contains the physical location of every disc sector that begins a new track and other information about the physical layout of the disc to be mastered.

A typical fee for premastering is from $250 to $500, depending on the number of files to be included in the image. Having fewer than 1500 files qualifies for the lower price, and having more than 1500 files draws the higher one.

Premastering suppliers forward your image file to the manufacturer in different forms. The common forms are

- 9-track tape
- 8 mm tape cartridge
- 4 mm tape cartridge

Which format is used doesn't matter to you unless you are having premastering done by a service bureau. The service bureau will know where your image file is headed for mastering and should know the formats accepted for mastering there, but it doesn't hurt to double-check.

The equipment for premastering CD-ROM discs is typically a workstation with a hard disk array of from 0.8 to 2.4 gigabytes (GB). The software includes formatting programs to build image files for different file structures, such as HFS and ISO 9660. Provisions for input from a variety of different mass storage devices and an output tape drive complete
the system.

It's important that the volume name of the premastering disk array (or partition) be set accurately before the build so that pathnames involving the CD-ROM produced will work.

Before building the image, premastering equipment can perform other operations on your data that may be useful, such as

- disc emulation
- disc optimization
- creating an HFS-ISO hybrid
- adding Red Book tracks
- proof discs

Disc Emulation

Disc emulation software on the premastering equipment locks the disk array and matches its performance to that of a CD-ROM drive, giving you some idea of how your product will perform as a disc. You can get an even better indication by using proof discs during testing.

Disc Optimization

Programs for optimizing disc performance carry out some of the same tasks you do during disk preparation: defragmenting files if necessary and grouping files that are used together to minimize seek time. Facilities charge by the hour for disc emulation and optimization, so you may prefer to use the methods you can do yourself.

Hybrid HFS-ISO

To have a hybrid HFS-ISO image built you must supply everything you would to premaster a disc in each format. Because both sets of data will be included on one disc, the total of the two combined must be less than the total size you've selected for your disc, usually 580 MB if your product must play on every kind of CD-ROM drive. Not all suppliers have the software to build a hybrid image. Check your supplier's capabilities ahead of time if you want a hybrid disc.

Red Book Audio

Premastering workstations equipped with an audiotape drive can add Red Book tracks to your disc image, creating a mixed mode disc. If you want this done, make sure your premastering supplier offers it and find out what audiotape formats they accept. Commonly available are 8 mm DAT cassette and PCM1630 U-matic tape.

If accurate timings are needed, use a tape with *SMPTE timecode*. This is digital timing information recorded alongside your audio. It's accurate to one-sixtieth of a second. Without time-code information your cues can end up noticeably ahead or behind the points intended for synchronization.

With your audiotape you will need to supply a *track sheet*. This is a list of the audio cuts on your tape with information about where to find them and where to put them on the CD-ROM. Figure 15-1 is an example of an audio track sheet.

Figure 15-1 Sample Red Book audio track sheet

Analog Track Table

NOTE: On a mixed mode disc with ISO 9660 formatting, the first audio track will be at least track 2. Track 1 will contain the data.

Tape #	Requested track #	Track title	Track time	Description (Desired track description indicates to audio engineers where each track begins, for example, the first few words)

Rev: 2/26/92

Proof Discs

Many premastering suppliers can create proof discs if desired before building the image file. These are for final testing, and three different kinds of media are commonly used:

- WORM
- one-offs
- stack checks

WORM **(**write once, read many**)** cartridges are sometimes used for testing. They are available in capacities to hold the whole image but have the disadvantage of requiring a special drive. And they contain the same volume as the assembly disk, not an actual CD-ROM data image.

One-offs (sometimes called **proof discs**) are writable compact discs that contain the actual CD-ROM image and play in CD-ROM drives. They lack the capacity to hold an entire CD-ROM, but this limitation may not affect you. The price per disc is $200–$500, and delivery time is from 1 to 3 days. Some vendors will provide one-off service at your site. Disc plants also offer one-off discs and will credit part of the fee toward manufacturing if the job is approved for production without changes.

Stack checks are actual CD-ROM discs produced from your master. They cost from $500 to $700 and most manufacturers provide several copies of the disc for this price. Delivery is from 1 to 3 days. Because stack checks are the actual product, they provide full capacity. Manufacturers will also credit part of the fee for stack checks if the job is approved for production without changes.

Final Testing

Final testing provides your last chance to check everything.

Click every button, select every option, choose every item from every menu, and do everything else that a user could. Then do it all over on every model and configuration of machine meant to run it.

Look for typos; make sure the colors selected also work in monochrome; do your level best to break it before the users can.

Finally, run every virus program in your arsenal against it—twice—and call it version 1.0.

CHAPTER 16

Packaging and Pressing

Events at the pressing plant are the biggest part of the project outside your control. An understanding of what manufacturers offer and expect can reduce the uncertainties. This chapter explains the elements of packaging a compact disc product, the services provided by disc manufacturers, and the way to work with them.

Packaging the Disc

Disc manufacturers want everything on hand before they'll start your job.

This includes

- *disc label design*
- *printed materials* for packaging if they're doing it
- *disc holders* if you don't want sleeves, trays, or jewel boxes
- *envelopes and mailing labels* if they'll be shipping to users for you

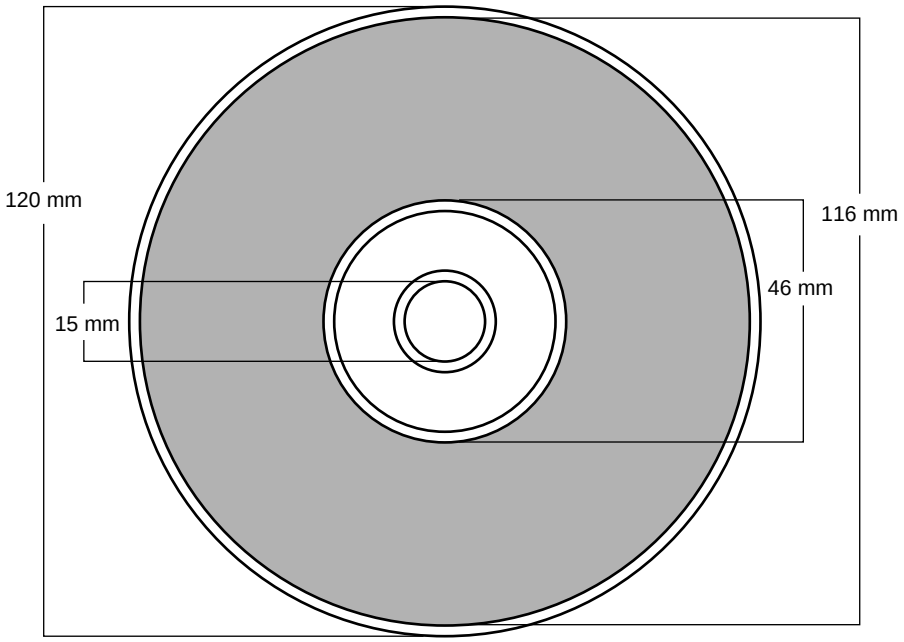
These elements may be required as much as two weeks before pressing, so it's important to get them finished in plenty of time.

Disc Label

The back side of the disc gets printed as the label of your product. Special inks are applied atop the acrylic lacquer over the mirrored surface. The label makes it obvious to users which side to play and can be designed
to make your disc stand out. For CD-ROM products it's a good idea to include on the label some installation information and the minimum system or hardware requirements.

The manufacturer will send you a diagram that shows your artist the size and shape of the label printing area. Figure 16-1 shows an example.

Figure 16-1 A disc label design guide



Compact disc specifications:

Compact disc inner diameter: 15 mm; outer diameter: 120 mm.

Production control number (PCN) will be engraved between the 41.8 mm diameter and the 45 mm diameter.

Print requirements:

Acceptable print area: 46 mm to 116 mm (indicated by the shaded area above).

Two-color printing is included in the disc price. You pick colors from a standard selection. Special colors and extra ones cost more. A third color (silver) is always available from the aluminum mirror of the disc. Rather than covering this, some labels incorporate it in their design.

Your label design goes to the plant as *film positives*, sheets of photographic film with the design in black on a clear background. You send one film for each color. The film must arrive up to two weeks before pressing for the printing process to be ready. Ask your manufacturer
for details.

Manufacturers offer a variety of special treatments for your disc label at extra cost:

- additional colors
- special inks
- photographic labels
- colored polycarbonate for the disc itself
- fancy metalizing
- serial numbering

Additional colors can be added to the two included in the disc price if you need them for your design. You can specify nonstandard colors by using *PMS* (Pantone Matching System) numbers, to match your printed materials, for example. Some manufacturers also offer special inks such as fluorescents and metallics.

Four-color process printing is available to reproduce color photography on your disc label. Not all plants offer the same resolution. If this option interests you, ask to see samples. You can provide the color separations or have the manufacturer do them, but you must let the plant know which you plan to do.

Transparent polycarbonate comes in colors, and some can be used without affecting performance. This is not something manufacturers talk about, but some have done it.

Plating the disc with a different metal can also produce a different color disc. Again, manufacturers rarely mention this possibility, but gold, platinum, and aluminum-bronze are alternatives. The precious metals are expensive and used more often for extended disc life than for appearance. Aluminum-bronze is an alloy that forms a gold-colored mirror at much lower cost. Alternative plating doesn't hurt disc performance, and the effect can be striking. But such discs may cost more and take longer to produce.

Several manufacturers have shown discs with imagery encoded as pits in the data area, a kind of ultra-high-resolution radial dot matrix printing. For discs carrying 50 MB or less this presents interesting possibilities.

All manufacturers offer serial numbering. Numbers are applied after the printed disc label and can be repeated on packaging or shipping cartons. However, automatically serialized discs may not pass performance testing, so the plant will ask whether gaps in the number sequence are acceptable to you.

Disc Holders

Several types of containers developed for audio CDs can be used for CD-ROM products as well.

- jewel boxes
- DIGIPAKs
- pouches
- binder pages

Jewel Boxes

The familiar polystyrene boxes in which most people in the United States store audio CDs are called *jewel boxes*. Jewel boxes have three parts. The outer two, transparent and hinged together, form the shell. The inner one, called the *tray*, holds the disc on a small raised knob that fits snugly into the center hole.

Standard jewel box trays are charcoal gray, but many other colors are also available.

For multiple disc projects there are jewel boxes that hold two, three, or four compact discs.

Jewel boxes have the advantage of stacking nicely, both vertically and horizontally. They provide an edge for spine labeling, which is especially handy when disks are shelved. But they are not typically produced from recycled materials nor are they readily recycled. They are also bulky to ship and store, they weigh more than the discs they protect, and they’re surprisingly easy to damage.

DIGIPAKs

Some CD-ROM products use a one-piece disc container called a DIGIPAK, from AGI Incorporated. The size and shape of a jewel box, these enclose a disc with heavy coated card stock in the manner of a book cover. Both sides of the front cover and the back of the container can be printed.

Pouches

A lightweight, unbreakable alternative disc container is the sleeve or pouch. These are slipcases for discs, available in paper, paperboard, or lightweight, flexible plastic.

Paper sleeves from the pressing plant are white, but other colors are available and all can be printed. Ask your disc manufacturer to recommend a printer with the appropriate dies.

Plastic pouches called CD-Viewpaks are a patented design available from Univenture. These provide space for a standard CD booklet and a flap to keep the disc in place. Special nonabrasive material is incorporated in the pouch to protect the disc surface.

Binder Pages

Univenture also offers looseleaf binder pages of different sizes to hold multiple compact discs. These feature the same protective materials as the pouches.

Printed Materials

If the manufacturer is packaging for you, all your materials must be on hand before the manufacturer will press your discs. This may include

- booklets
- inlay cards
- boxes
- manuals
- response cards
- stickers

Booklets

If you're using jewel boxes, there's space for a booklet between the front door of the shell and the disc itself. For CD-ROM products the booklet should include installation information and minimum system or hardware requirements.

Booklets are approximately 4¾ by 4¾ inches and are bound by saddle-stitching, that is, stapled through one edge like a magazine. Depending on the type of paper used, booklets of up to 32 pages are possible. But thick booklets are more likely to bind on the plastic ears that hold them to the jewel box door.

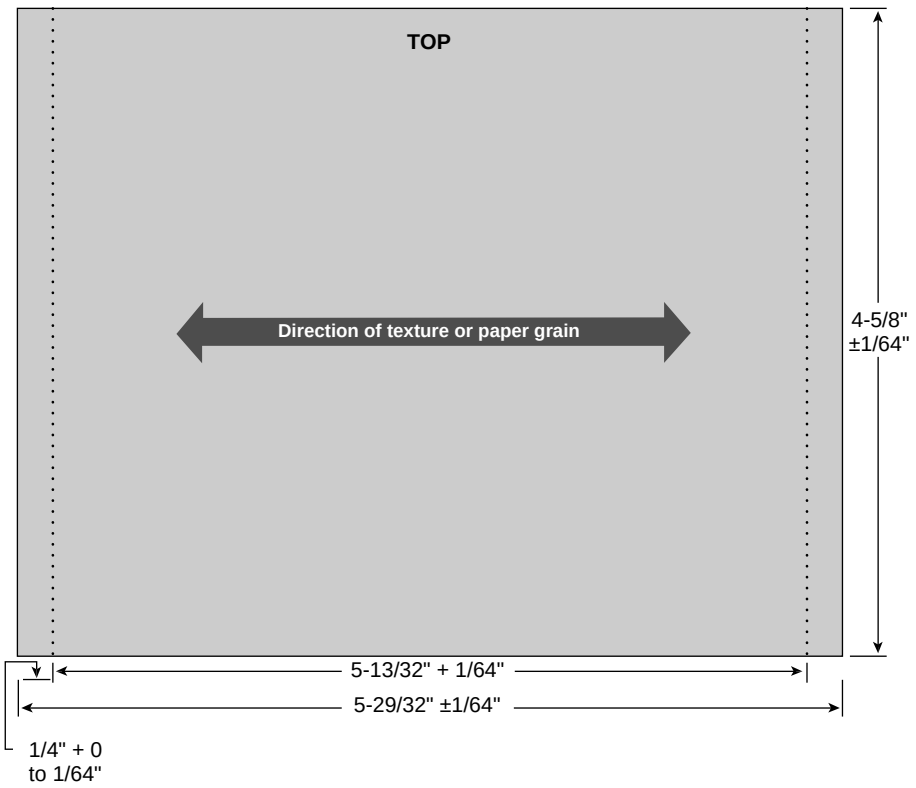
Because the jewel box door is transparent, the cover of this booklet becomes the design for the front of the package. Some products have no booklet but simply allow the label of the CD-ROM disc to show through the door. Others insert a single sheet of printed card stock in the same dimensions as a booklet, but these slip out more easily than booklets and tend to get lost.

Inlay Cards

In the back half of the shell, behind the tray, is a second place for printed material. This insert is called the **back inlay card,** or simply the **inlay card,** and measures approximately 4⅝ by 5⅞ inches.

Both ends of the inlay card are scored a short distance from the edge and folded at right angles to form spine labels. Figure 16-2 shows how the space on an inlay card is used.

Figure 16-2 Layout of a jewel box inlay card



Disc manufacturers can provide detailed specifications and recommend printers who specialize in jewel box inlay cards and booklets.

Other Components

Like other computer software products, yours may be designed to ship in a box that also contains manuals, inserts, response or registration cards, and other materials. If the disc manufacturer is assembling these for you, they must all be on hand for your job to start.

The printed materials for your product will most often ship directly from the printer to the pressing plant. Make sure your printer understands exactly how you expect the materials to be shipped and the importance of timely delivery. Many CD-ROM projects have cleared all production hurdles, only to be thwarted by a printing delay. Don't overlook this shipping expense when you budget, especially if expedited delivery will be necessary.

Pressing the Disc

Most compact disc manufacturers offer CD-ROM discs. But CD-ROM discs are a small part of the business for some plants, a large part for others. Manufacturers who press mostly audio CDs see a volume of business that follows the retail cycle. The pre-Christmas rush, from August through November, can be a hard time for small CD-ROM customers in a plant with big CD audio contracts. But big customer volume helps keep their prices low. It's a tradeoff.

Get acquainted with the manufacturers early. Tell the sales reps what you think you'll need even before you know for sure. Ask them to suggest other CD-ROM customers you can talk with. One of the best ways to see if you'll be comfortable with a supplier is to find out who else is.

Estimates

Once you have a preliminary schedule, contact the manufacturers for quotes. Be sure to ask about first-time developer pricing. Most plants have attractive offers for those who qualify.

Some manufacturers price everything separately. Be sure to explain exactly what you will supply and what you expect to receive from them. Then insist that their estimate cover everything needed to accomplish your goals. Getting this kind of estimate in writing can prevent unpleasant surprises.

To give you an estimate they will need to know

- the number of masters
- the number of discs from each master
- the turnaround you need
- what you want for disc labels
- what you want for disc containers
- whether premastering will be required
- who's packaging the product

You pay a flat fee for each master. This varies with the speed of turnaround you require.

You pay by the disc for pressing, and prices depend on the quantity manufactured. Some manufacturers will give quantity pricing on the total number of discs made at one time, even if they're from different masters.

Turnaround is how quickly you need the product and may affect the price of some services, including mastering, pressing, printing, and packaging.

Two-color disc labels are included in the pressing price. Extra colors and disc label options like serial numbering are available at an additional cost per disc.

Discs can be shipped to you in paper sleeves, on jewel box trays alone, or on the trays in standard jewel box cases. The option you choose affects the price per disc.

All disc manufacturers offer premastering at rates comparable to those of the service bureaus. However, time for premastering is not provided in the calculation of turnaround. Allow for this in your schedule.

If you want the plant to assemble your packaging, that's extra, and the manufacturer will need additional information, as well as your materials, in advance.

Scheduling and Turnaround

Manufacturers offer delivery ranging from same-day to 10-day service. A 5-day turnaround is considered standard.

It helps to let the plant know your job is coming. They won't hold a place without your order, but they'll be watching for the job. Once your order arrives, and all required materials are checked in, you get scheduled.

According to manufacturers, the following are the most common reasons for jobs to be delayed:

- The data for the disc isn't received with the order.
- The printed materials are late.
- The film for the disc label is late or not properly prepared.
- The programs for the disc turn out not to run from a locked volume.
- The quantity of discs hasn't been finalized.

Mastering

Mastering turns computer data into pits on a disc and generates tooling to reproduce them.

How Mastering Works

What goes into mastering is your premastered tape. What comes out is a stiff metal circle called a *stamper*. It's the size of a large tin can lid and thinner than a razor blade. On it are the billions of microscopic bumps that put the dimples in the face of compact discs.

How the tape becomes a stamper may vary from place to place. Here's the general idea:

A thick round slab of glass, the size of a dinner plate, is coated on one surface with *photoresist*. This special paint reacts to laser light. The painted glass *blank* is mounted on a powerful motor and spun like a big heavy compact disc.

While it spins, your data tape begins to play. Data is translated into code combined with error-detecting information. This signal pulses a laser as its beam tracks outward over the spinning blank. Where the laser pulses strike they cause a chemical change, a "picture" of your information etched in photoresist as a thin spiral line up to 3 miles long. The blank is now a master.

When this laser "picture" is developed, the exposed areas dissolve, forming the pattern of dimples for your CD-ROM.

To transfer this pattern, the dimpled surface of the master is plated with metal. First a very thin layer condenses on it from a heated metal mist. Then a thicker layer is built up by attracting metal out of chemical solution in a special bath. When it is thick enough to separate from the master, the metal layer has become a stamper, with the spiral pattern of bumps across its shiny face.

What Mastering Costs

You pay as much for a master to produce hundreds of discs as for one to make hundreds of thousands. The fee depends on how quickly you want it done.

The fastest is same-day service. Discs are mastered, pressed, and shipped within 24 hours. You pay a mastering fee of $2500–$3000 for this.

The lowest price for mastering is $500–$700. That goes with discs shipped in seven to ten days, depending on the manufacturer.

Replication

Compact discs are injection molded, like plastic silverware or model airplane parts. The only difference is extreme precision.

How Replication Works

Molten plastic is squeezed into a disc-shaped mold. Along one side of the mold is the metal stamper. High pressure forces the hot plastic to fill the mold and flow around every bump in the stamper. The mold is cooled rapidly by liquid nitrogen to solidify the plastic, locking in details. Then it opens to release the freshly pressed disc, clamps shut, and does it again.

Presses make 300 to 500 discs an hour. But it takes a while to change stampers between jobs, so short runs cost more.

The reflective mirror for the disc goes on the dimpled side. Metal vapor is “sputtered” from a hot filament and deposited on the plastic surface.

A coat of tough acrylic lacquer protects the thin metallic mirror. Your product’s label is printed on that, and the CD-ROM is ready to play.

What Replication Costs

Prices range from about $1 to $2 per disc for replication.

Your price depends on

- *volume*. There are price breaks at various quantities.
- *aggregate discount.* The price can sometimes be lower for those having more than one CD product pressed within the period of a year or so.
- *predictability.* Discs repeated on a regular schedule are cheaper.
- *commitment.* There are further discounts for customers under contract.

Other Services

Most pressing plants offer other services at extra cost. Consult your manufacturer for details about

- premastering
- packaging
- shipping
- fulfillment

Packaging and Pressing

Premastering is available from all manufacturers. See “Premastering” on page 110 for a description and typical prices.

Manufacturers will assemble your product packages. They can also shrink-wrap your product, apply stickers, and pack your product into cartons. These are added cost options.

Plants ship F.O.B. (Free on Board) their dock, which means you own the product in transit and you pay the freight. If packaged, the weight depends on your package design. If shipped in bulk, there’s a difference in weight between paper sleeves, jewel box trays, and jewel boxes. A 30-pound shipment, by whatever carrier, brings you about 500 CD-ROM discs in sleeves, roughly 250 on trays, and only 100 or so in jewel boxes.

Some manufacturers also provide *fulfillment*, that is, they warehouse your product and fill orders, shipping directly to your customers. The range and quality of services offered should be carefully explored in comparison to those of firms that specialize in fulfillment.

Selected CD-ROM Resources

The companies and organizations mentioned in this book are listed here, along with a few others you may find useful.

3M Optical Recording
3M Center
St. Paul, MN 55144
612-736-3274
compact disc premastering, mastering, and manufacturing

AGI Incorporated
1950 North Ruby Street
Melrose Park, IL 60160
708-344-9100
DIGIPAK compact disc holders

AND Group
11th Floor, 6th Avenue SW
Calgary, Alberta T2P 3T1 CANADA
403-232-6211
The Vendor, software to enable selective access to parts of a CD-ROM

APDA
20525 Mariani Avenue, Mailstop 33-G
Cupertino, CA 95014
408-562-3910
Apple's source for developer tools

Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014
408-996-1010
Macintosh computers and AppleCD SC drives

Authorware
8500 Normandale Lake Boulevard, 9th Floor
Minneapolis, MN 55437
612-921-8555
multimedia object authoring environment for developing interactive applications

Claris Corporation
5201 Patrick Henry Drive, P.O. Box 58168
Santa Clara, CA 95052
408-727-8227
HyperCard

CMC ReSearch, Inc.
7150 S.W. Hampton, Suite C-120
Portland, OR 97223
503-639-3395
Disc Passage search engine

Denon America
222 New Road
Parsippany, NJ 07054
201-575-7810
compact disc premastering, mastering, and manufacturing

Digidesign
1360 Willow Road, Suite 101
Menlo Park, CA
415-327-8811
Audiomedia card and software for digitizing audio

Digital Audio Disc Corp.
1800 North Fruitridge Avenue
Terre Haute, IN 47804
812-466-6821
compact disc premastering, mastering, and manufacturing

DMI
1409 Foulk Road, Suite 202
Wilmington, DE 19803
302-433-2500
compact disc premastering, mastering, and manufacturing

Discis Knowledge Research Inc.
45 Sheppard Avenue East
Toronto, Ontario M2N 5W9 CANADA
800-567-4321
data conversion and preparation

DiVA Corporation
222 Third Street
Cambridge, MA 02142
617-491-4147
DiVA VideoShop

DMR Group
57 River Street
Wellesley, MA 02181
617-237-0087
CD-ROM data preparation software and project management services

E-Machines
9305 SW Gemini Drive
Beaverton, OR 97005
503-646-6699
QuickView Studio video digitizer

Eastman Kodak Company
343 State Street
Rochester, NY 14650
800-233-1650
ColorSqueeze image compression software and Photo CD

Electronic Sound and Pictures
St John's Innovation Centre, Cowley Road
Cambridge, CB4 4WS ENGLAND
44-223-420222
CD-ROM product design and production services

Farallon Computing, Inc.
2000 Powell Street, Suite 600
Emeryville, CA 94608
415-596-9000
DiskPaper documentation software

Fulcrum Technologies (Canada, Italy)
785 Carling Avenue
Ottawa, Ontario K1S 5H4 CANADA
613-238-1761

Via Elio Vittorini 129
Rome 00144 ITALY
39-6-502-72562
Ful/Text search engine

Gold Disk Inc.
20675 S. Western Avenue, Suite 120
Torrance, CA 90501
213-320-5080
Animation Works animation software

Ivy Hill Graphics and Packaging
170 Varick Street
New York, NY 10013
212-741-1404
CD-ROM printing and packaging services

KimTec UK
8 Highland Road
Wimbourne, Dorset BH21 2QN ENGLAND
44-202-888873
CD-ROM project consulting

Lasec Datenbank Technologie GmbH
Fasanenstrasse 47
D-1000 Berlin 15 GERMANY
49-30-882-7718
search engine

Light Source Inc.
17 East Sir Francis Drake Boulevard, Suite 100
Larkspur, CA 94939
415-461-8000
MovieTime

M.P.W. Marketing Services GmbH
Weiderehre 11
W-3007 Gehrden GERMANY
49-5108-7080
compact disc premastering, mastering, and manufacturing

Macromedia
600 Townsend
San Francisco, CA 94103
415-442-0200
MacRecorder audio digitizer and multimedia development tools including MacroMind Director, MacroMind Director Interactive, MacroMind Three-D, Film Maker, Swivel Art, Swivel 3D

Meridian Data
5615 Scotts Valley Road
Scotts Valley, CA 95066
408-438-3100
premastering equipment and premastering services, one-offs

METATEC
7001 Discovery Boulevard
Dublin, OH 43017
614-761-2000
compact disc premastering, mastering, and manufacturing

Moore Langen Printing
200 Holman Street
Terre Haute, IN 47802
812-234-1585
CD-ROM printing and packaging services

NEC, Professional Systems Division
1255 Michael Drive
Wood Dale, IL 60191
708-860-9500
PC-VCR computer-controlled video cassette recorder

Next Technology Corporation
St. John Innovation Centre
Cambridge CB4 4WS ENGLAND
44-223-421180
one-offs

Nimbus Information Systems
Wyastone Leys,
Monmouth, Gwent NT5 3SR ENGLAND
44-600-890682
Box 7305
Charlottesville, VA 22906
804-985-1100
compact disc premastering, mastering, and manufacturing

On-Site CD Services
13901 Lynde Avenue
Saratoga, CA 95070
408-867-0514
one-offs

Optical Media International
485 Alberto Way
Los Gatos, CA 95032
408-395-4332
premastering services, premastering equipment

Personal Library Software
15125 Shady Grove Road, Suite 204
Rockville, MD 20850
301-926-1402
Personal Librarian search engine

Philips and Du Pont Optical
Klusriede 26
W-3012 Langenhagen 1
49-511-730-6227
Queen Anne House, 11 The Green
Richmond-upon-Thames, Surrey TW9 1TX ENGLAND
44-81-948-7368
compact disc premastering, mastering, and manufacturing

Pivar Computing Services
165 Arlington Heights Road
Buffalo Grove, IL 60089
708-459-6010
data file format conversion services

Pixar
1001 W. Cutting Boulevard
Richmond, CA 94804
510-236-4000
Showplace and MacRenderMan three-dimensional rendering software

Pixel Productions
39 Ripley Gardens
London SW14 8HF ENGLAND
44-81-876-1385
creative services

Pressed for Time
St John's Innovation Centre, Cowley Road
Cambridge, CB4 4WS ENGLAND
44-223-420222
data conversion, audio recording, one-offs

Queens Litho
620 South Belmont Avenue
Indianapolis, IN 46221
317-635-7777
CD-ROM printing and packaging services

RasterOps
2500 Walsh Avenue
Santa Clara, CA 95051
408-562-4200
monitors, video digitizers

Ray Dream Inc.
1804 N. Shoreline Boulevard
Mountain View, CA 94043
415-960-0765
Ray Dream Designer three-dimensional modeling and rendering software

Reference Technology, Inc.
5700 Flatiron Parkway
Boulder, CO 80301
303-449-4157
premastering and mastering equipment

Serius Corporation
1981 E. 4800 South
Salt Lake City, UT 84117
801-272-7788
Serius Programmer object-oriented, visual programming environment

Shorewood Packaging
10 East 53rd Street
New York, NY 10002
212-371-1500
CD-ROM printing and packaging services

Silicon Beach Software
9770 Carroll Center Road, Suite J
San Diego, CA 92126
619-695-6956
SuperCard software tool kit

Sonopress GmbH
Carl-Bertelsmann-Strasse 161
W-4830 Guetersloh 1 GERMANY
49-5241-80-3074
compact disc premastering, mastering, and manufacturing

Specular International
Box 888
Amherst, MA 01004
413-549-7600
Infini-D modeling, rendering, and animation package

Storm Technology Inc.
1101 San Antonio Road, Suite 101
Mountain View, CA 94043
415-691-1111
PicturePress accelerator card and image compression software

SuperMac Technology
485 Potrero Avenue
Sunnyvale, CA 94086
408-245-2202
VideoSpigot video digitizer

Telemedia SonoPress (UK) Ltd.
26-27 Conduit Street
London W1R 9TA ENGLAND
44-71-499 6813
compact disc premastering, mastering, and manufacturing

Telesystemes-Questel
83-85 Boulevard Vincent Auriol
Paris 75013 FRANCE
33-1-45-82-6464
search engine

TGS Systems
2745 Dutch Village Road, Suite 200
Halifax, Nova Scotia B3L 4G7 CANADA
902-455-4446
Prograph 2.5 object-oriented, visual programming environment

Univenture
P.O. Box 570
Dublin, OH 43017
800-992-8262
CD-Viewpak compact disc holders

Working Knowledge Transfer Ltd
Brunel Science Centre, Coopers Hill Lane
Egham, Surrey TW20 0JZ ENGLAND
44-784-436744
CD-ROM project design and management services

Workstation Technologies, Inc.
8004 Sky Park Circle, Suite 240
Irvine, CA 92714
714-250-8983
WTI-Moonraker *video digitizer*

Glossary

back inlay card *See* **inlay card.**

bit depth The number of bits used to describe each pixel of an image. *See also* **pixel.**

CD-I Acronym for compact disc interactive—a compact disc technology similar to CD-ROM but intended for the consumer electronics market. CD-I discs play only in special players.

CD-ROM Acronym for *compact disc read-only memory*—a compact disc technology for the storage and distribution of digital information intended for computer use. The information is designated as read-only memory because a CD-ROM drive can read the information but cannot record new information.

CD-ROM drive The computer peripheral device required to play CD-ROM discs.

CD-ROM/XA Acronym for *CD-ROM Extended Architecture*—an extension of the original CD-ROM standard which adds the capability for interleaving data to enhance real time playback of time-based data. CD-ROM/XA is closely related to CD-I but intended for use with computer systems. CD-ROM/XA discs play only in specially equipped CD-ROM drives. *See also* **CD-I, interleaving.**

compression Operations which minimize the number of bytes required to transmit or store data.

compression ratio A measure of the efficiency of compression, expressed as the ratio of the original size of the data to its compressed size. For example, data with an uncompressed size of 5 MB has undergone 50:1 (fifty-to-one) compression if it now occupies 100 KB. *See also* **compression.**

data transfer rate A measure of how quickly data is supplied to the computer from the CD-ROM drive.

decompression Operations that reverse data compression, restoring the original information after storage or transmission. *See also* **compression.**

document imaging An approach to digitizing documents in which they are stored as scanned images rather than text files.

file format The description of how information is organized inside a file. File format is usually determined by the program that creates a file.

full inverted index An index including all words which occur in a collection of documents except those deliberately excluded.

ISO 9660 An international standard for CD-ROM file structure adopted by the International Standards Organization. Files on a disc organized according to ISO 9660 are recognized by any computer that understands this format.

inlay card Part of the printed packaging material used in compact disc jewel boxes. The inlay card is inserted into the back half of the jewel box behind the tray and measures approximately 4⅝ by 5⅞ inches. Same as **back inlay card.** *See also* **jewel box.**

interleaving The practice of sector-by-sector alternation between data types within files on a CD-ROM disc. Interleaving permits different types of data to be routed to different hardware or software as a file is playing. Special circuits for this purpose are included in some CD-ROM drives and in CD-ROM/XA or CD-I drives. *See also* **CD-I, CD-ROM/XA.**

inverted index *See* **full-inverted index.**

jewel boxes The hinged polystyrene cases in common use for audio compact disc storage in the United States.

markup codes Short strings of printing characters embedded in the text of some documents as markers to designate parts of

the text for typesetting in a predefined fashion. Because they include characters that also occur naturally in text documents, such as *<ti>*, markup codes are sometimes difficult to remove from files and typesetting tapes that contain them. Compare **style codes.** *See also* **SGML.**

mastering Part of compact disc manufacturing. The process in which data is converted into a stamping pattern for the presses, mastering follows premastering and precedes replication. Compare **premastering, replication.**

mastering fee The fixed charge by a manufacturer for preparing a master from which compact discs can be replicated. Because it does not depend on the number of discs being produced from a master, the contribution of the mastering fee to the price per disc declines rapidly as quantity increases.

mixed mode disc A CD-ROM disc which also contains audio tracks in the compact disc audio Red Book format. *See also* **Red Book.**

noise Meaningless information in a signal.

OCR Acronym for *optical character recognition*—converting printed text and images to electronic form as text and files by using a scanner.

one-offs Writable compact discs used for testing CD-ROM products. One-offs contain the actual CD-ROM image and play in CD-ROM drives. Same as **proof discs.**

premastering A production step in which all the individual files of a CD-ROM product are combined into a single large file for the mastering machine.

pixel Short for picture element—the smallest unit of the display screen you can control.

proof discs *See* **one-offs.**

public domain The legal status of a product or publication not protected by patent or copyright. Works created by the government are generally in the public domain. Works for which patent or copyright protection have expired are in the public domain.

QuickDraw The part of Macintosh system software that provides facilities for displaying bitmapped and object-oriented images.

QuickTime An extension of the Macintosh system software that provides facilities for managing **time-based data.**

replication Part of compact disc manufacturing. The process of pressing discs, replication follows mastering. Compare **premastering, mastering.**

Red Book Refers to the specification documents for the compact audio disc format, developed by Philips and Sony. By extension, audio tracks in this format which may be included in mixed mode discs. Now an international standard, this specification ensures that CD audio discs can be played in players from different manufacturers. *See also* **mixed mode disc.**

sampling The process by which audio is put into digital form. A sample is a snapshot of sound pressure at one instant in time. Samples are taken quickly enough that recreated in sequence the result is a kind of audio animation, the impression of an actual sound.

sampling rate The frequency in which sampling occurs during digital audio recording. The higher the sampling rate the greater the range of pitches accurately recorded.

seek time The length of time it takes to reposition the head to read data from a different sector of a CD-ROM disc or a hard disk.

SGML Acronym for *Standard Generalized Markup Language*—an international standard (ISO 8879) for defining markup codes. *See also* **markup codes.**

signal-to-noise ratio A measurement of signal quality expressed as the ratio of meaningful information to the amount of noise accompanying it. The higher the ratio, the better the quality of the signal.

stack checks A limited quantity of compact discs produced by normal manufacturing methods. Stack checks are sometimes used for testing instead of one-offs when more than a single copy is required. *See also* **one-offs.**

Standard Generalized Markup Language
See **SGML.**

stopword list A list of words to be ignored when indexing. *See also* **inverted index.**

style codes Nonprinting characters embedded in the text of a document file to control the font, size, and style used to display or print the text. Compare **markup codes.**

time-based data Data that can be stored as samples taken over time, such as audio, video, and animations.

transcoding The process of changing the way a QuickTime movie is compressed to improve its performance.

Yellow Book Refers to the specification documents for the CD-ROM format, developed by Philips and Sony. By extension, CD-ROM data tracks in this format. Now an international standard, this specification ensures that CD-ROM discs can be played in drives from different manufacturers.

Index

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y, Z

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