This book is dedicated to my parents, Paul and Nanette LaBarge, who taught me that honesty, hard work, perseverance, and respect for others are the keys to success.
Acknowledgments

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Chapter 1

INTRODUCTION

*DVD Authoring & Production* is the result of more than six years of practical experience authoring and producing DVD-Video, DVD-ROM, and WebDVD titles. When I started developing DVD titles in early 1996 there was almost no documentation or literature available that described the process of producing a DVD title. In 1997 Jim Taylor’s *DVD Demystified* was published and has since become the bible for everyone in the DVD business. *DVD Demystified* is a great book, and I strongly encourage anyone getting into DVD to buy a copy, but it is primarily a technical book. While both books cover some of the same material, *DVD Authoring & Production* provides an in-depth look at the process of authoring and producing DVD titles. Conversely, *DVD Demystified* provides an in-depth look at the technical details of the DVD specifications, the history of DVD and it’s predecessors, as well as the future of the format. To sum it all up, *DVD Demystified* answers the question “Why DVD?”, while *DVD Authoring & Production* answers the question “How do I make a DVD?”. Although I am somewhat biased, I truly believe having both *DVD Demystified* and *DVD Production & Authoring* is worthwhile, particularly if you are directly involved with the authoring or production of DVD-Video, DVD-ROM, or WebDVD titles.

In writing *DVD Authoring & Production* I have drawn on my knowledge and experience gained in designing, authoring, and producing over 200 DVD titles. Developing a DVD title is still a fairly complicated process. A large number of issues can delay the completion of the project and result in a final product that does not meet all of your requirements. As you read *DVD Production & Authoring* you will see that there is more to producing a successful DVD title than just using a DVD authoring program to create a valid DVD disc image. In fact, the actual authoring of a DVD disc is just one of a dozen steps in the process, and is often the easiest part of the project.
Chapter 1: INTRODUCTION

During the year 2000, I completed over 25 new DVD-Video, DVD-ROM, and WebDVD titles. I am planning on releasing another 25 or so during 2001. Every time I complete a project, I feel that I have learned something new about the process of producing and authoring DVD titles. When I start a new project, I try to use a DVD feature in a new or different way, or some new combination of features that I have never used before. The DVD-Video format is an extremely rich multimedia-publishing medium. I am convinced that just about anything is possible in DVD as long as you have the desire, and patience, to make it happen.

As with skinning cats, there is more than one way to author and produce a DVD title. I will outline a process that has worked well for me over the past five years, and one that I believe will also work for you. However, as you become more proficient at developing DVD titles you’ll find you need to use your own experience and knowledge to amend or modify the process I discuss in this book to suit your own specific business needs.

Who Should Read this Book?

Anyone who is involved in the production or authoring of DVD-Video, DVD-ROM, and WebDVD titles should read this book. The book covers every aspect of the DVD production and authoring process, so it may not be necessary for everyone to read every section of the book. For example, if you are only involved in the process of authoring DVD-Video titles, then you should definitely read Chapters 1–6, which discuss the process of producing DVD titles as well as the details of DVD authoring, and refer to Chapters 10 and 11, but you probably won’t need to read Chapters 7–9, which cover Enhanced DVD, DVD-ROM, and the business aspects of producing DVD titles. Similarly, if your primary interest is in the production or sales of DVD titles, then you should read Chapters 1–3, covering the process of producing DVD titles, as well as Chapter 9, which covers the business of producing DVD titles.

Naturally, I would like everyone to read every chapter. Realistically, this is simply not practical in the fast-paced world of DVD title production. I have organized the book so that you can either read it from start to finish to fully understand the DVD production process, or read a chapter at a time to bone up on one specific DVD production issue. Finally, it is my hope that this book will become a useful tool for DVD producers and developers to improve their projects as they learn more about the process of developing DVD titles and bringing them to the market.

How Is this Book Organized?

DVD Authoring & Production includes eleven chapters and an index. Chapter 2 provides details on each of the DVD formats (DVD-ROM, DVD-Video, DVD-Audio, DVD-R, DVD-RAM, and DVD-RW). Chapter 2 also discusses the “unofficial” DVD formats (DVD+RW and SACD). Chapter 3 presents a step-by-step process for authoring and producing DVD titles. Chapter 4 covers entry level DVD authoring, concentrating on the use of low-end or consumer authoring tools. Chapter 5 covers mid-range DVD authoring, while Chapter 6 covers advanced DVD authoring. Chapter 7 covers enhanced DVD authoring, and Chapter 8 covers DVD-ROM authoring. Chapter 9 provides an in-depth look at the business aspects of DVD production and authoring. Chapter 10 reviews most of the major software and hardware tools
required to develop DVD titles, as well as major DVD authoring service providers. Finally, Chapter 11 provides a detailed glossary of DVD terms and acronyms with definitions.

If you turn to the back of DVD Production & Authoring you will see that we have included a copy of StarGaze, one of my recent consumer DVD releases. I am a firm believer that a picture is worth a thousand words, so I wanted to include supplemental content to illustrate the DVD authoring and production processes discussed in the book. Rather than include a custom disc, which demonstrates specific features of the DVD specifications, I thought it would be better to include an example of a real world DVD title.

A Brief History of DVD

DVD, also known as Digital Versatile Disc, was born in 1996 from a marriage of two competing optical disc technologies. DVD was developed by a group of ten consumer electronics companies, called the DVD Forum, who agreed on a set of technical specifications for each DVD format. Initially five specifications were published, including DVD-ROM, DVD-Video, DVD-Audio, DVD-R, and DVD-RAM. Recently a specification for DVD-RW has also been added to the list of “official” DVD formats. The DVD Forum has published “official” DVD formats, while “unofficial” DVD formats are those that are compatible with at least one official DVD format, but provide other features as well. DVD+RW is an example of an unofficial DVD format as it can read DVD-ROM discs, but can also read and write DVD+RW discs, which are not documented in any DVD Forum publications. The original members of the DVD Forum included Hitachi, Matsushita Electric Industrial Co. LTD (also known as Panasonic), Mitsubishi Electric Corporation, Philips Electronics, Pioneer Electronics, Sony Corporation, Thomson Multimedia, Time Warner, Toshiba Corporation, and Victor Company of Japan.
Prior to 1996 there were two competing groups of companies, one led by Sony, and the other by Toshiba. Each group was trying to develop proprietary high-density optical-disc formats to be used in the next generation of consumer electronics and personal computer products. Fortunately these two groups joined forces and agreed to form the DVD Forum. The DVD Forum actively encouraged participation from members of the entertainment and computer industries so that the DVD format had a broad base of support in both the consumer and computer electronics areas. The DVD Forum now has over 200 members representing a broad spectrum of companies offering a wide variety of DVD related products and services.

The early years of DVD were difficult and in many cases frustrating. DVD was viewed with some interest by many Hollywood studios looking to publish their content on a high quality medium, but they were concerned over copyright protection and conditional access issues. Several major motion picture studios such as Time Warner and Universal Pictures were committed to releasing their movies on DVD, while the rest of the studios remained uncommitted pending resolution of these copyright issues. The issue of how to protect content once it was distributed on a DVD-Video disc was the topic of a number of discussions between members of the DVD Forum and representatives from the motion picture and software industries. In late June of 1996 representatives from the computer, consumer-electronics and movie industries signed off on a technical working group recommendation for encrypting all data stored on DVD-Video discs and including decryption hardware in DVD Video players. During September and October of 1996 proposals from the computer industry recommending an alternative method of encrypting just the video content were considered and accepted by the Copyright Protection Technical Working Group. Finally in November 1996 all parties agreed to a specific set of analog and digital copy protection methods.

The first DVD-Video players were sold in Japan starting in November of 1996. The U.S. market for DVD-Video players and DVD-ROM drives was launched during early 1997. Initial projections for sales of DVD-Video players were quite optimistic, with many estimates as high as 2 million units or more sold during the first year. Actual sales fell far short of these initial projections due primarily to the high cost of consumer DVD-Video players as well as the limited number of DVD titles released by the major motion picture studios. When the DVD-Video format was officially launched in the U.S. on March 17, 1997 there were less than 200 titles available in only seven regional test markets. DVD went nationwide in the U.S. on August 22, 1997, although there were still several major motion picture studios not supporting the format, including Disney, Fox, and Paramount.

During 1997 a number of respected industry analysts expressed concerns over the viability of the DVD format. Some experts predicted that the DVD format would fail in its effort to become a viable home entertainment format, becoming a niche product only for high-end audio and videophiles. These predictions seemed justified by the failure of the Laser Disc format to break into the mainstream consumer market.

In September 1997 things started to look up for DVD as Disney announced that they would be releasing their non-animated movies on DVD, leaving only Fox and Paramount as major studios who were still not supporting DVD. Actual sales of DVD-Video players in the U.S. market during 1997 were only about 315,000 units, well below the industry predictions. While the future of DVD was looking brighter, total sales of DVD players and titles were below expectations, and it was not clear that DVD would become a success.

In April 1998 Paramount decided to release DVD versions of their movies, and Fox followed suit in August 1998. With all of the major motion picture studios now on board the
future looked much brighter for DVD. Over 1,000,000 DVD-Video players were sold in the U.S. market during 1998, while at the same time the European DVD market was launched. Initial sales in Europe were slow due to a lack of Region 2 titles, as well as resistance by many consumers who did not want to purchase DVD players that due to region coding prevented them from watching movies released in the US. To this day most Europeans despise the use of Region Coding by the studios, while most American consumers don’t even know that their players can only play Region 1 titles. By the end of 1998 with a worldwide installed base of over 2,000,000 players and more than 1,000 titles available, most of the critics of DVD had been silenced. All of the major motion picture studios had commitments to release their entire catalogs on DVD, as well as many independent distributors and smaller studios.

By the end of 1999 DVD had become the fastest growing consumer electronics product ever. Over 4,000,000 DVD-Video players were sold in the U.S. market alone during 1999, and remarkably there were almost 4,000 DVD titles available by year-end. Perhaps the biggest news during 1999 was Circuit City’s decision to abandon DIVX, its proprietary pay per view version of DVD. Circuit City had spent several years, and over $200,000,000 to develop DIVX, but in the end bowed to pressure from consumers who did not like certain technological aspects of the DIVX business model, including the ability to track consumer viewing habits and advanced copy protection features that only allowed movies to be played on DVD players registered to a specific household.

DVD solidified its claim to the most successful new consumer electronics format during 2000. In the U.S. market over 8,000,000 new DVD-Video players were sold and over 8,000 titles were available in the DVD format by the end of the year. The European market also grew significantly during 2000 with most major motion picture studios releasing specific versions of their movies for Europe, rather than simply repackaging the US versions of each release. The year 2000 was also a watershed year for DVD in several other areas. DVD branched out from the movie business to become a mainstream technology for corporate, educational, and government applications. DVD-ROM drives became common options for new consumer and corporate personal computers, and a large number of products and services were announced to help corporate, educational, and government clients move into the world of DVD. DVD-Video players were available in the U.S. for less than $100, and DVD-ROM drives became a no-cost option on many higher-end personal computers. The year 2000 ended in a bang for DVD with several recordable DVD products released worldwide, addressing the only major drawback to widespread adoption of the DVD format — the inability for the consumer to record their own content onto DVD discs.

While it is always difficult to predict how consumers will react to new technologies, it is clear that DVD will be successful for many years to come. DVD-Video is firmly entrenched as a mainstream high quality, low cost home entertainment format. Over the next few years DVD-ROM will replace CD-ROM as the standard optical disc format in all consumer and corporate personal computers. DVD-Audio products will come on the market during 2001, and it will compete directly with the new Super Audio CD format. It is too early to tell if DVD-Audio or Super Audio CD will be accepted as a mainstream replacement for CD-Audio technology, which is firmly entrenched worldwide. Finally the DVD-R, DVD-RAM, and DVD-RW formats will start to offer consumers the ability to create and record their own high quality content on recordable DVD discs. The future of DVD looks very bright; in fact, DVD is likely to be a dominant technology over the next decade.
Chapter 1: INTRODUCTION

Figure 1.1 shows the projected growth of DVD over the next ten years. (Source: DVD Intelligence, and independent market surveys.) It is easy to see from this graph that DVD has just begun its dominance as a critical component in consumer home entertainment products.

Figure 1.1    Worldwide Markets for Home Video Equipment
Chapter 2

DVD FORMAT SPECIFICATIONS

The DVD Forum has released separate books to document each of the following DVD specifications (listed with the current version at the time of this writing).

- DVD-Video v1.11
- DVD-ROM v1.02
- DVD-Audio v1.2
- DVD-R v2.0
- DVD-RAM v2.1
- DVD-RW v1.1
- DVD-Video Recording v1.1
- DVD Stream Recording v1.0

Each of the listed formats are “official” DVD formats, which means they have gone through a formal submission and review procedure and they have been approved by a vote of DVD Forum member companies. The submission, review, and approval process can take up to two years for a new DVD format. The DVD Forum is currently developing specification for advanced interactive content, also know as WebDVD, which defines an optional mechanism to include links between content stored on DVD-Video titles and content available on
Chapter 2: DVD Format Specifications

Sony and Philips have proposed an alternative to the recordable DVD specification called DVD+RW, which was published in 1999 and revised in 2000. Sony and Philips have also proposed an alternative to the DVD-Audio specification that is called Super Audio CD (SACD), which was published in 1999. As shown in Figure 2.1, all of the DVD format books include a physical layer section, which defines the physical properties of the disc, and a file system layer section, which defines how data will be stored on the disc. The DVD-Video and DVD-Audio format books also include an application layer section, which defines how multimedia data will be formatted and stored on the disc and read back by DVD-Video and DVD-Audio players to create high quality home entertainment devices.

The physical layer section for the DVD-ROM, DVD-Video, and DVD-Audio formats are the same, and define the physical properties of a read-only DVD optical-disc. The physical layer section of the DVD-R write-once format and the DVD-RAM and DVD-RW read-write formats are different since these media types are physically different from the mass-produced DVD-ROM, DVD-Video, and DVD-Audio discs.

Each of the format books allows a micro-UDF file system to be used. Micro-UDF is a new optical disc file format specification developed by the Optical Disc Storage Association (OSTA) and is designed to allow optical discs to be compatible with all major operating system software (Windows, Mac OS, Unix, Linux, etc.). The DVD-ROM, DVD-Video, and DVD-Audio format books also allow for a standard ISO 9660 file system to be used in addition to UDF. The DVD-Video and DVD-Audio format books include an application layer section that defines how video, audio, graphic, and textual information will be digitized, compressed, and stored onto the DVD disc, and how the various interactive features of the DVD-Video and DVD-Audio formats will be implemented and used.

A copy of the DVD format books can be purchased for $5,000 from:

DVD Format/Logo Licensing Corporation
Shiba Shimizu Bldg. 5F
2-3-11 Shibadaimon, Minato-ku,
Tokyo, JAPAN, 105-0012
+81-3-5777-2883 (Voice)
+81-3-5777-2884 (Fax)
http://www.dvdfllc.co.jp (Web)
A signed confidentiality agreement and full payment must be received prior to shipment of the DVD format books. It is generally not necessary for DVD authoring or production companies to purchase a copy of the DVD format books. While the format books provide all of the low level details required to completely understand and implement the DVD-Video specification, they are typically only required for companies that are developing DVD-Video players, DVD-Video decoders, or DVD-Video authoring tools. Some advanced DVD-Video title developers may find access to these format books can be beneficial in understanding nuances of the DVD-Video format, but in general this is not required.

**DVD Forum**

The DVD Forum is an organization whose goal is to promote broad acceptance of DVD products on a worldwide basis. The DVD Forum has targeted the entertainment, consumer electronics, and information technology industries as potential users of DVD technology. The DVD Forum performs the following functions.

- Defines the requirements and specifications for all DVD formats including DVD-Audio, DVD-R, DVD-RAM, DVD-ROM, DVD-RW, and DVD-Video
- Publishes the various DVD format books
- Licenses the DVD Format and DVD Logo, through the DVD FLLC organization
- Administers the DVD Verification Labs throughout the world
- Holds worldwide DVD conferences, promotes DVD through public relations activities, and maintains the DVD Forum web site (http://www.dvdforum.org)

The DVD Forum currently has 64 Principal Members and 235 Associate Members. Principal Members are allowed to participate in defining the DVD formats, and can vote at the DVD Forum general meetings. The annual fee to become a Principal Member of the DVD Forum is approximately $8,000 (1,000,000 Yen). Associate Members are provided access to the DVD Forum Technical Working Group reports. The annual fee to become an Associate Member of the DVD Forum is approximately $2,500 (300,000 Yen). Current members of the DVD Forum Steering Committee include Hitachi, IBM, Intel, ITRI, JVC, LG, Matsushita, Mitsubishi, NEC, Philips, Pioneer, Samsung, Sharp, Sony, Thomson, Time Warner, and Toshiba.

The DVD Forum currently has eight Technical Working Groups.
1. DVD-Video and Video Recording
2. DVD-ROM
3. File Format
4. DVD-Audio
5. Rewriteable (DVD-RAM)
6. Write-Once (DVD-R) and Re-Recordable (DVD-RW)
7. Copy Protection
8. Pro-Use Applications
Two of the primary technical goals of DVD are to provide both higher capacity and higher throughput than CD-ROM technology offers. All DVD formats and playback devices support a minimum throughput rate that is at least nine times faster than a conventional CD-ROM, and many DVD playback devices support even higher transfer rates. The DVD-ROM, DVD-Video, and DVD-Audio formats have storage capacities between 4.7 and 17.0 billion bytes. The variation in total storage capacity depends on the use of up to two data storage layers on each side of a DVD disc.

The DVD physical specification provides for up to four different data recording layers and two different sizes (12cm and 8cm in diameter). A single-layer, single-sided disc is referred to as a DVD-5; a dual-layer, single-sided disc is a DVD-9; a single-layer, dual-sided disc is a DVD-10; and a dual-layer, dual-sided disc is a DVD-18. It is technically possible to have a DVD disc that uses three recording layers, two on one side and one on the other. This is called a DVD-14, but is not very common.
Figure 2.2 shows how a single-layer and dual-layer DVD disc are constructed. Both single-layer and dual-layer discs are made from two distinct pieces of molded plastic that are bonded, or glued, together. For a DVD-5 disc only one recording layer is used so a reflective material is added to the middle of the disc. Then the laser can read the data stored just before the reflective material. For a dual-layer disc two data layers are recorded and separated by a semitransmissive layer. If the laser is focused on the data recorded on Layer 0, which is on the bottom of the disc, then it is reflected to the optical sensor. If the laser is focused in the data recorded on Layer 1, which is on the top part of the disc, then the semitransmissive material allows the laser to pass through and read the data on the top layer. The semitransmissive material used on most dual layer DVD discs is gold.

DVD increases capacity through the use of multiple layers and specialized lasers, which use a shorter wavelength than traditional CD-ROM devices. This means that the pits and tracks used to store data on a DVD disc can be much smaller than those used on a CD-ROM.

A traditional CD-ROM uses pits that are at least 0.83 microns long, and has tracks that are spaced 1.6 microns apart. A DVD disc uses pits that are at least 0.4 microns long, and tracks that are spaced 0.74 microns apart. The pits and tracks used in DVD are less than half the size of the pits and tracks used on CD-ROM discs.

The use of smaller pits and more closely spaced tracks on a DVD optical disc increase the total storage capacity by over 700 percent compared to a traditional CD-ROM. Figure 2.3 shows the difference between the pits and track spacing on a CD-ROM and DVD-ROM, DVD-Video, DVD-Audio, DVD-R, and DVD-RW discs.

Using multiple layers and multiple sides for data storage has increased total capacity to a maximum of 15.9 Gb on a DVD optical disc compared to just 650 Mb on a standard CD-ROM — an increase of more than 25 times the capacity.

Table 2.1 provides the relevant physical properties and storage capacities for each type of DVD disc. The DVD format books refer to the storage capacity of each type of DVD disc as Gbytes, but this term has a different meaning than the classic definition for computer Gb. In the field of computer science a byte is defined as 8 bits of data, Kb as 1,024 bytes, Mb as 1,024 Kb, and Gb is 1,024 Mb. In the DVD format books a GByte is simply defined as 1 billion
Chapter 2: DVD FORMAT SPECIFICATIONS

bytes. This is about 7.3 percent less than a computer Gb, which is actually 1,073,741,824 bytes. When working with DVD disc storage capacities it is important to keep this difference in mind.

It is also important to note that the capacity of a dual layer (DVD-9) disc is not simply double the capacity of a single layer (DVD-5) disc. Dual layer discs have a slightly larger mark pitch than single layer discs do, so a dual layer disc can only hold about 82 percent more than a single layer disc. Table 2.2 shows some of the common physical properties of DVD discs.

### Table 2.1 DVD Storage Capacity Chart

<table>
<thead>
<tr>
<th>Parameters</th>
<th>DVD-5</th>
<th>DVD-9</th>
<th>DVD-10</th>
<th>DVD-14</th>
<th>DVD-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Data Capacity (Gb)</td>
<td>4.37</td>
<td>7.95</td>
<td>8.75</td>
<td>12.3</td>
<td>15.9</td>
</tr>
<tr>
<td>12cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8cm</td>
<td>1.36</td>
<td>2.47</td>
<td>2.72</td>
<td>3.83</td>
<td>4.95</td>
</tr>
</tbody>
</table>

* Storage capacities are listed in computer Gb ($2^{30}$)

### Table 2.2 DVD Physical Parameter Chart

<table>
<thead>
<tr>
<th>Parameters</th>
<th>DVD-5</th>
<th>DVD-9</th>
<th>DVD-10</th>
<th>DVD-14</th>
<th>DVD-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Wavelength</td>
<td>650/635 nm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disc Diameter</td>
<td>12cm</td>
<td>120 mm</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8cm</td>
<td>80 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Disc Thickness</td>
<td>1.2 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disc Center Hole</td>
<td>15.0 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Area Inner Radius</td>
<td>24.0 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Area Outer Radius</td>
<td>12cm</td>
<td>58.0 mm maximum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8cm</td>
<td>38.0 mm maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User Data Bit Rate</td>
<td>11.08 Mbps</td>
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<td></td>
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</tbody>
</table>
**DVD File System Specifications**

The DVD-Video format book requires the use of a general purpose volume and file layout structure so that DVD discs can be read by a variety of consumer and computer electronics devices, regardless of the specific processor or operating system used to access the disc. The DVD-Video format book requires the use of either the ISO-9660 or Micro-UDF (Universal Disc Format) file formats for storing data on a DVD disc. The ISO-9660 format has been in use for a number of years, and most CD-ROM discs that are cross-platform compatible use this format. DVD currently implements a hybrid approach, called UDF-Bridge, that provides both the newer UDF system as well as the older ISO-9660 system used by the CD-ROM format. This allows DVD discs to be used with computer operating systems that do not have any provision for UDF support.

DVD-Video requires that data stored on the disc follow the volume structure shown in Figure 2.4. Lead-in and lead-out areas are provided at the start and end of the disc to facilitate synchronization of DVD players with the data stored on the disc. An ISO-9660 and Micro-UDF file format is used to store all data. Video, audio, subpicture, menu, and still image data elements are stored in the DVD-Video zone area of the disc. The data is logically organized into the Video Manager area, which acts as the table of contents for the disc, and up to 99 Video Title Set areas, which hold individual programs, or collections of multimedia content.

All DVD discs should be mastered to include all required data as specified by ISO 13346 and UDF. This allows the playback of DVD discs on standard computer systems that support either the ISO 13346 or UDF formats. The ISO is the International Standards Organization that sets worldwide standards for a wide variety of industries, including personal computers and consumer electronics devices. Examples of such required data include the time, date, permission bits, and a free space map (indicating no free space if ROM media). While DVD player implementations may ignore these fields, a UDF computer system implementation will not. The UDF format has many features and can be complicated, however much of the information can be ignored in a dedicated DVD player environment. Due to limited computing resources within a DVD consumer player, only a subset of the UDF format is used for storing data on the DVD disc. The following restrictions apply to using the UDF format for DVD-Video discs.

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**Tips, Tricks & Techniques**

Always refer to DVD storage capacities using the computer definition of Gb, rather than the DVD format book definition. DVD authoring and production tools are computer-based, so it is better to keep track of storage capacities and requirements by using the computer convention for Gb. An easy way to convert between DVD bytes and computer bytes is to multiply DVD storage sizes in billion bytes by 0.932 to get the correct computer storage size in Gb.
• DVD-Video files should be stored in a subdirectory directly under the root directory. The directory name should be Video_TS.

• DVD-Video file names should consist of the characters A-Z (upper case), 0-9 (digits), _ (underscore), and . (period). Not more than one . should be used in a file name.

• Maximum compatibility will be ensured if the DVD-Video file names consist of no more than eight characters, optionally followed by a ., optionally followed by no more than three characters.

• There should not be any files in the DVD-Video directory that differ only by case (i.e., Movie and movie cannot coexist).

• DVD-Video authoring systems should constrain individual files to less than 1 Gb.

All these constraints apply only to the directory and files to which the DVD-Video player needs access. There may be other files and directories on the DVD disc that are not intended for the DVD-Video player and do not meet the listed constraints. Files outside the Video_TS directory, as well as files in the root directory, are ignored by the DVD player.
Copies of the UDF Specification can be obtained from:

Optical Storage Technology Association
311 East Carrillo Street
Santa Barbara, CA 93101
(805) 963-3853 Voice
(805) 962-1541 Fax
ray@osta.org (E-Mail)
http://www.osta.org (Web)

Most DVD authors and producers will not need to know the details of how the volume and file information is stored on a DVD disc. The authoring tools you'll use to create the DVD disc image will handle all the nuances of creating a valid DVD volume and file structure. However it is helpful if DVD authors and producers understand the file naming conventions used on DVD discs, and what each file is supposed to do.

All the files required for a DVD-Video title are stored in a directory called Video_TS in the root of the DVD disc volume. Within this directory there will be a number of files with three different types of extensions. Figure 2.5 shows the directory and file structure of the StarGaze disc.

Figure 2.5    DVD-Video File Structure

Files that end with the .ifo extension are information files that describe the content stored in the DVD-Video zone of the disc and how that content can be accessed directly. Files that end with the .bup extension are backup copies of the .ifo files with the same name. Files that end in the .vob extension are Video Objects that contain all the still images, video streams, audio streams, subtitle streams, and menus that are included on the disc.
Chapter 2: DVD Format Specifications

**DVD-Video**

DVD-Video is a read-only optical-disc format that can be used for the interactive playback of high quality video, audio, and graphics content. The DVD-Video format allows consumers to playback full-length motion pictures as well as interactive games with higher quality than traditional VHS, SVHS, CD-i, and Laserdisc playback systems. The DVD-Video format can deliver full screen, full motion video at a resolution of 720 × 480 pixels per frame and a frame rate of 30 frames per second for NTSC countries, or 720 × 576 pixels per frame and a frame rate of 25 frames per second for PAL countries. Video quality delivered by a DVD-Video player has the potential to be as good as the original broadcast source tape.

The DVD-Video format supports extremely high quality audio using either Dolby Digital 5.1 channel surround-sound, linear PCM encoded audio, DTS surround sound audio, or Sony SDDS surround sound audio. Each of these digital audio formats provides significantly better quality than traditional Audio-CD devices. The DVD-Video format also provides the capability of storing up to eight different audio tracks that are all synchronized to the digital video stream.

The DVD-Video format supports up to 32 subpicture streams used for subtitles, closed captioning, graphical overlays, and even simple animations. Each subpicture stream is synchronized to the video and audio streams so that a wide variety of multimedia elements (video, audio, graphics, text, and animation) can be delivered to the user in a coherent fashion. The DVD-Video format can also deliver high quality still images that can be displayed for a fixed period of time, or until a user input is received.

The DVD-Video format supports a wide range of functions that enable the user to control and interact with the DVD-Video title. Simple functions such as start, stop, pause, fast forward, and reverse are provided so the user can control the playback of a title in a manner similar to a VHS, SVHS, or Laserdisc system. In addition to these simple interactive features, DVD-Video provides random access to all of the data on the disc, allowing the user to jump to any portion of the title in less than one second. Finally the DVD-Video format provides high-level interactive functions that allow the development of titles that ask the user to respond to questions, or to provide interactive menus to determine how the user wishes to view the title.

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**Real World Example**

*StarGaze* is a “hybrid” DVD title with features designed for both DVD-Video players as well as personal computers with DVD-ROM drives. Place the *StarGaze* disc into a DVD-ROM drive and look at the files and directories on the disc. You will notice that most of the capacity of the disc is used by files in the `Video_TS` directory. This is where the data is stored for the DVD-Video portion of the title. There are also ten files in the root-directory used to install a Windows screen saver program. DVD-Video players ignore these files.
Video, audio, subpicture, still image, and control data are all multiplexed together within a DVD-Video title to form a single bit stream that can be decoded by a DVD-Video player in a manner that provides seamless transitions between different video scenes, language tracks, or subpicture streams. DVD-Video data has the following logical structure, as shown in Figure 2.6.

**Title**  The Title area provides the ability to have up to 99 titles or episodes on a single disc. Titles can consist of a single program chain or multiple program chains. A title is typically used to store an entire movie or any items of content that can stand on their own.

**Program Chain**  A collection of programs that are logically grouped together based on the content. Generally a movie is stored in a single program chain, while different episodes of a television series would be stored in separate program chains.

**Part_of_Title**  Links to one or more programs. Part_of_Title can be used to support different versions of the title. For example if you developed a DVD for a movie that had several different endings, you would create a Part_of_Title for each unique ending. The Part_of_Title would call out the specific programs used in each variation of playback.

**Program**  A collection of cells that are logically grouped together based on the content. Programs are usually used to identify different chapters within a movie.

**Cell**  A collection of video or audio data packets that are logically grouped together based on the content. Cells are usually used to identify different scenes within a chapter.