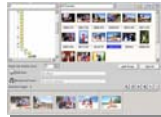


DVD Fundamentals



Douglas Dixon
Manifest Technology® LLC



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www.manifest-tech.com

Making Sense of DVD

Consumer, Computer, Products, Formats

- **DVD Concept**
 - Convergence Media
- **Consumer DVD - On the set-top**
 - Players, Recorders
- **Prerecorded Formats**
 - DVD-Video, DVD-Audio, VCD
- **Recordable Formats**
 - R/RW, dash/plus -- Compatibility
- **Desktop DVD - For computers**
 - Burners, Players
- **DVD Trends and Futures**
 - Re-Edit, Web DVD, WMV HD, HD DVD



DVD Breakout Success



DVD is the fastest selling consumer electronics product of all time

- **DVD players in half of US homes by the end of 2003**
 - Estimate 2/3 by end of 2004
 - 90M playback devices in US homes (1/3 owners have multiple)
(set-top players, DVD-ROM drives, game machines)
- **Sales increased another 34% in 2003**
 - Shipped 30M players in first 5 years (CD 8, VCR 13)
 - DVD sales surpassed VCRs in Sept. 2001
 - U.S. 2003 - 34M players, 1B titles
- **Home video is the most popular entertainment medium**
 - U.S. - Movie tickets, video games, music, mass-market books
 - DVD & VHS outsold movies 2X in 2002 & 2003

(DVD Entertainment Group, 2/2004)

What is DVD?

- **Disc Format**
 - Bigger, better optical disc: 4.7 GB
 - Convergence: Hollywood & Computer
- **Consumer Electronics Product**
 - Huge success
 - Movies and Music, DVD-Video
 - Set-top DVD Recorders
- **Computer Data Format**
 - DVD Recordable, Burners & Software
- **Digital Video on the Desktop**
 - Fulfillment of digital media promise
 - End to end, all digital, full quality
 - Camcorder DV input -> DVD output



DVD as a Disc Format

Designed for Consumer and Computer

- **Bigger, better optical disc**
 - Same form factor as CD - 6-7X larger
 - 4.7 BB single-sided
 - Mini / Half-size, Dual-layer, Double-sided
- **Convergence format: Computer and Hollywood**
 - Movies, audio with high quality, surround sound
 - Computer data files
 - Prerecorded and recordable
- **Set-top to Desktop, and back**
 - Prerecorded movies, play on computer
 - Burn on computer, play on set-top



DVD as Convergence Media

- **Hollywood / Recording Industry**
 - High picture quality, better than laser disc
 - 5.1 channel high-quality sound
 - 2+ hours of recording
 - Multi-aspect ratio, Multiple languages, subtitles
 - Copy protection, Parental lock features
 - Low cost for drive, media
- **Computer Industry**
 - Unified format for AV & PC
 - Backward CD read compatibility, No mandatory cartridge
 - Write-once and rewritable
 - Single file system for all content, disc types
 - Random-access, high reliability
 - High capacity, Future capacity expandability
 - High performance for both sequential, nonsequential data
 - Low cost



DVD for Consumer Electronics



DVD Players

- Under \$50
- CD Audio, MP-3, Win Media



DVD Recorders

- Under \$200
- R, RW/RAM + Hard disk



Portable DVD Players

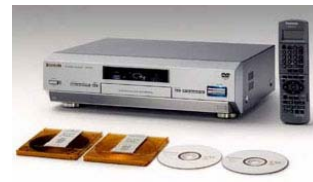


DVD Camcorders- - Mini DVDs

Set-Top DVD Recorders

Digital VCR – Plus Video Transfers

- **Digital Video Recorder**
 - Record off-air TV, like VCR
 - Analog input: VCR, camcorder
 - FireWire input: DV digital
 - Local hard disk; TiVo
- **Multiple Formats**
 - R – Read-only
 - Permanent, more compatible
 - RW / RAM – ReWritable
 - Temporary, re-use in recorder
 - Edit menus and clips
 - VR – Video Recording – formats



DVD vs. Tape

High Quality, Digital Copies, More Accessible

- **Higher quality video and sound**
 - Video resolution, sharpness, colors
 - Surround sound, multiple channels
- **Can play without degrading quality**
 - Exact digital data
 - Analog tapes wear out, degrade
- **Optical media lasts 25 - 100 years**
 - Tape lasts 10 - 30 years, more delicate
- **Interactive navigation**
 - Menus with thumbnails, jump direct to clip
 - Skip between chapters
- **Accessible**
 - Set-top or computer



Prerecorded DVD Formats

Manufactured Disc Products

- **DVD Forum**
 - Industry consortium, 200+ members
 - Physical and Logical formats
- **DVD-ROM - Read-Only**
 - Manufactured – Prerecorded
- **DVD-Video - Movies**
 - Movies, surround audio, multiple tracks
 - Menus, navigation
- **DVD-Audio**
 - Multi-track, surround-sound
 - Audiophile
- **Multiple disc sets, Dual Disc**



Prerecorded Formats – DVD-Video

High Quality, Multiple Streams, Interactivity

- **Full-quality, digital video and audio**
 - MPEG-2 video
 - Dolby Digital Surround AC-3 audio
- **Advanced interactive features**
 - Menus, interactive navigation, seamless branching
 - Alternate video camera angles
 - Multiple audio tracks, Subtitles
- **Copy protection**
 - Region code, Macrovision analog
 - CSS encryption, Parental controls



DVD-Video Features

Movies on DVD



- **Navigation**
 - Video: Up to 9 camera angles
 - Audio: Up to 8 language tracks, com
 - Subtitles: Up to 32 tracks, karaoke
- **Full-Quality Video**
 - NTSC: 720 x 480, 29.97 fps
 - PAL: 720 x 576, 25 frames/sec
 - 4~8 Mbps CBR or VBR (Constant/Variable Bit Rate)
 - Aspect Ratio Standard 4:3 & widescreen 16:9 – Anamorphic
- **Surround Audio**
 - Linear PCM: 16-24 bits, 44.1, 48, & 96 KHz
 - Dolby Digital: 2-channel or full 5.1 surround (AC
 - MPEG, DTS, SDDS



Prerecorded Formats - DVD-Audio

Audiophile Alternatives

- **DVD-Audio**

- Higher-quality PCM audio
- Multi-channel surround sound
- Menus, navigation, multimedia
- Dashboard to universal players



- **Super Audio CD (SACD)**

- Sony and Philips, for audiophiles
- Dual-layer with CD



SUPER AUDIO CD

- **Dual Disc – End 04**

- Double-sided: CD album, 2nd DVD side
- DVD-Audio w/ album in high quality sound
- Plays anywhere: Plus DVD extras



DVD Disc Sizes

Sides and Layers

- **Form factor same as CD**

- 120 mm / 12 cm
- 4.7 BB single-sided
- (CD originally 640 MB, 7x)



- **Mini / Half-size**

- 80 mm / 8 cm
- 1.4 - 2.8 BB ss / ds

- **Mastered DVD Formats**

- DVD-5 - 4.70 BB - Single-sided
- DVD-9 - 8.54 BB - Dual-layer
- DVD-10 - 9.40 BB - Double-sided
- DVD-14 - 13.24 BB - 2 Sides, 1 & 2 Layers
- DVD-18 - 17.08 BB - 2 Sides, 2 Layers

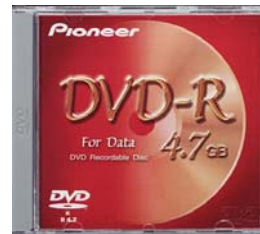


DVD Mathematics

Counting Billions ...

- **“Billions of Bytes” of Capacity ...**
 - Optical media is measured in powers of 10
 - Magnetic media is measured in powers of 2

 - BB = Billion bytes, billion decimal (1000^3 or 10^9)
 - GB = Gigabytes, billion binary (1024^3 or 2^{30})
- **“4.7 GB” DVD is Actually “BB”**
 - $4.7 \text{ BB} = 4.377 \text{ GB}$
 - 93.13 % smaller
 - or 323 MB !



Dual-Layer (DL) Recordable

Burn 8.5 GB

- **Same 8.5 GB capacity as DVD-9**
 - “Double Layer” = “Dual-Layer” – vs. “Dual” format (-/+)
 - Great for DVD-9 authoring – check discs
 - Compatibility issues with initial products
- **DVD+R DL shipped 2H 2004**
 - Verbatim media: ~ \$4-\$8 (vs. \$1)
 - Sony burner: “DVD+R Double Layer / DVD+-RW Drive,” < \$200
 - DVD-R DL coming (DVD Forum)
- **DL Issues**
 - Compatibility issues with initial products
 - Layer break: Physical break, auto or manual, chapter within clip
 - Balance data: Write same amount to both layers, finalize



Video CD / Super VCD

DVD (sort of) on CD

- **VCD - Video CD**
 - 74 min., VHS-quality
 - MPEG-1, 352 x 240, ~ 1.2 Mbps
 - Popular in Asia
- **SVCD - Super Video CD**
 - 35+ min., near-DVD quality video
 - MPEG-2, 480 x 480, VBR, 1 - 2.4 Mbps
 - Interactive menus
- **DVD on CD**
 - Full DVD format on CD
 - ~ 18 min. at 4 Mbps
 - Limited player support



Recordable DVD Formats

“Format War”

- **DVD Forum: Original Formats (“Dash”)**
 - 230+ members
 - Logical & physical formats, 4.7 GB size
 - DVD-ROM, DVD-Video, DVD-Audio
 - Recordable: DVD-R, DVD-RW, DVD-RAM
 - Pioneer (DVD-R), Panasonic (DVD-RAM)
 - www.dvdforum.com
- **DVD+RW Alliance (“Plus”)**
 - HP, Mitsubishi / Verbatim, Philips, Ricoh, Sony, Yamaha, Dell, Thomson / RCA
 - Recordable: DVD+RW, DVD+R
 - www.dvdrw.com



Recordable Formats

Bigger, Faster CDs

- **DVD-R** – Recordable, Write once
 - Best compatibility: existing set-top players
- **DVD-RW** - ReWritable, Rerecordable
 - Write & bulk erase to reuse
 - Overwrite 1000 times, last 30 - 50 years
- **DVD-RAM** - Random access
 - Like hard disk, Write over 100,000 times
 - Error correction & defect management
 - Not compatible, uses caddy



Recordable Formats / “Plus”

Alternate Recordable Formats

- **DVD+RW Alliance** (“Plus”)
- **DVD+RW** - ReWritable, Rerecordable
 - Designed later
 - Aimed for high compatibility
 - Efficient ReWritable
- **DVD+R** - Recordable
 - Added later for write-once option
 - Write once, Better compatibility than RW
 - Shipped mid 2002



DVD Compatibility - Tests

Independent Testing

- **Ralph LaBarge - DV Magazine, June 2003, July 2002**

- Set-top player compatibility testing
- Large variation between manufacturers and brands
- Things are getting better

Format	Compat.	Range
DVD-R for Authoring	96%	(3.95)
DVD-/+R	87%	67 - 100%
DVD-/+RW	83%	73 - 87%

- **DVD Compatibility Comm. - NIST, OSTA, DVDA (1/04)**

- DVD-ROM drive compatibility testing, Physical testing
- Compatibility improving: Drives since 2002
- No difference between dash / plus, R / RW
- Huge difference between manufacturers and brands
 - R 8 – 82%, RW 27 – 73%

About DVD Compatibility

This is not a VHS vs. Beta Issue !
 DVD is all about read compatibility
 Competition is for recording formats



- **Products are improving – like early CD**

- Disc manufacturing, player design
- Will be more compatible in the future

- **Stay with known brands**

- DVD format matters - R more consistent
- Media brand matters - record off-brand at slower speed
- Player make and model matters - test compatibility



- **Can create highly compatible discs – today**

(Just not any arbitrary disc on arbitrary player)

Choosing DVD Formats

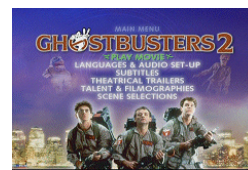
Like CD-R, CR-RW

- **Recordable Formats**
 - R - For permanent copies, more compatible
 - RW - Interim copies, less compatible
 - RAM - Local storage, set-top, data, not compatible
 - VR - Set-top players
- **R vs. RW Is Not The Issue**
 - CD-RW is almost never used today
 - Prices of CD-R low enough to use for everything
 - DVD-R is already under \$3, to \$1
- **RW / RAM Has a Niche**
 - Computer backup and Video test discs
 - Set-top recorders
 - Need to be aware of compatibility issues



DVD on the Desktop

- **Success of DVD-Video**
- **Sanity in DVD Format Wars**
- **Affordable Burners & Media**
- **Enhanced DVD Players**
- **Wide Selection of Authoring Tools**



DVD Burners

Desktop DVD Recording

- **1998: Burner \$17K (SCSI)**
 - Media \$50 (3.95 BB), DLT \$4K
 - Software \$10K's
- **June 2000: Burner \$5400**
 - Media \$35, Software to \$129
- **Jan. 2001: Pioneer DVR-103 \$1K**
 - DVD-R for General media
- **Today: Under \$100**
 - Internal, External: SCSI -> FireWire, USB
 - DVD-R media dropping under \$2, to \$1
- **Dual Format burners: dash/plus**



DVD Software Players

Enhanced Playback on Computers

- **Apple DVD Player**
- **Windows XP Media Player**
 - Requires DVD/MPEG and MP3 Plug-Ins
- **CyberLink PowerDVD**
- **InterVideo WinDVD**
- **Sonic CinePlayer**
 - Enhanced playback
 - Explore navigational structure
- **InterActual Player / PC Friendly**
 - Enhanced DVD / WebDVD (Sonic)



DVD Player Interfaces

Windows XP Media Player



CyberLink PowerDVD



Full-Screen Playback

InterVideo WinDVD



DVD Player Features

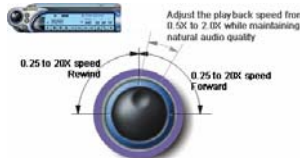
Enhanced Experience

- **Navigation**
 - Explore: Title, Chapter lists
 - Fast / reverse scan, with audio
 - Playlist: MPEG, video files

- **DVD Features**
 - Audio / video tracks
 - Multiple subtitles

- **Video**
 - Full-screen, Deinterlace
 - Digital zoom, Pan

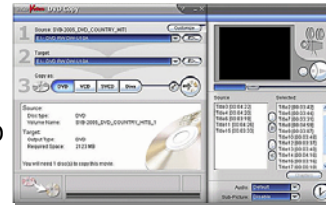
- **Audio**
 - Multiple tracks, Karaoke
 - Surround sound, Dolby headphone



DVD Trends & Futures: Re-Edit

Copy/Rip and Re-Edit DVD: DVD is the Project

- **Copy / Rip from DVD**
 - Commercial products (not CSS-encrypted discs)
 - Extract movies, features; Merge multiple discs
 - Select titles, audio/subtitle tracks
 - Rip to hard drive: MPEG-1/2, DivX
 - Re-compress
 - DVD to VCD/SVCD
 - Dual-layer to recordable DVD, to DivX CD
- **Re-Edit on DVD**
 - Bridge set-top and desktop (-/+VR)
 - Re-edit on RW (defrag), R (unfinalized)
- **Dual-Layer Recordable - 8.5 GB**



DVD Trends & Futures: Web DVD

Interactivity - Enhanced / Web DVD

- **Broadband Experience**
 - Local content + dynamic updates
- **Local content**
 - DVD video + HTML information
 - Activities and games
- **Web content**
 - Associated Web site
 - Dynamic updates, Group
- **InterActual / PC Friendly**
 - Player on 70M DVDs
- **Sonic eDVD**
 - Hook DVD folders, \$199



DVD Trends & Futures: WMV HD

Windows Media High Definition Video

- **Microsoft Windows Media 9**



- High definition - up to 1080p
- Full HD movie on single DVD
 - Digital Rights Management (DRM)
- Terminator 2: T2 - Extreme Edition (6/03)
 - 1440 x 816 (1920), 5.1 channel surround
 - 6.8 Mbps in 6.5 GB
- Windows Media support
 - Accepted at Sundance, installed in Landmark theatres
 - WMA/V supported in 500 devices



- **Sonic DVD Producer – WME – WMV HD Edition**

- Authoring - \$12,999

MPEG-4 on DVD

Playback on CE Devices

- **DivX Networks**



- Core DivX video codec over 120 million users
- DVD quality at 10X compression of MPEG-2
- 20 million DivX Certified DVD players end 04
- 2005 – HD DVD players, DVD recorders, DVRs, digital cameras, portable media players, set-top boxes, network-connected devices



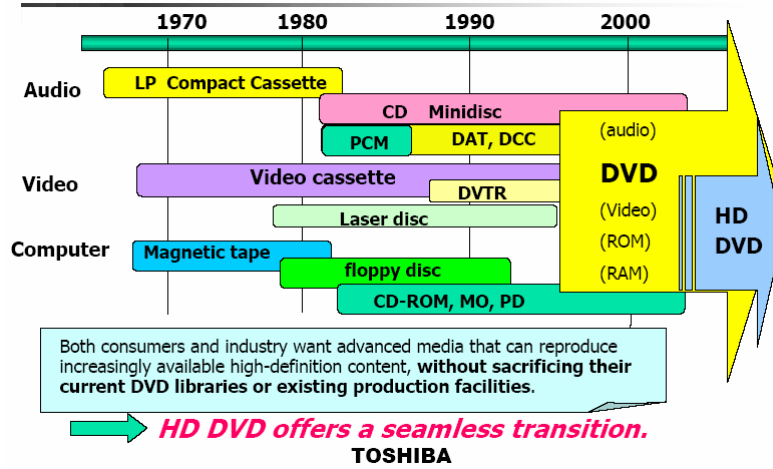
- **Nero Digital**



- Standards: MPEG-4 Simple & Advanced profiles, AAC
- DVD quality in 20% of the space
- DVD-like: 2 audio streams, subtitles, chapters
- HDTV profile next generation



Trends in Media: High-Def DVD



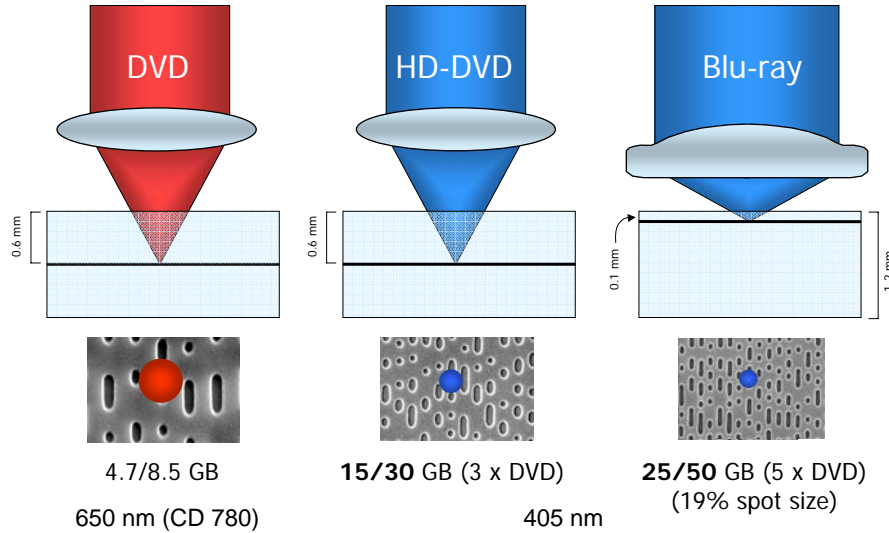
End of format stability: DV for acquisition, DVD for delivery
Consumer and professional, Set-top to desktop, CE to PC

Path to High-Capacity DVD

- **Backward Compatible**
 - Same disc form factor: CD + DVD + HD
 - Floppy 1 MB -> CD 650 MB -> DVD 4.5 GB (7X)
- **Higher Capacity – Blue Laser**
 - 2 hour HD movie per side (w/ layers)
 - Blue-violet laser: shorter wavelength
- **Better Compression**
 - Video: MPEG-2, MPEG-4 AVC, WMV (VC-1)
 - Audio: Dolby Digital+, DTS-HD, MLP lossless ...
- **Next-Gen Product**
 - Playback and Record: Unlike original DVD
 - Next-Gen Authoring: Video + Interactive (Java)



Increase Density: Red to Blue Laser



High-Def DVD Formats

- **HD DVD**

- 3X DVD - 15 / 30 GB SL/DL
- DVD Forum - AOD (Advanced Optical Disc)
Toshiba, NEC - Memory-Tech, Sanyo, Thompson
- Less aggressive, closer to DVD manufacturing
- www.hddvdprg.com



- **Blu-ray Disc (BD)**

- 5X DVD - 25 / 50 GB SL/DL
- BD Assoc (100+): Sony, Panasonic (Matsushita)
CE - Hitachi, LG Electronics, Mitsubishi, Pioneer,
Philips, Samsung, Sharp, Thomson
- PC - Apple, Dell, Hewlett-Packard
- Studios - Fox, Disney; Media - TDK
- More capacity: 2/3 more
- www.blu-raydisc.com



Another Format War




- **Studio Support (DRM)**
 - HD DVD: / Paramount (Viacom – CBS, MTV)
Warner Bros & New Line (Time Warner – HBO)
Universal (GE – NBC) – not exclusive
 - Blu-ray: Sony / Columbia & MGM
Disney & Buena Vista; EA, Vivendi Univ. Games



- **Products Coming to Market**
 - Extensive test manufacturing
 - BD on market: Consumer and ProData
- **VHS vs. Beta Again, Not DVD +/-**
 - Unlike DVD, Need compatible burner and player
 - Maybe multi-format players (vs. recorders)?

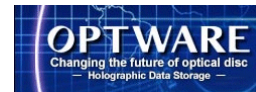
High-Def Reality



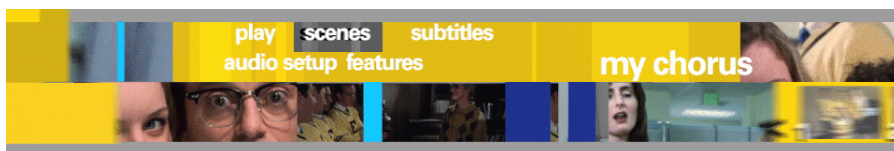
- **Advanced Access Content System (AACs)**
 - Manage content stored on next generation of prerecorded and recorded optical media, for consumer use with PCs and CE devices
 - **Hard Coat - Fingerprint Resistance**
 - **Playback Compatibility - HD/DVD/CD pick up**
- 
- **Professional Blu-ray Products**
 - Sony ProData, XDCAM HD camcorder, Blu-ray recorder
 - **Replication Lines: Cycle time, Yield curve**
 - **HD DVD Products: Toshiba, Sanyo, Thomson, NEC**
 - Releases: ~ 90 Titles – Paramount, Universal, Warner

More High-Def DVD Formats

- **EVD – Enhanced Versatile Disk – China**
 - Red laser DVD – 9 & 16 GB DL (25 & 48 GB blue later)
 - MPEG-2 video, Coding Technologies audio
- **FVD – Forward Versatile Disc - Taiwan**
 - Red laser – 5.4 & 9.8 GB SS/DL (720) to 6 & 11 GB
 - Next generation over 15 GB (1080i)
 - Microsoft WM Video 9 and WMA 9 Pro
 - Royalty 10¢ vs \$2.50 MPEG-2, 25¢ MPEG-4
- **Many Layers**
 - Hybrid Dual-Layer: HD DVD + DVD; Quad-layer BD
 - VMD – Versatile MultiLayer Disc
 - New Medium Enterprises; MPEG-2, 1080i/p HD
 - Red laser – Multiple layers – 5 GB each – 20 - 40 GB
- **Holographic**
 - Optware – HVD – Holographic Versatile Disc
 - 300 GB to 3.9 terabytes on single DVD
 - InPhase – Tapestry Holographic Drive
 - Maxell; 300 GB to 1.6 TB – OEM 2006



HD Authoring for High-Def DVD



- **Advanced Interactivity and Communications**
 - Motion and interactivity
 - Remove modal constraints and limitations
- **Video layer – HDMV – High Definition Movie mode**
 - Like today's DVDs – video, menus, navigation
 - Can author with extensions of today's tools
- **Interactive layer / mode – BD-J – Java platform**
 - BD-J – Java programming environment
 - HD DVD – Declarative markup (XHTML+CSS+SMIL) + JavaScript
 - Communications to external CE & PC devices, Internet

References



- References
- Glossary
- Software Gallery

- **Books**

- “Desktop DVD Authoring” – Douglas Dixon - tools
- “DVD Demystified” - Jim Taylor - technology
- “DVD Authoring and Production” - Ralph LaBarge



- **Magazines**

- DV, Camcorder & Computer Video

- **Online**

- DVD FAQ - Jim Taylor - www.dvddemystified.com
- Video Help - www.videohelp.com (www.vcdhelp.com)

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For More Information



The Manifest Technology site by Douglas Dixon contains over 150 articles and technical references on multimedia technology, especially digital video editing and DVD authoring.



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