

**CD-i FAQ
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0. About this CD-i FAQ

0.1 What's the goal of this CD-i FAQ?

This FAQ has been written in early 2000 to answer most of the questions that are still being asked by a lot of people about the Compact Disc Interactive system. There are other sites and FAQ lists about CD-i available on the web, but most of them are incomplete or even contain inaccurate information. This FAQ tries to clear up most of the myths about CD-i that go around. Furthermore, it is a tribute to what I feel is the most important new technology that was ever introduced onto the multimedia market.

0.2 Who wrote it and who maintains it?

This CD-i FAQ was written and is maintained by Jorg Kennis. Jorg, who is currently studying interactive technologies in The Netherlands, closely followed the CD-i development process during the late 80s and 90s and was actively involved in demonstrating the system for Philips in The Netherlands in the early 90s. Furthermore, he wrote articles about CD-i for various magazines and web sites, he created CD-i software and he wrote evaluations and recommendations for Philips' new CD-i hardware and software products. Today, Jorg maintains all activities of the New International CD-i Association at www.icdia.org, continuing support to the thousands of active CD-i users and developers.

0.3 Who helped along the sidelines?

This CD-i FAQ could never have been written if it weren't for dozens of people who shared their knowledge with me over the past years. Of course there were the guys and girls at Philips Interactive Media Systems in Eindhoven, The Netherlands, who introduced me to the system. Among them were Gerard Smelt, Frans Speijer, Peer Custers, Loek Sanders and many others. And then of course there are two close friends of me, Stefan Peters and Wouter Robers, which whom I discovered nearly all of CD-i's great features in the early years. Over the years, I met a lot of other passionated CD-i enthusiasts, who shared my love for the system. We mainly used the Internet to discuss the system and its features. Among those guys were Bo Raun Nielsen from Denmark and Stephane Cazat from France. This FAQ was also inspirated by an early version of the CD-i FAQ once made by Erik Eiselstadt, and the CD-i FAQs from Philips Interactive Media of America and the International CD-i Association. My warm thanks to all of you!!

0.4 How can I contact the author?

If you have any comments, questions or suggestions, please do not hesitate to contact me at jorg.cdi@kennisonline.com. Please refer to the contact page at the New International CD-i Association website at www.icdia.org for more information on how to reach me by other means such as fax or ICQ.

0.5 What's the official status of this FAQ?

There is none! This FAQ is entirely non-official. It is not endorsed nor supported by Philips or any other company. All of the opinions mentioned in the FAQ are solely mine. I do not guarantee correctness, nor will I be responsible for any consequences occurred from the usage of information in this FAQ. Although this FAQ is mirrored at various locations within the Philips web site (such as at Philips System Standards & Licensing), the latest version can always be found on my web site at www.icdia.org/faq/. Look for the revision date on the FAQ index page.

1. The CD-i system

1.1 What is CD-i?

CD-i is short for Compact Disc Interactive. It is an interactive multimedia system combining moving and still video, audio and program content on a compact disc, which can be played back in a dedicated CD-i player. A CD-i player is a stand-alone device, consisting of a CPU, memory and an integrated operating system. It operates on its own and it can be connected to a standard TV-set for displaying pictures and sound, and optionally to a stereo-system. All system interactivity is generated by positioning a cursor using an X/Y pointing device (such as a remote control with a pointing device or a mouse), and clicking options using one of the two provided action buttons.

1.2 Who invented CD-i?

CD-i was jointly developed by Philips Electronics NV and Sony Corporation in the mid 80s. Together, both companies defined CD-i's basic specifications in what is known as the Green Book. They decided to use the well-tested OS-9 operating system from Microware Systems Corporation, which was designed for embedded, real-time applications. Microware was also heavily involved in the CD-i design process. Eventually, Philips took the biggest part in the development process, being responsible for at least 90% of CD-i's development.

1.3 Is CD-i proprietary?

Developers of CD-i software do not need a license, from a software point-of-view, CD-i is an open standard. Of course, as with all CD-types, the normal CD-pressing license fees need to be payed, but this is to be taken care of by the CD pressing plant. Manufacturers of CD-i (compatible) players need a license from Philips and Microware.

1.4 What is the Green Book

Green Book is the informal name of the Compact Disc Interactive Full Functional Specification, as laid down by Philips, Sony and Microware. It is named after the green cover of the book, and it is in line with the other CD-systems which also bear their own "color"-identification (such as red for CD-Audio, yellow for CD-ROM and white for Video-CD). It sometimes also referred to as FFGB or Full Functional Green Book. The Green Book consists of the CD-i specification and the Microware OS-9 2.4 Technical Manual. In contrast to other CD-systems such as CD-Audio and Video-CD, the Green Book not only specifies the disc-format of the system, but also the playback-device including the required CPU and operating system are extensively specified.

1.5 What versions of the Green Book are available?

In essence, there is only one Green Book. However, some minor additions, changes and fixes have been applied over the years (as is the case with the original CD-Audio specification!). When we do not count early "pre-release" versions, the first version of the Green Book is dated September 1990. The first major revision is the March 1993 edition, which included Chapter 9 (the CD-i Full Motion Video extension). The latest version dates back from March 1994.

1.6 Where can I get a copy of the Green Book?

The Green Book is no longer available in print but only as a digital file on CD-ROM at a price of US\$ 150. Licences and copies of the Green Book are available from Philips System Standards and Licensing (www.licensing.philips.com). As a hardware or software developer, you can subscribe to receive all Philips CD standards including updates for a period of 5 years for US\$ 5000.

1.7 Will any CD-i disc play on any CD-i player?

In general: yes. This is one of the beauties of the CD-i system. Since both disc and playback device are extensively specified, every CD-i disc is compatible with every CD-i player, in contrast to a CD-ROM disc, of which you never know whether it will play on your PC-configuration. Look for the CD-i logo on both disc and player to ensure compatibility. Please note that it is possible for both software and hardware manufacturers to include additional features which are not part of the basic CD-i specification. Discs which are designed for these extensions (such as a Digital Video cartridge, keyboards or modems) will play on standard CD-i players, however they will lack the additional functionality. At least, they must display a message indicating that additional hardware is required to play the disc.

1.8 What's a Base Case player and a Base Case disc?

Every CD-i disc or CD-i player which conforms to the minimal demands as set by the Green Book is called Base Case. This means that a Base Case title plays on every CD-i player, and that a Base Case player will play only Base Case discs. When a title uses an extension to the standard specification, such as implementing Digital Video, it is no longer considered a Base Case title, since it is not ensured that this disc will play on all players. It must however be able to start up and display a message.

1.9 Does CD-i support Full Screen video?

The basic CD-i specification allows a CD-i player to display full screen animations in 128 colors over a 16.7 million color background, or play partial screen moving video in a lower framerate in 16.7 million colors, both with accompanying sound. However, these capabilities are extended when a Digital Video cartridge is placed in the player. In this case, the player is able to display full-screen, full moving 30 fps video in 16.7 million colors according to the MPEG-1 standard. Although Digital Video is not a part of CD-i's basic specification, it is generally considered to be a "must-have" extension to a CD-i player since it adds an enormous audiovisual performance boost to the system. Digital Video is specified as an optional extension in chapter 9 of the Green Book.

1.10 What disc types can be played on a CD-i player?

In general, a CD-i player only plays discs that incorporate a dedicated application program that was designed for CD-i's operating system and hardware components. For some disc types, such as Video-CDs, Photo-CDs and CD-BGM, this CD-i application is a mandatory part of the disc's specification. This means that in order for a Video-CD to bear the Video-CD logo, it must contain a CD-i application, and it must be able to be played back on a CD-i player. Next to this, the CD-i standard requires the player to be able to play back standard CD-Audio discs. Most players (including all Philips consumer models) are able to display the graphic contents of CD+Graphics discs, although this is not a requirement of the CD-i standard.

In conclusion, a CD-i player plays CD-Audio, CD-i, CD-BGM, CD-ROM/XA Bridge discs like Photo-CD and Video-CD, and most of them play CD+Graphics as well. Please refer to section 5 (Disc Types) for more information on the various CD systems that can or cannot be played on CD-i.

1.11 What are the advantages of CD-i over PC-based interactive systems?

CD-i has various advantages over PC-based interactive systems, of which the most important are:

- Cost. To build a PC with the same audiovisual performance and functionality, you need at least to spend double or triple the cost of a CD-i player.

- Compatibility. Every CD-i disc is compatible with every CD-i player. There are no "system requirements". A content-provider can be sure that its disc can be played without troubles, without worrying about the type of display-adapter, sound card, version of the operating system, screen resolution, CD-ROM drive speeds, drivers, hardware conflicts, etc.
- Ease-of-use. A CD-i player and its software are very easy to use. Just pop-in the disc and you're gone. No need of setting up the software, adjusting the hardware or other complex installation procedures. Besides this, CD-i's easy pointing-device interface allows it to be virtually fool-proof.
- TV-based. CD-i can be connected to any TV set and stereo-systems, which allows it to be used virtually everywhere. As an additional advantage, it has a TV-style look-and-feel, making it a far more comfortable system for many people to use over a PC.
- Worldwide standard. CD-i is a worldwide standard, crossing the borders of various manufacturers and TV-systems. Every disc is compatible with every player, regardless of its manufacturer or the TV system (PAL, NTSC or SECAM) that is being used.

1.12 How is CD-i related to other TV-based interactive systems?

In the early nineties, several other TV-based interactive playback devices using a CD as their main storage device existed. They were sold by different companies trying to pick a share of the market. Some of them were clearly based on all CD-i marketing techniques, others choose a slightly different approach.

The most important of them were:

- 3DO. Game/children's device designed by The 3DO Company, and build under license by Panasonic and Goldstar.
- CDTV. Commodore Dynamic Total Vision. An interactive videoplayer based on Commodore's Amiga technology. The player was built by Matsushita and sold by Commodore and included a caddy-loading CD drive. A later version was called CD32, which had slightly improved hardware.
- VIS. Video Information System. Sold by Tandy, based on a PC-architecture (80286) using a Microsoft operating system.

None of these formats were interchangeable. 3DO played Photo-CDs, 3DO and CDTV/CD32 played CD+Graphics and 3DO and CD32 could be expanded with a Video-CD add-on. None of these devices managed to gain a market share comparable to CD-i, and none of them were ever used in professional applications, unlike CD-i. They all quickly disappeared from the market.

Currently, there are too some TV-based disc systems which are used in "CD-i like" applications. One of them is M2 by Panasonic, which is an interactive player based on 3DO-technology (but they do not mention that!) incorporating a CD or DVD drive. The unit never gained much popularity. And of course there is DVD-Video. Standard DVD-Video provides some interactive features, but lacks the degree of interactivity that is offered by CD-i. For more information refer to: 11.9 What good alternatives are there for CD-i in the professional field?.

1.13 What is the official CD-i logo?

The official CD-i logo is the Compact Disc trademark with the word Interactive in a box in negative color beneath it. This logo may only be used on software or hardware products that comply 100% to the CD-i specification (see: 1.4 What is the Green Book?). The word Interactive may alternatively be white on a negative or positive surface. The logo may never be displayed smaller than 9 millimeters wide.

In addition to the standard CD-i logo, Philips also created a marketing logo for CD-i, which is the one you can see on top of this page (and all other pages in my CD-i section). This logo may only be used by Philips, but in some cases Philips allowed other manufacturers to carry it too. It may

never function as a replacement for the system logo, i.e. when it is used on hardware or software products, it must be accompanied by the system logo.

1.14 What is the correct way of writing CD-i?

Originally, Philips stated that CD-I is the correct way of referring to the system. However, since many people unfamiliar with the system pronounced this as CD-One, they changed it into CD-i (with the lower case 'i') around 1992. All other ways of writing the name (CDi, CDI, Cd-i, etc.) are wrong and should not be used.

2. CD-i Applications

2.1 In what areas is CD-i used?

When CD-i was being designed in the mid 80s, it was supposed to function both as a consumer device, being sold as an addition to the family's entertainment centre (in a way similar to a VCR), as well as in professional areas. Initially, Philips and Sony expected CD-i to become the next "big thing" in consumer electronics, on which all future electronic development would (partially) be based.

Unfortunately, CD-i never took of that way in the consumer electronics market, leaving the system with a few 100,000s of units sold in America, a few 100,000s in Asia and about half a million in Europe. In the professional field however, CD-i became very popular. It quickly emerged to be the de-facto standard for easy-to use, TV-based interactive programs. CD-i was, and is still, being used by dozens of companies for a wide variety of purposes. This proves that the system was very technology-proof, since its hardware specification never changed in the last decade in which it was extensively used. Currently, CD-i still performs many functions better than a PC.

2.2 How was CD-i used as a consumer device?

CD-i was positioned as a multi-purpose device, unlike for example game consoles which had only one major function. It was this versatility that made CD-i unique, but it was this same versatility that made CD-i very hard to explain and hence sell to consumers.

When I was asked to explain what CD-i could do back then, I usually said: "The CD-i player is used by the children in the morning to help them with their homework, some time later they play an exciting game on the device. In the afternoon, you plan your next holiday on your CD-i using some encyclopedias or travel guides. During dinner, the CD-i will function as an audio player providing background music. Grandma pays a visit, an excellent time to show your latest holiday pictures from a Photo-CD. And in the evening, you will all watch the latest blockbuster movie on Video-CD." This story used to indicate the true versatile ways in which CD-i could be used.

CD-i consumer programs were, among others, available in the following areas:

- Children's titles
- Games
- Arts and Culture
- Special Interest
- Reference (encyclopedias)
- Music
- Karaoke
- etc.

A few hundred consumer CD-i titles were available during CD-i's consumer years.

2.2.1 Who made consumer CD-i titles?

Most consumer CD-i titles were distributed by Philips. In 1986, Philips and PolyGram established AIM (American Interactive Media), a joint venture which had the mission to support the launch of CD-i on the consumer market with the full availability of titles. Just before the launch of CD-i onto the American consumer market in 1991, PolyGram resigned from AIM and the name was changed to PIMA (Philips Interactive Media of America). But the titles were already pressed, which is why some early titles indicate PIMA on the cover of the box, but start with an AIM intro animation.

Philips Interactive Media sold titles that were produced both by internal software studios, as well as for other software manufacturers, and in this way they handled the promotion, marketing and distribution for them.

The Philips studios each were specialized in their own area. There was for example the Philips Sidewalk Studios, which produced excellent children's titles, Philips POV Entertainment Group, which developed the first games with real actors and Philips Freehand Studios, which developed titles that took CD-i's technology to the edges, such as Create your own Caricature or Face Kitchen.

Among the studios that produced software for CD-i were Infogrames, SPC Group, Lost Boys, Valkieser, NOB, Codim, CapDisc, Fathom Pictures, Spinnaker Software, Microds, Mirage, PIMC, Epic Interactive Media, Radarsoft, US Gold, AVM and lots of others.

A lot of publishers, TV companies and game developers licensed their characters and other material to Philips or its software partners to turn them into a CD-i title. Among them were Nintendo, Paramount Pictures, Milton Bradley (MB), MGM, Bertelsmann, Oxford University Press, Compton's New Media, EMI, NBC, Hanna-Barbera, Virgin Interactive Entertainment, BBC, Manga Entertainment, Namco, Standaard Uitgeverij Antwerpen, Hachette, Playboy Enterprises, Richard Scarry, Motown Records, Don Bluth, Warner Bros., Time-Life, Smithsonian Institution, Vivid Video, American Laser Games, Ravensburger, Psygnosis and many others.

2.3 How was CD-i used in professional areas?

The biggest success for CD-i was in professional applications. CD-i was used in a wide variety of corporate and institutional environments, in such areas as:

- Point-of-information
- Site-based advertising
- Training
- Educational
- Background Music

Point-of-information applications used a CD-i player in some kiosk-like setup, enabling users to view information using for example a touchscreen. This allowed them for example to view all variations of a particular car model in showroom, or to find their ways in a museum. CD-i is an excellent medium for this kind of applications, because of its low cost, its easy to use interface and its high quality, TV-like video images.

In another area, CD-i was also extensively used in training environments. CD-i allowed company work force to train themselves in a particular field, using their own speed, selecting their own areas of interest, while being given feedback by the system. Also here, CD-i has the main advantage of the lack of complicated installation procedures or compatibility issues usually found on PC-based setups.

CD-i was also widely used in schools. Both primary and secondary schools used the system for a variety of purposes, ranging from training infants to using their eye-hand coordination skills up to teaching students about the arts of the Renaissance.

2.3.1 Which companies used CD-i?

Since CD-i is an open platform, not all uses of the system have to be reported to a single body such as Philips. It is known that CD-i was and is used by hundreds of companies all over the world in dozens of areas. Among them are the following companies:

A&P / Hermans Groep, Abbots Labs, ABN Amro Bank, Absolut, ACOG, Adidas, Advertising Display Company, AFT-IFTIM, Agfa Gevaert, Air Plus, Alabastine, Albert Heijn, Alcon, Alied Van Lines, Allianz, Alpine, American Express, American Greeting, Ameritech, AMPED, Amsterdam Arena, Amsterdam Automobile Exhibition, msterdam Police, Amsterdam Stock Exchange, AASHTO, American Greetings, Ameritech, ANRA, ANWB, AOK, APAC, Aquamris Hotel Rügen, Arai Helmets, Armstrong Flooring, ASC, ASICS, ATAG, Auto Rai, AT&T Wireless Services, Aviodome, AVM Dialog AB, Aylesford News print B B.A.T. GmbH, B.F. Goodrich, Backs Electronic Publishing Ltd, Badisches Landesmuseum Karlsruhe, Ballast Nedam, Banyu, Barclays, Barton Creek School, BASF, Battenfeld Spritzgieß Technik, Baume & Mercier, Bayer, Bayerische Landtag, Baylor College of Medicine, Baxter, BBC, Bell Atlantic (electronic Yellow Pages), Bell Atlantic (InfoTravel), Bénéteau, Bertelsmann AG, Best Buy, Better Health Network, BEWAG, Beursdata B.V., Beyschleg GmbH, B.F. Goodrich, B.H.V., Bibliotheque Nationale de France, Bicycle Rai, Big Hand Productions, Bildzeitung, Bionova Teichbau, Blum, BMW, BOCO, Boehringer Ingelheim, Böhler Uddeholm, Bose Lifestyle Systems, Brantano, Bristol Meyers Squib, British Petroleum, British School Motoring, British Sky Broadcasting, B.S.L. Publishers, Burger King, C Cadbury beverages, Cadillac, Calcografia Nacional, Madrid, Caltex Petroleum, Canon & Shea Associates Inc., Canton, Carphone Warehouse, Carrier Corp., Carter Retail Technologies, CBR, CD-Interior, Cellular One, Chanel, Chargeurs, Chauvin, Chicago Transit Authority, Chronopost, Chrysler, Churchill Livingstone, Ciba Gigy, Circon Nova B.V., Citroen, City of Nijmegen, Clarins, Classic Worldwide Productions, Cleveland Lumberjacks, CNA, CNN, Coca Cola Finland, Codim, Cognac Otard, Comercial press (HK) Ltd., Commerzbank, Compumed, Congress Innsbruck, Continental Can, Codes Rouseau, Corning, Corporate Market Stratagies, Coulter Electronics, Course Care & De Geldergroep, CSX Railroad, CTE D Dähne Design, Daka KG, Dane Investment, Dantuma, De Dietrich, De Hullu, Degener, Dental Video Verlag, Department of Justice (Netherlands), Detlev Louis GmbH, Deutsche Bahn, Deutsche Messe, Deutsche Telekom, Deutsche Museum München, Deventer Tourist Office, DG-Verlag, Diamon Publishing Multimedia, Disney World, DocData, Dodge, Doka, Dorinth Hotelgesellschaft, Dr. Oetker, Dresden Bauspar AG, Dubois Ceramics, Dulux, Dun & Bradstreet Software, Dupont, Dutch Hospital, Association, Dutch Libraries E Eaton Corporation, ECMI, Ecolauto, EDF/GDF, Ediser, Edutech, Eheim, Eichbaum-Brauereien AG, EKZ, Elsevier, EMG Ltd., ENJO, Ericsson, Euro Disney, European Traffic Tuition, Evoluon, Exectrain, Explainer Interactive BV, Exxon, Eybl Dumont, Federal Highway Administration, First Bank of Boston, Fischer Schi, Fischer Tennis, Flaga Gas, Flammarion, Flughafen Wien, Forbes, Ford, Freemans, Free Record Shop, Free University, Future Media Systems, Futuroscope, Futuremedia PLC, GAK, GAP Consulting, General Motors, Georgia Pacific, Gewerkschaft der Gemeindebediensteten (Austria), GGK, Glaxco, Goldstar, Goodyear, Gran Dorado, Greiner, Groninger Museum, Grundig, Gullet Touristik, Gulliver Ritchie Assocs., Inc, Hachette, C.Hafner GmbH, Hall of Fame - WI, Halm, Hans Anders, Hans Schwarzkopf GmbH, Harley Davidson, Haskoning, HEAD, Henkel, Heras Hekwerk, Hij/Zij Mode, Hödlmayr Spedition, Hoechst, Homestead, Hooge Huys Insurances, Houde, Hubert EBNER Verkehrsmittel Ges.m.b.H, ICI, IDV, Imperial Chemical Industries, Infodent, ING Bank, Inmedia Inc, Innothera, Intermarché, Ipsen, Jaguar (Netherlands), Janssen-Cilag, Janssen Pharma, J.C. Penny, Johnson & Johnson, Junkers, JVC, Kaindl Laminatboden, Kaiser Friedrich GmbH, Kantonspolizei Schaffhausen, Ken Cook Education Systems, Kentucky Fried Chicken, Kerastase, KIA, Kiddies' Kiosk, Kimberly Clark, Koch International, Komatsu, KPN, Krys, Kunsthistorisches Museum (Austria), Kvaerner, La Redoute, Lab-CDI, Lancaster Group World Wide, Lancâme, Laroche-Posay, Lease Concept / ABN Amro Bank, Lee Jeans, Lengers Yachting, LEO Laboratories, Levi Strauss, Liebherr, Life Learn, Lights of Vienna, Lipha Sante, Lithonia Lighting, Locatel, Lockheed Aeronautical, LOI, L'Oréal, Lotto, Lowe's Warehouses, L.G. Electronics, 3M, MacPherson-Meistergram, Majorica S.A, Manatees, mannaSpace, Mannesmann Transmodal, Marine Nationale (France), Marriot, Martell, Maryland Lotterie, Maynard & Associates, Masco, Masterdoc, Matsushita, Mazda, McDonald's, McDonnell Douglas, McGill Multimedia, MCI, Med. I.A. Inc., Media Art, Media Design Group, Meistergramm, Melitta, Melrose, Mercedes Benz, Merck Sharpe & Dohme / Merck Pharmaceutical, Miles Laboratories, Ministry of Int. Affairs (Netherlands), Ministry of Public Work (Netherlands), Mopalpa, Mont Blanc, Mood Media, Moore Int., Mother Network (mannaSpace), Motel 6, Motorola, ,MSD, Merck Sharpe & Dorné, Muffin Head Productions, Multi-Media Corporation, Multimedia International, Museum

Amparo, Museum of London, Muzak DMI, 11er Nahrungsmittel National Cancer Institute, National Safety Council (UK), Nationale Nederlanden, Naturkundemuseum Stuttgart, Naturschutzzentrum Bad Wurzbach, Nestles, Netherlands Antilles Police Force, Netherlands Film Festival, Nethold, New Media Systems, Nieuwe Revue, Nikon, NIMA, Nine West Group, Nissan, NÖ Landesausstellung, NOB Interactive, Nordsjö Färg, NOTA Multimedia LTV Allemande, Notre Dame University, Novare International, Novem, Novotel, Nuclear Electric, Nursery Union O O'Neill, ÖBB Bahnstrom, ODME, Office du Tourisme de Lorraine, Office Int. de l'eau, Office National de la Chasse, ÖGB 100 Jahre, ÖO Landesausstellung, Olympic Austrian Committee, Orthopädische Industrie-Otto Bock, Österreichische Nationalbibliothek, Österreichische Werbegesellschaft, P.Reincke Direkt Marketing GmbH, Page & Moy, Pall Hydraulik, Pantheon Productions, Penthouse, PepsiCo, Pergo Flooring, Peugeot, Pfaff Silberblau, Pfizer, Pharma Lab, Pharma-laser, Pharmascience, Philip Morris SA, Philips, Phönix Backbedarf GmbH, Pierre Fabre, Plasser & Theurer, Plawerg, Madrid, Playboy, Plymounth, PNEM, Poilane, Point Series, Polygram, PPG Industries, Precor USA, Proctor & Gamble, PTT Telecom BV, Public Museum of Grand Rapids, Qualifortour, Rabobank, Raiffeisen Bank, Raleigh, Ramada Inns, Rand McNally, RATP, RDR-Affektive Störungen, Reckitt & Coleman, Renault, Reuters, Rhone Poulenc, Rijksmuseum, Rise International, Royal Canin, Royal Dutch Air Force, SAAB GmbH, Sake, Sale '96, Salzburger Tourismus, Sanofi Pharma, Saturn, Schering, Schindler, Schleswag, Schloemann Slemag, Schöller Bank, Schiphol Amsterdam Airport, Schwäbisch Hall, Schweizerische Industriegesellschaft, Scottish Office Education Dept., SeaFirst Bank, Seagram, SeaWorld, Sealy, Searle Canada, Sears, Sep, Serv & Tech AB, Service One Catering, Shell, Sherwin Williamis, Shimano, Shindler, Siemens, Signum, Simstar Inc., Sipa, Sita, Skillmaster, Sofidoc, Sony, Southwest Bell, SPC Vision, Stabernack, Jr. Partner GmbH & Co., Stadt Dornbirn, Stadt Heiligenstadt, Stadt Wien, Stadtmuseum Bad Ischl, Stadtwerke Geinhausen GmbH, St. Elisabeth Hospital, Start Opleidingen, Stephansdom, Storck GmbH, Studio Hamburg, Subaru of America, Swatch, Symphony Group, Synthelabo, Syracuse University, Tauernkraftwerke AG, Target Vision, Teleac, Tempo, Tengelmann, Texaco, The Amsterdam Stock Exchange, The Brain Center, The National Cancer Institute, The Palace Museum China, The Spanish Ministry of Social Security and Welfare, Thomson CSF, Thyssen, Tirol CD-i, Tissot, TNO, Toyota, Trodat, TRT, Tsuyata, Unisource, United Nations, United Technologies Corp., University of Glasgow, University of Guelph, University of Iowa, University of Nijmegen, US Federal Government, US Gold Association, US Navy, US Pharmacopeia, US Postal Services, US West, Valkieser New Media, Van Cleef & Arpels, Vekabest, Verband Österreichischer Hobelwerke, Veritech, Verkade, Versalius Klinik, Victory Interactive Media S..A, Video Arts, Videotronic, VGZ medical Insurance, Vismed LTD, Vivanco, VOEST Alpine, Vogelbusch, Vogel Verlag, VOK Dams Gruppe, Volksbund Deutsche Kriegsgräberfürsorge, Volkswagen, Volvo, Vredenstein, Vroom & Dreesmann, Vucom Graphic Systems, VVD, VVV, Wella AG, Wendy's, Werndl Furniture, Western Autostores, Weyerhouser, Whirlpool, Wifi Wien, Wilson Learning, Wolf Gartengeräte, Wyeth, Yamaha, Yamanouchi Pharma GmbH, Yves Rocher, Yves Saint LaurEnt, Zambon, Zegna, Zeneca and Zumtobel.

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3. CD-i Techniques

3.1 What are CD-i's basic specs?

A CD-i player is based on a 68000 CPU running at least at 15 MHz, it is equipped with at least 1 MB of RAM, a single speed CD-drive, dedicated audio and video decoding chips, at least 8 KB of non-volatile storage memory and a dedicated operating system called CD-RTOS. The minimal specifications to which every CD-i player should comply are laid down in the Green Book, which is covered in full detail in section 1 of this FAQ. A CD-i player can have extended hardware (such as more RAM or more non-volatile storage space), as long as the minimum requirements of the Green Book are met.

3.2 What CPU does CD-i use?

A CD-i player is equipped with a Motorola 68000-like processor, similar to the ones used in the original Apple Macintosh, Atari ST and Commodore Amiga. All Philips CD-i players used a Philips-build 68070, which differs from the 68000 in that way that it had some port controlling features built in. The processor runs at 15 MHz. According to the Green Book, the 68000-CPU should at least have a 16 bit external data path, and a 32 bit internal data path, very similar to Intel's 80386SX processor. The CD-i standard allows for a faster CPU, but since CD-i's performance is almost entirely based on the realtime retrieval of audio and video data from the disc, the performance will not be raised that much when a faster CPU is used. This is why CPUs in all CD-i players built to date are based on the minimal Green Book requirements.

3.3 What OS does CD-i use?

The operating system used in a CD-i player is called CD-RTOS, which stands for Compact Disc Real-Time Operating System. It is hard coded in a ROM of at least 512 KB, along with other player-specific software such as the player's startup shell. CD-RTOS is based on version 2.4 of Microware's OS-9/68K operating system. OS-9 is very similar to Unix, and supports full multitasking and multi-user operation. The original OS-9 was built in the early 80s as a realtime operating system to be used in industrial and embedded applications where real time functionality is a key criteria, such as with robotics, automobile production and set-top boxes. It was slightly adapted to CD-i, for example by including the correct device descriptors for the CD drive, and with drivers for CD-i's specific audio and video decoding ICs. Since OS-9 is a modular operating system with a very small kernel of only about 25 KB, only the parts used by a specific CD-i player have to be preset in ROM. For example, a CD-i player with a floppy disk drive contains additional driver modules, whereas most consumer players do not need them.

3.4 What's a real-time system?

A real-time computer system is a system in which the timing of events plays a critical role in the operation. For example, in the robotics area, where OS-9 is also extensively used, it is of great importance that different tasks occur at the exact specified moment. In CD-i, real-time behaviour is also important, since audio and video data need to be decoded by the appropriate processors and then sent to the appropriate outputs. At the same time, the system should take care of user input.

3.5 What's sector interleaving?

One of the clever design criteria of CD-i was that the system should be able to retrieve audio and video information in realtime from the disc and send this information directly to the appropriate decoder ICs, without putting a heavy load on the over-all system performance. Because of this, a CD-i player does not need much RAM or processing power, since all audio and video decoding is performed in realtime without storing large amounts in RAM for later decoding.

To enable the simultaneous retrieval of both audio and video information, data is interleaved on the CD-i disc. This means that each sector contains a piece of either audio or video information, and that those sectors can be put in consequence next to each other.

Since a CD-i disc is read at a constant continuing speed, the designer needs to be aware of the load of a certain choice of quality for audio or video in the disc's datastream. When a lower audio quality is used (refer to 3.x for more information about audio coding), fewer sectors will be occupied than with a higher quality. For example, when level A stereo sound is used, only half of the remaining sectors can be used for other information like video.

It's also possible to read for example only the sectors belonging to one audio channel at a time, and then move back to the beginning of the disc and read the sectors of another audio channel. Since the lowest audio quality only uses one in every sixteen sectors, and a CD-i disc lasts for 74 minutes, the total time for audio can be (16 x 74 min =) over 19 hours!

Because of this realtime reading of sectors, every CD-i player reads data at the same speed, sometimes referred to as normal speed or single speed. It would be unnecessary to make a CD-i player with a higher speed CD-drive, since data is to be read in realtime according to the specifications (thus single speed) and audio, video and animation would be out of sync when being read at a higher speed. The designers of the CD-i system put more attention to the development of encoding techniques that enable for high quality audio and video within the single data speed and hence resulting in a longer playing time, instead of utilising a high speed drive and by such reducing the playing time.

3.6 What's CD-i's sector format? What about mode 1 and 2, form 1 and 2?

For CD-ROM, the Yellow Book defines the mode 1 sector format. This format allows for 2048 bytes of user data in every sector, with an accompanying 280 bytes of error correction information in each sector. When data is read at 75 sectors per second (the normal CD speed), this results at a datarate of 150 KB per second.

For CD-i it was not always necessary to have error correction in each sector. For example, audio and video need a much lower degree of correction than data or programs. Instead, the 280 bytes used for error correction in mode 1 could be added to the 2048 of user bytes, resulting in 2324 bytes of user data per sector. This larger sector size then results in an improved datarate of about 170 KB per second. The new sector format was called mode 2. Within mode 2, 2 forms were defined: form 1 does incorporate the original error correction and is used for data and programs, and form 2 which lacks the error correction and is to be used for audio, video and other media information.

Mode 2 added an additional subheader to the header of mode 1, which holds information about the type of data that is contained in a sector (audio, video, data, etc.), the way it is coded (for example which audio level is used), and an indication of the used sector form. This subheader is interpreted by the CD-i system for each sector, which is then processed by the appropriate decoders. Both forms of mode 2 sectors can be interleaved, so that program data and audio and video can be read instantaneously from the disc.

Because of the mixage of both form 1 and form 2 sectors, it is impossible to tell the capacity of a CD-i disc. When all sectors are form 1, the disc will hold 648 MB. When all sectors are form 2, the capacity is 744 MB. CD-i's disc capacity will hence be between 648 and 744 MB.

Although a CD-i disc consists of only mode 2 sectors, a CD-i system must be able to read mode 1 sectors on CD-ROM discs, and of course the audio sectors that are defined for CD-Audio in the Red Book.

3.7 What's CD-i's disc structure?

Like with all official CD-standards, a CD-i disc is divided into tracks. A CD-i disc contains at least one CD-i track, and may optionally contain additional CD-Audio tracks that may also be played on a standard CD-Audio player. The CD-i track must be the first track on the disc, with the optional CD-Audio tracks hereafter. An exception to this rule is defined in the 'CD-i Ready' format, which is covered in more detail in section 5 (Disc types).

The first 166 sectors of the CD-i track are message sectors, followed by the Disc Label. Hereafter come an additional 2250 message sectors. Message sectors contain a spoken message in CD-Audio format, which informs users who put the disc in a regular CD-Audio player about the possible damage to equipment or speakers when the disc is not taken out immediately. Usually, a modern CD-Audio player will recognize the CD-i track as a data track and will not play it, so you won't hear the message. It's only included for compatibility with older CD-Audio players. The Disc Label contains some specified fields which offer a lot of information about the disc, such as the title, creator, expiration date, but also the name of the CD-i application file that needs to be run at startup. Most of those fields are not used by most CD-i players, but it allows for example for CD-i players which show the name of a disc on the FTD-display or in the player shell.

Furthermore, the Disc Label contains the File Structure Volume Descriptor, which is loaded into RAM at startup. This allows the system to find a certain file on a CD-i disc in only one stroke. After these message sectors and Disc Label, the actual CD-i data starts.

3.8 What filesystem does CD-i use? Is it based on ISO-9660?

A true CD-i disc uses the OS-9 filesystem, which is not compatible with ISO-9660. It allows for additional information about the files to be stored. This information is very Unix-like, and contains data about execution or read permissions. The filenames can be up to 28 characters in length. The system also provides for unlimited depth subdirectories to be used on the disc. Files can contain upper and lower case characters, but files may not exist with existing names in upper and lower case (for example: when a file 'multimedia' is present, the file 'Multimedia' may not exist).

Since CD-i uses a dedicated filesystem, it is not possible to see the filenames on a disc using a regular computer with a CD-ROM drive. However, a CD-i filesystem driver has been written for Windows 95/98, that allows you to access a CD-i disc in the same way as a CD-ROM. More information about this driver can be found in section 9 of this FAQ: CD-i on other platforms.

Although a CD-i disc is not ISO-9660, the Green Book defines that a CD-i player must be able to read ISO-9660 discs, for example data from a CD-ROM disc. It is also possible to include a CD-i application on a standard ISO-9660 CD-ROM disc to enable playback on a CD-i player. This is defined in the CD-i Bridge format, as explained in further detail in section 5 of this FAQ: Disc types.

3.9 How much RAM does CD-i incorporate?

The Green Book defines that a CD-i player should at least have 1 MB of Random Access Memory. This memory is divided into two memory banks of 512 KB each. Each of these banks contain one video image of CD-i's two video planes (see: 3.13 How does CD-i video work?) Depending on the video encoding type, a picture takes up about 100 KB, leaving the remaining memory for application programs, data, sound samples, and all other kinds of information.

All consumer CD-i players contain 1 MB of RAM by default, but when a Digital Video cartridge is installed, additional memory is added. Besides the 512 KB of decoding RAM, the cartridge also offers a full 1 MB of extra memory. When no Digital Video is displayed, the decoding RAM can also be used for general purposes. This makes up for a total of 2,5 MB RAM in a CD-i player equipped with a Digital Video cartridge, allowing content developers to use more RAM for more

complex programs, additional audio samples, or faster transition of pictures that are stored in RAM and need not to be loaded from the disc again.

The additional 1 MB of RAM in the Digital Video cartridge is not defined in the Green Book, nor in the Digital Video extension, but since it is a standard part of every Digital Video equiped CD-i player (from Philips and other manufacturers), a content developer that designs an application for a Digital Video equiped CD-i player can be fairly sure that this extra memory is available.

3.10 What's the CSD?

Every CD-i player has a piece of non-volatile storage memory (NV-RAM) that is at least 8 KB in size. This memory is kept when the player is turned off. Although this doesn't seem much, it allows for powerfull storage options, such as games scores, test results, names, prefered language settings, etc. The NV-RAM is also used by the system to store the CSD.

When a CD-i player is turned on, the CD-RTOS kernel is initialized. One of the startup routines includes the creation of the CSD, which stands for Configuration Status Descriptor. The CSD contains information about a certain CD-i system, such as the amount of NV-RAM available, which kind of pointing device is connected, the version of CD-RTOS used, but also wether a floppy disk drive is available, if a printer is connected, etc. All of these variables are stored per device type on one line of the CSD, which are defined in the Green Book. Each of these devicetype settings are called DSD, which stands for Device Status Descriptor (and not Direct Stream Digital as for Super Audio-CD!). Each time the player is turned on or reset (which happens when you eject a disc or exit from a program), the CSD is recopiled. Any newly attached devices will therefore only be recognized and initialized after a reset.

The CSD can be read by an application program to gather information about a certain CD-i player. For example to load a PAL or NTSC optimized version of the program, to offer storage capabilities when a disk drive is available, to know the seek times of the CD drive, or to know the size of the NV-RAM to show the correct usage percentages when displaying the used space of a certain file. The CSD is stored in an ASCII file called 'csd'.

3.11 What kind of CD-drive is used in a CD-i player?

A CD-i player contains a CD-drive that runs at normal or single speed, to allow for the correct timing when retreiving realtime data. Speeding up this drive speed would result in the requirement of extra buffer RAM to store audio and video, which would make the CD-i player much more complex. Furthermore, playing time of realtime data would be decreased when a disc would be played at a higher speed.

CD-i discs are normal CDs, based on the physical definitions as laid down in the Red Book for CD-Audio. It not a special kind of high-denisty CD, such a GD-ROM from the Sega Dreamcast, nor does it use a differently colored reflection layer like Sony Playstation.

The CD-drive in a CD-i player is physically able to read all normal CD-types, but not high density formats like DVD.

3.12 How does CD-i audio work?

A Base Case CD-i player should be able to decode standard PCM audio as specified for CD-Audio, as well as a dedicated audio coding scheme called ADPCM, or Adaptive Delta Pulse Code Modulation. The difference with PCM is that audio is not stored individually per time segment, but that only the difference (delta) from the previous sample is recorded. This allows for a significant decrease in the used storage space on the disc, and hence in the datastream being read from the disc. When normal PCM CD-Audio would be used (which occupies all succesive sectors), this would not leave room for video or animations to be read without interrupting the audio playback.

CD-i provides for 3 levels of ADPCM audio, all of which can be used either in mono or stereo:

- CD-Audio PCM, 44.1 KHz, 16 bit, all sectors, up to 74 mintues
- ADPCM Level A Stereo, 37.8 KHz, 8 bit, 1 in 2 sectors, up to 2.4 hours
- ADPCM Level A Mono, 37.8 KHz, 8 bit, 1 in 4 sectors, up to 4.8 hours
- ADPCM Level B Stereo, 37.8 KHz, 4 bit, 1 in 4 sectors, up to 4.8 hours
- ADPCM Level B Mono, 37.8 KHz, 4 bit, 1 in 8 sectors, up to 9.6 hours
- ADPCM Level C Stereo, 18.9 KHz, 4 bit, 1 in 8 sectors, up to 9.6 hours
- ADPCM Level C Mono, 18.9 KHz, 4 bit, 1 in 16 sectors, up to 19.2 hours

So, when ADPCM level C is used, only 1 out of every 16 sectors needs to be used for audio, leaving all other sectors for other data such as video or animation. It's also possible to record different audio channels at once, allowing for the seamless switching between for example various langues. The disc may also be read from the beginning while decoding a different audio channel, allowing for increased audio playing times, as indicated in the table.

A CD-i player equiped with a Digital Video cartridge is also able to decode MPEG-1 layer I and II audio. MPEG is far more efficient in coding audio, resulting in even further decreased storage needs while providing a highly increased audio quality when compared to ADPCM. This is because of the fact that MPEG audio is based on PASC (Precision Adaptive Subband Coding, the coding technique originally developed for DCC, Digital Compact Cassette), which uses the characteristics of the human ear to only store those audio signals that are audible, and leaving others out. CD-i offers a very flexible way of using MPEG audio (for example at various bit rates and quality levels). CD-i cannot decode MPEG-1 level III, or MP3 files. A content developer needs to be aware of the fact that MPEG decoding is not supported in a Base Case player, and can only be used on player equiped with a Digital Video cartridge.

3.12.1 Does CD-i support Dolby Surround, Dolby Digital or MPEG Multichannel?

Dolby Surround is an analogue encoding technique that allows for the storage or center and rear audio in addition to the normal left and right stereo signal. Every stereo audio carrier that provides for a high frequency audio reproduction can use Dolby Surround encoding. In CD-i, Dolby Surround can only be used for MPEG audio, since ADPCM does not offer the dynamic range that is necessary for the encoding of the additional channels. Most movies use Dolby Surround, as do several games such as Seventh Guest. Please be aware of the fact that Dolby Surround is an analogue matrixing technique, which does not add extra discrete audio channels.

Dolby Digital and MPEG Multichannel are audio encoding techniques that allow for discrete surround channels to be encoded individually. Ususally, this includes two front signals, two back signals, a center signal and a low-frequency subwoofer signal. Both techniques are widely used in DVD-Video. CD-i does not support either of them.

3.12.2 Can CD-i play back MP3 files?

No. The MPEG audio decoder in the Digital Video cartridge is only capable of decoding MPEG layer I (used for example in the former Digital Compact Cassette - DCC) and layer II (used for example in Video-CD). It is not capable of decoding layer III, the one used in the popular MP3 files. The CD-i's normal CPU (an 68000 at 15 MHz) is not capable of doing this in software, so it probably is out of the question :-(

3.13 How does CD-i video work?

The video image of a CD-i player consists of four 'planes', which are shown on top of each other. The first plane is used by a cursor, its size is limited to 16x16 pixels. The second and third planes are shown beneath the cursor, and are used for full screen images. The fourth plane finally, is

used for a single-colored background or for MPEG full motion video (or to display video from an external source on some players). The content of each of both middle planes is placed in one of the two memory banks (see: 3.9 How much RAM does CD-i incorporate?).

Parts of an image on one of the middle two planes can be transparent, so that the underlying plane becomes visible. This can for example be used to show subtitles or menubars on an image. Both planes can also be used to dissolve from one image to the other, using an unlimited variations of wipes, including professional fades in a way that's virtually impossible to achieve with today's modern VGA adapters.

There are various encoding techniques for video that can be used in CD-i:

- **DYUV**

DYUV or Delta YUV is used for the encoding of high quality photographs and other natural images. It is based on the fact that the human eye is more sensible for differences in brightness than for differences in color. Therefore, it stores one color for a set of pixels, and a brightness value for each pixel. The result is an image of slightly more than 100 KB, leaving enough space in memory for other information. Due to the complexity of a DYUV image it must be stored on the disc in advance, a DYUV image can not be created nor modified in the player. DYUV is used most often in CD-i titles because of its high quality and efficient storage.

- **RGB 555**

RGB 555 is a professional image format which allows for 5 bits per R, G and B value, resulting in a picture with a maximum of over 32,000 colors. Since RGB 555 uses both planes to display the image, it can not be used in combination with other graphics. An RGB 55 image is roughly 200 KB in size. The image can be altered by the player at runtime. RGB 555 is actually never used in regular CD-i titles because of its inefficiency and limitations in usage.

- **CLUT**

CLUT, or Color Look-Up Table, is a way of encoding simple graphics. The colors that should be used in a certain picture are stored in a CLUT-table, which reduces the size of the image dramatically because color values refer to the appropriate CLUT-entry instead of indicating for example a 24-bit color value. In CD-i, a CLUT image can have a 8 bit (256 color), 7 bit (128 color), 4 bit (16 color) or 3 bit (8 color). The latter two can be used in double resolution (see: 3.13.1 What is the screen resolution of a CD-i player?).

- **Run Length Encoding**

RLE or Run Length Encoding is a variation of CLUT. Besides storing the CLUT-color table in an image, it further reduces the image size by storing certain 'run lengths' of repeating horizontal pixels with the same color. The results are usually pictures between 10 and 30 KB in size. This makes RLE ideal for animations. Most of the animations you see on Base Case CD-i titles are RLE.

- **QHY**

QHY or Quantized High Y is an encoding technique that is in essence not a part of the Base Case, but it is described in the Green Book and supported by all CD-i players. Its encoding technique is made up of the combination of DYUV and RLE, resulting in a very sharp high quality natural image, that is displayed in CD-i's high resolution mode (see: 3.13.1 What is the screen resolution of a CD-i player?). A QHY image is usually about 130 KB in size. Since it consists of a DYUV component, it cannot be modified by the player. QHY is for example used to display the images of a Photo-CD in high resolution on a CD-i player.

Besides these Base Case video encoding options, a player equipped with a Digital Video cartridge can also display MPEG motion video, and normal and high resolution MPEG still images. The encoding techniques for MPEG are far more advanced than the ones defined for Base Case CD-i, but images in these formats cannot be viewed on players without a Digital Video cartridge.

3.13.1 What is the screen resolution of a CD-i player?

CD-i can display both main planes in either normal, double or high resolution, which are 384x280, 768x280 and 768x560 respectively. Some encoding techniques are limited to a single resolution, for example a DYUV image is always standard resolution. It is possible for the images on each of the planes to be displayed at once, even if they are in different resolutions. For example double resolution CLUT4 menu bar can be overlayed on a standard resolution DYUV image.

CD-i highest resolution (768x560), used for QHY images, is the highest resolution that can be made visible on a normal TV set, so CD-i takes TV-technology to its edges.

3.13.2 Does CD-i make a difference between PAL and NTSC?

A CD-i consumer player is usually suitable for a dedicated TV standard, such as PAL or NTSC. Some professional players have a switch at the backpanel to select the appropriate TV standard. A CD-i disc is TV-standard independent: any CD-i disc can be played on any CD-i player wherever in the world. But due to the characteristics of both TV systems, special care has to be taken into account when designing a CD-i title. An NTSC-display usually displays slightly less lines, with slightly less pixels on each line. Usually the NTSC display is 720x480, compared to 768x560 for PAL. When a full resolution image is displayed on an NTSC-display, the most oversized pixels will drop out of the picture. When an NTSC picture is displayed on a PAL screen, very small black bars are shown at the bottom and top of the screen (these bars are really small and should not be compared to the black bars of a letterboxed movie). For this, the 'safety area' is defined, the size of an image that is expected to be correctly displayed on all TV-sets. This safety area is 640x420, no 'critical' information such as menu buttons should be displayed outside this area.

The same limitations with respect to the safety area apply today to DVD-Video titles that are to be distributed world-wide.

3.13.3 Does CD-i support wide screen (16:9) TV sets?

Yes, any CD-i title can be viewed on a wide screen TV set using either one of the options offered by the TV itself. No special resolutions adapted to the 16:9 aspect ratio are defined for CD-i, however a picture can be 'squeezed' within a normal 4:3 image that can be 'de-squeezed' at runtime by the TV-set.

Please be aware of the fact that, in contrast to any DVD-Video player, a CD-i player has no build in facility to correct the display of a widescreen image on a normal 4:3 display by filling the screen with black bars at the top and bottom. When a widescreen title is also to be used on a 4:3 display, the content should also be stored in this aspect ratio on the disc.

Some consumer CD-i players (like the Philips CDI-220/60 and up) provide for a 16:9 switch in the player shell. This switch records the setting in the CSD (See: 3.10 What is the CSD?), which allows for applications to look for the connected TV format. When such a player is set in 16:9 mode, the player's startup shell is displayed in wide screen, but when a CD-i is started, the screen is switched to 4:3 mode. An application that interprets the aspect ratio setting in the CSD may then turn the screen back to 16:9. This CSD entry is an extension that is not specified by the Green Book, and there are only a few applications that supported it.

3.13.4 How does CD-i Full Motion Video work?

When the term FMV, or Full Motion Video is used, it often refers to the display of MPEG Digital Video. Although a CD-i player is capable of various full screen animation options and partial screen motion video, it can be extended with a Digital Video cartridge. In some players, this Digital Video cartridge is already built-in. Digital Video is considered a must-have extension to CD-i, and is described as an option in chapter 9 of the Green Book.

CD-i Digital Video is based on the MPEG-1 standard, which is now extensively used in a wide variety of applications, but it was initially developed mainly for CD-i. This standard allows CD-i to display full resolution (384x280) moving video images in either 24, 25 or 30 frames per second. The video is not interlaced, like with MPEG-2 used in DVD-Video. Video-quality is roughly comparable to standard VHS. CD-i's standard ADPCM audio features can be used in conjunction with MPEG video, but this is very unlikely since the Digital Video cartridge also provides for some extra audio decoding schemes based on MPEG-1 layer I and II, allowing for very high quality CD-Audio like audio that takes up only a fraction of the storage space and bandwidth of CD-Audio.

MPEG-1 video is based on an encoding technique called DCT, Discrete Cosine Transform. The basis for this encoding is the knowledge that successive pictures in a video usually do not differ that much from each other. Instead of encoding and storing each picture by its own, MPEG only stores the differences between images. There are three different types of MPEG images: I or Intra frames that consist of a full image that can be displayed without information from other images - this is used for displaying images when performing a fast forward or reverse, P or Progressive frames that need information from previous images and B or Bi-directional frames that need information from both previous and future images to build a picture. As you can see, the images are not stored in chronological order on the disc: the MPEG decoder takes care of the decoding of the information and putting all images in correct order for display.

Digital Video is displayed on the background plane (see: 3.13 How does CD-i video work?), and can be overlayed with images from the CD-i's Base Case video codecs, such as CLUT or RLE.

4. CD-i players

4.1 Which companies sold CD-i players?

The CD-i standard was set up in the late 80s by Philips and Sony, the same companies behind the CD-Audio and CD-ROM spec. The idea was to establish a worldwide standard that could be licensed by other manufacturers in a similar way as previous CD-standards. In the early development-stage, changes looked very promising for CD-i: almost all big consumer electronics companies announced plans to manufacture players, or showed prototype models. Among those companies were Pioneer and Matsushita (Panasonic), but the players that they showed were never actually taken in production. Sony sold some portable CD-i players for a very short period of time in 1991. But in the end, Philips became the major backer of the CD-i system, supporting the system with software titles, authoring tools and some 20 or so models of CD-i players, which were produced until June of 1999. By then, CD-i was already disappeared from the consumer market for some years, but it was extensively used by a wide variety of companies in the professional field. Refer to section 2 (CD-i applications) for more information. Over the years, several companies joined Philips in producing players, or selling modified OEM-versions of existing players, such a LG Electronics, Kyocera, Bang & Olufsen, Grundig, Digital Video Systems, NBS and Memorex.

4.2 What CD-i players are available?

Philips alone produced some 20 models of CD-i players, including consumer models to fit in a regular stereo system, mini CD-i players, portable CD-i players with and without a screen, stereo systems with an integrated CD-i player, TVs with an integrated CD-i player, professional CD-i players and special authoring CD-i players. A complete list of all CD-i players ever made, including their subtle differences, is available at the Complete CD-i players overview at www.icdia.org.

4.3 What is the difference between a consumer and a professional CD-i player?

Philips sold various professional CD-i players next to the standard consumer models. Both types of players comply fully to the CD-i standard as defined in the Green Book and were based on the same CPU and audio and video ICs, but the professional players usually offered some extra features. There were professional players with an integrated floppy disk drive, with a parallel port to connect a printer or ZIP-drive, with SCSI-ports, with ethernet network connections or with up to 5 MB of extra RAM. Some players had a feature that enabled the users to customize the startup screen of the player shell. Several professional players were especially made for CD-i development studios, since they included input ports to connect an emulator (see section 7 (CD-i authoring) to simulate the playback of a CD-i disc from an external harddisk for testing purposes. Refer to the Complete CD-i players overview at www.icdia.org for more information about the differences between the various players.

4.4 Does system performance differ between the various players?

No. Although there are various models of CD-i players, every CD-i disc will perform exactly the same in terms of system speed or audio and video quality on every CD-i system. The Green Book extensively specifies how and at what speed the audio and video data should be read from the disc and parsed through the appropriate decoding ICs. Even if a faster CPU is used in a CD-i player (which is allowed by the Green Book, but so far never actually implemented in any CD-i player), system performance will only rise slightly because the realtime retrieval of audio and video from a disc is not influenced by the processor. The seektime of the laser-unit in the CD player may, according to the Green Book, not be more than 3 seconds for a full stroke. It is possible for a CD-i player manufacturer to implement a CD drive with a faster seek time, but apart from getting faster to the desired data, also in this case the performance will not actually differ.

Some CD-i players however are known to load the CD-i application faster than others (at startup of a particular CD-i disc), due to the internal system functions that need to be performed on a CD-i player with more integrated functionality, but this is also just a matter of seconds.

4.5 What are the differences between the various player shells?

The player shell is the startup application of every CD-i player that is displayed when the player is switched on. The player shell allows for the start of a CD-i application, for CD-Audio controls when a CD-Audio disc is loaded, for checking or deleting stored items in NV-RAM and for selecting general player settings.

In essence, there were 3 different versions of the player shell for Philips CD-i players. The first version was only used in the CDI 180 system, and offered only the basic functionality. The second version was especially developed for the first professional stand-alone CD-i players in 1990, the CDI 601 and CDI 602. This player shell was also used in a slightly adapted version in the first batch of consumer CD-i players like the CDI 910, CDI 205, the portables CDI 310, CDI 350 and CDI 360 and the first versions of the CDI 210 and CDI 220. The third version was made more attractive for consumer usage and included more colors, an introduction animation of the CD-i logo, button highlighting and a more intuitive interface. This player shell was used in all successive consumer and professional CD-i players in one way or the other.

Philips continued to improve the player shell. That's why similar-looking player shells might contain subtle differences when compared from player to player. In the second generation player shell, the CD-Audio screen layout was often changed, as new on-screen controls like searching were added. The third version appeared in a version without background images and with subtle images in the background, like a small dragon, a movie camera and a moon. The version of the third generation player shell that is used can be found under the Copyright option in the General Settings screen.

4.6 What does the /00, /20, etc. after the type-indication mean?

Philips uses its version indication method for two reasons: to indicate the region for which a specific product is intended, and to indicate a revision change. The version is indicated behind a slash after the initial type number, e.g. CDI 670/00. It is printed on the type number indication at the back or bottom of a device. You can never tell which version a device is by looking at the type number which is printed on the front, since these do not include the version number. The numbers below 20 indicate the region for which a device was adapted. Mostly, changes consist of a different voltage or TV broadcast system, but they might include more regional changes. The most important regions used are /00 for Europe mainland, /05 for the UK, /11 for Japan and /17 for the US.

Numbers above 19 indicate versions. Usually 20 is added for each follow-up version, e.g. /20, /40 and /60. Differences may for example consist of the usage of a different PCB, usually there are no big changes that are important to the customer. The region code number is added to the version number, resulting in a unique number that describes the region code and the revision change. For example /37 means a /20 version adapted for the American market (because the US indication 17 was added).

4.7 What do I need a Digital Video cartridge for?

Every Base Case CD-i player is capable of displaying high quality still images, cartoon style animations and partial screen moving video. However, when consumer CD-i players were introduced in late 1991, it became clear that the techniques to encode full screen, full motion video within the bandwidth of a CD became available soon. Philips therefore equipped all CD-i players with an extension socket in which a Digital Video cartridge could be placed. When such a cartridge is installed, CD-i discs that are especially made for this extension and which include full

motion video can be played back. To achieve this, the cartridge is equipped with MPEG audio and video decoding ICs, and an additional 1.5 MB of system RAM. This extra memory may also be used to improve the performance of certain titles, for example by using it to store images that do not need to be reloaded from the disc each time.

Although the Digital Video cartridge is in essence not a part of the Base Case CD-i specification, it is the most important extension for the CD-i system that was ever introduced. The full motion video extension is extensively specified as an optional extension from the March 1993 version onwards of the Green Book. Roughly 75% of all CD-i titles require the cartridge to be installed. Please note that a title should be made specifically for the Digital Video cartridge to use its features, standard Base Case CD-i titles do not look any different, nor will the quality of audio and video be improved, when a cartridge is installed in the player.

4.7.1 Is there a difference between the various Digital Video cartridges?

There were two models of the Digital Video cartridge available: the larger 22ER9141, and the slightly smaller 22ER9956. The first model was used in the first batch of players (CDI 910, CDI 205, first versions of CDI 210, first versions of CDI 220 and the portable players CDI 310, CDI 350 and CDI 360), the second one is used in all other players. The new cartridge was introduced in late 1994, to allow for a smaller design of a CD-i player (the CDI 450). By then it was possible to reduce the size of the cartridge because of large scale integration of the various components. In technical terms there is a small difference: the 22ER9141 delivers its video signal in an analogue way into the player, the 22ER9956 produces a digital signal that is parsed to the players internal DACs. In terms of performance there is absolutely no difference, all CD-i Digital Video titles look exactly the same with both cartridges.

Due to problems with decoding MPEG video that was not 100% according to the specifications using the first batch of 22ER9141 cartridges (errors in decoding, displaying of green "ghost sprites" on screen), a second version with a different decoding IC which was more tolerant was introduced slightly after. This new cartridge had /20 added to the type number indication, see Overview of Digital Video cartridges at www.icdia.org for more information about all available cartridges and compatibility issues. To check which cartridge should be used in a particular player, please refer to the Comparison table of all Philips CD-i players at www.icdia.org.

4.7.2 Is the extra RAM used by non-DV titles?

Every Digital Video incorporates an additional 1.5 MB of RAM. This memory consists of 1 MB of standard RAM, and 512 KB of decoding RAM for buffering data when decoding MPEG audio and video. All of this memory can be used by a CD-i application to improve performance. For example, a title can store data in RAM that does not need to be reloaded from the disc each time. But since a Base Case CD-i title must work on every CD-i player, even if no Digital Video cartridge is available, the software must not depend on this extra RAM.

The best example of the usage of this extra RAM is the Photo-CD on CD-i application. When you select the thumbnail overview of a Photo-CD disc, all of the thumbnails that are generated from the pictures on the disc are stored in RAM. The more RAM that is available, the more thumbnails that can be stored without reading the pictures from the disc again. So, Photo-CDs benefit in this way from the Digital Video cartridge. Besides this, I know of only one "Base Case" CD-i title (the game Christmas Crisis) that uses the extra RAM to load soundmaps (audio effects). These sounds can not be heard when no Digital Video cartridge is installed.

4.8 How much NV-RAM storage space does a CD-i player have?

According to the Green Book, every CD-i player should at least provide some way to store at least 8 KB of data. In most players, this storage space is implemented as battery-powered NV-RAM (Non-volatile Random Access Memory). The data is kept in this memory when the player is

turned off or unplugged from the mains. NV-RAM can be used by an application to store high scores from games, personal presets, Favourite Track selections for Audio-CDs, Favourite Picture Selections for Photo-CDs, preferred language settings, etc. NV-RAM is also used by the system to store the CSD (see: 3.10 What is the CSD?)

Although 8 KB is the minimum storage space, some CD-i players have 4 times that capacity, resulting in 32 KB. Refer to the Comparison table of all Philips CD-i players at www.icdia.org to see how much NV-RAM space a particular player has. Files are stored using standard OS-9 filenames of up to 28 characters in length with upper and lower case letters. When player memory is full, the application may provide a way to erase certain items. Maintenance of items in NV-RAM can always be taken care of by selecting Memory or Storage from the player's startup shell.

4.8.1 I cannot delete items from my CD-i player's memory, why?

You are probably suffering from the CD-i broken NV-RAM issue. Please refer to the article in the CD-i Articles section at www.icdia.org for more information on how to solve this problem.

4.9 What pointing devices can be connected to a CD-i player?

The Green Book defines that every CD-i system should be able to control the cursor on screen using an X/Y control device, including two action buttons. It is not specified in what way this should be taken care of, or how pointing device should be connected or interfaced to a player. However, Philips defined a connector type and interface format for pointing devices that is used on all Philips CD-i players, even the ones with a bundled Infra Red remote control (except the early CDI 180), and most CD-i players from other manufacturers (LG, Grundig, Memorex, DVS, etc.). This connection type is not part of the Green Book, but just a recommendation from Philips. Note that the Infra Red remote control does not use this pointing device connector or interface, it is completely player dependend (see: 4.9.2 What is the difference between RC5 and RC6?).

All kinds of pointing devices were available. Among them were mice, trackballs, kids Roller Controllers, game pads, touch pads, touchscreens, wired joypads and even a game laser gun. For a complete overview of all available pointing devices including a picture, please refer to the Philips CD-i Pointing Devices overview at www.icdia.org.

4.9.1 How many ports for pointing devices does a player have?

All Philips CD-i players provide at least one input port for pointing devices. Some players have an RS-232 port at the back that can also be used to connect a pointing device (CDI 910, CDI 205, early versions of CDI 210, early versions of CDI 220, among others). A few players provide two ports for input devices alongside this RS-232 port (CDI 740, CDI 615, CDI 660, CDI 670). All other players have either only one input port, or one input port and an RS-232 connector that can not be used for pointing devices. In this case, a port splitter should be used to connect two pointing devices to use for example in multi-player games (except the portable players CDI 310, CDI 350 and CDI 360). To make things even more complicated: this port splitter can not be used on players that already have an input port for pointing devices. Refer to the column I/O in the Comparison table of all Philips CD-i players at www.icdia.org to see how pointing devices can be connected to a particular player.

4.9.2 What's the difference between RC5 and RC6?

Most Philips CD-i players (except the CDI 450, CDI 550 and the CD-i/Hifi combination FW380i) provided an IR receiver for the usage of a wireless controller to point the on screen cursor and select options. The first batch of players used the Enhanced RC5 system and were bundled with the Thumbstick, a remote control with a small thumb-controlled joystick on it. Later models used RC6 and were bundled with the CD-i Commander, a stylish remote that allowed for pressure

differences to speed up or slow down the movement of the cursor. A few players accepted both RC-formats. Refer to the Comparison table of all Philips CD-i players at www.icdia.org to see which remote can be used. Please note that both Enhanced RC5 and RC6 are Philips-specific developments, they are not part of the Green Book.

4.10 Can a keyboard be connected to a CD-i player?

Yes. Philips sold a keyboard for CD-i players called CD-i KeyControl. The keyboard could be used to enter Favourite Track Selection names for CD-Audio discs in the player's startup shell, for entering text in CD-i Internet applications and for searching in the Dutch encyclopedia and the Dutch medical encyclopedia titles. I know of no other titles that supported the CD-i KeyControl. CD-i developers please note: the CD-i KeyControl is not a terminal-style RS-232 keyboard, it cannot be used for text input using for example MediaMogul!

4.11 Can a CD-i player be used for accessing the Internet?

Yes. A CD-i Internet connection kit was sold by Philips in the UK, The Netherlands and Belgium as CD-Online, and in the US as Web-i. It consisted of a 14.4 Kbps modem with appropriate connection cables, a CD-i disc and the subscription data for the service which was provided by selected partners. The package allowed users to view web pages, browse through newsgroups and send and receive e-mails. On the CD-i discs were all required software, several video clips that could be triggered from the CD-Online or Web-i homepages and some images from the most popular web sites. In that way, the CD-i disc functioned as a cache for this information. But due to the relatively slow CPU used in a CD-i player (an 68000 equivalent at 15 MHz), the decoding of simple JPEG and GIF images took a very long time and when done they looked rather jerky on the TV screen. Therefore, the CD-i Internet kit did not become popular among CD-i users. It was impossible to speed up the decoding process due to CD-i internal bottlenecks, nor was it possible to include a faster modem because it had to work with all existing players, of which the first models were equipped with a UART that could not handle speeds above 14.4 Kbps. All in all, the CD-i Internet connection kit was a fun but not very useful addition to the already extensive list of possible usage opportunities of a CD-i player.

4.11.1 What was Tele-CD-i?

Tele-CD-i had nothing to do with the CD-i Internet connection kit. Tele-CD-i was aimed solely at professional applications where the producer needed to access external data through a network connection. For this, the Tele-CD-i assistant, a 2400 bps modem, was introduced. Tele-CD-i could for example be used to send statistical information about the usage of a CD-i information kiosk to the head offices, or to gather the latest price information from a central location. One of the companies that used Tele-CD-i was Bose in its kiosk application about its Dolby Surround products. The kiosk in a store could be controlled from a central location using the network connection. Tele-CD-i was never sold as a consumer accessory.

4.12 Can a CD-i player read CD-Recordable (CD-R) or CD-ReWritable (CD-RW) discs?

Unlike some DVD-Video players, every CD-i player can read CD-Recordable discs with compatible content (eg. CD-Audio, CD-i, Video-CD, Photo-CD, etc.). The player makes no difference between regular pressed discs and CD-Recordable discs, there is no need for any adaptation like on the PlayStation. Because CD-ReWritable was not yet available at the time most CD-i players were introduced, they cannot read CD-RW discs. However, we found that the CD-i players based on the CDM-9 optical drive unit (CDI 910, CDI 205, early versions of CDI 210, early versions of CDI 220) were able to read CD-RW discs of good quality (we tested Philips-branded discs to be successful, but other cheaper discs which failed). Please note that there is no guarantee on this, just try some brands of discs if you want for some reason to play CD-RW discs on a CD-i player.

4.13 Can a CD-i player read multi-session CDs?

Yes, most players can. Multi-session was defined in the Orange Book part II for CD-Recordable when Philips and Kodak were working on the Photo-CD specification to allow for the addition of new pictures at a later time. Since Photo-CD was introduced as a subset of CD-i, multisession became a standard feature of all consumer CD-i players. Only some early professional CD-i players that were introduced before the Orange Book/Photo-CD spec was finalized (CDI 180, CDI 601, CDI 602 and CDI 605/00) were unable to read multi-session discs, those players only access and play the first session. Because of this multi-session capability, some CD-ROM discs with Audio-content (the so called CD-Plus or CD-Extra discs) can not play audio on a CD-i player. The CD-ROM part is contained in the second session which is ignored by a regular CD-Audio player, but not by a CD-i player. Since the TOC in the second session does not refer back to the CD-Audio tracks, a CD-i player is unable to play them. Multi-session capability is not part of the Green Book, but is implemented by all manufacturers of consumer CD-i players.

4.14 How can a CD-i player be connected to a TV or stereo system?

It is completely up to the manufacturer of a CD-i player how the player can be connected to a TV set. There are several connection methods available, such as (ranging from bad to good) RF (antenna), CVBS (composite video), Y/C (seperated chroma and brightness information, sometimes referred to as Hi-8 or SVHS) and RGB (component video for each of the red, green and blue color components). If available use RGB, which is available on most European players as a SCART- or Euroconnector. If not, use Y/C. Only in all other circumstances use CVBS or RF, since these provide a significant lower color reproduction quality and sharpness compared to RGB and Y/C.

Most CD-i player have two standard cinch connectors for audio output. These connectors can be connected to any stereo-system (make sure not to use the input port for a phonograph if still available, any other one like tape, aux or TV is fine). Some players (most notably the portables) have a mini-jack audio output instead of two cinch outputs. Make sure you get the correct cable set.

4.15 What is the Digital Out connector on some players used for?

Some players have a Digital Ouput connector (newer versions of CDI 220, CDI 740, CDI 615, CDI 660 and CDI 670). This connection provides a standard S/PDIF (Sony/Philips Digital Interface Format) signal. It can be used to connect a CD-i player to a digital recording device like a MiniDisc-recorder or an Audio CD-Recorder. I would however not advise to use a CD-i player with digital recording, especially not with write-once media like CD-R, since the player shell does not allow for very accurate starting and stopping of playback. This is usually delayed some parts of a second, due to the fact that the player's shell first draws the information on the screen, and then executes the command. Please note: The Digital Out connector only provides a signal when playing a CD-Audio disc, *not* when playing a CD-i title, since CD-i uses a different audio coding scheme (ADPCM or MPEG audio) that differs from the standard S/PDIF format. The digital output connectors on the authoring players CDI 180 and CDI 605 are inteneded for connection to a CD-i authoring system or emulator, and can not be used for audio.

4.16 Is there a difference between PAL, SECAM and NTSC?

From a hardware point of view there is. A consumer CD-i player is localized for a specific broadcast system. The output signal of the video connectors is according to this local system. You can tell which broadcast system is used by looking at the version indication after the normal type ID (refer to: 4.6 What does the /00, /20, etc. after the type-indication mean?). Most professional and authoring CD-i players (CDI 180 and CDI 6xx) have a switch at the back panel which allows you to select the appopriate broadcast system.

From a software point of view, there is no actual difference between the three broadcast systems. Every CD-i disc can be played on every CD-i player. However, as with DVD-Video, some notes with respect to aspect ratio and safety area need to be take into account. Please refer to: 3.13.2 Does CD-i make a difference between PAL and NTSC?.

4.17 Can CD-i be used on DTV, IDTV and HDTV television sets?

Yes, they can. All future TV sets provide for some means of connecting an analogue video source like a CD-i player or VCR. Note that it is not possible to make a digital connection to for example a DTV (Digital TV) or HDTV (High Definition TV) set with current players, nor will the picture quality be improved when such a TV is used.

4.18 Is a CD-i player Y2K proof?

Yes. CD-i is based on the OS-9 operating system, which is very Unix like. It therefore does not suffer from Windows or DOS-style year 2000 problems. Since Unix stores a year in a 7 bit field which starts counting at the year 1900, the first problems (if any) will arise in 2027 (so then we have a Y2.027K problem :-). A CD-i player continues to count onwards from the beginning of 2000, but it needs to be switched off and on at least one time in the new millennium for the player to perform the necessary calculations at system startup. When displaying a post-2000 date from a file correctly, some calculations need to be made by the application (in most cases, this involves only adding a 100 to the results produced by the system). It is however very rare that an application displays file creation dates, and the Memory and Storage options in the CD-i player's startup shell have already taken care of this problem. The only problem-causing exception might be CD-i players equipped with a floppy disk drive (CDI 310, CDI 180, CDI 602, CDI 605 and CDI 615) when using MS-DOS formatted floppies. For this to be solved, an updated device driver (called PCF) is available from Philips. More information is available in a white paper from Philips that can be downloaded at the CD-i Technical Documentation downloads section at www.icdia.org.

5. Disc types

5.1 What is a CD-i disc?

A CD-i disc is a type of CD with audio, video and program content that can be played on a CD-i player. A CD may be called a CD-i disc only when it fully conforms to the CD-i Full Functional Specification, as laid down in the Green Book. When a CD-i disc does not fully conform to this specification (even if it can be played on a CD-i player, such as a Photo-CD or a Video-CD), it is not a CD-i disc. You can recognize a CD-i disc by its official logo that should be printed on the discs cover and on the disc itself. For more information about the CD-i system, the logo and the Green Book, refer to section 1 of this FAQ: The CD-i system.

5.2 What is CD-i Ready?

CD-i Ready is a special kind of CD-i disc. Following the rules from the Green Book, a CD-i disc may contain CD-Audio tracks. These should be placed after the CD-i track which is always track 1. However, on some older CD-Audio players, this CD-i track would be played back resulting in possible damage to equipment or speakers. To prevent this, the CD-i Ready format was defined. On a CD-i Ready disc, the CD-i program data (including all of its audio and video information) is stored in the pause sectors *preceding* track 1. Usually, pause sectors preceding track 1 are skipped by most CD-Audio players, but they can be read fine on a CD-i player. This allowed for a greater compatibility of CD-Audio discs which contained extra information when played on a CD-i player. In essence, a CD-i Ready disc is not a true CD-i disc, since it does not follow the rules of the Green Book for placing CD-Audio data, but they can be read correctly by all CD-i players ever produced.

CD-i Ready discs are usually music CDs (you can recognize these CDs by the indication CD-i Ready or CD-i Music in the upper left corner of the disc packaging), but they may also be other kinds of discs. For example, some games (most notably the games produced by SPC Group/The Vision Factory) are known to be in the CD-i Ready format. CD-i players equipped with the second generation player shell (refer to Comparison table of all Philips CD-i players at www.icdia.org) may optionally play the audio-tracks of a CD-i Ready disc using the standard CD-Audio screen.

5.3 What is CD-Digital Audio or CD-DA?

Compact Disc Digital Audio is the official name of the original music CD. It was defined by Philips and Sony in the early 80s and its specifications were laid down in the Red Book. All CD discs and CD players should be in accordance with this specification to allow the bearing of the Compact Disc Digital Audio logo. This specification assures that every CD-Audio disc can be played in every CD-Audio player where-ever in the world.

The Green Book defines that any CD-i player should be able to play back CD-Digital Audio discs. For this, a CD-i player pops up a player shell when a CD-Audio disc is loaded in the player. This player shell allows for the direct selection of tracks, for programming Favourite Track Selections, for standard search options, etc. It's up to each manufacturer to decide what this player shell will look like and what features are offered, as long as all content of a CD-Audio disc can be played back on a CD-i player.

Look for the special note about CD-Extra (CD-Plus or Enhanced CD) in question 5.18.

5.4 What is CD+Graphics?

CD+Graphics or CD+G is an extension to the Red Book, defined by Philips and JVC. CD+G allows for the storage of simple graphics in the subcode channels of each sector on a CD-Audio disc. Each sector has 8 subcode channels combining 384 bits, resulting in 75 (sectors per

second) x 384 bits = approx. 3.6 Kbyte per second. Due to this low bit rate, only very simple graphics can be stored. CD+Graphics can show 16 colors at one time on the screen, from a palette of 4096 colors in a resolution of 288x192 pixels. Any font that is used has to be encoded in the graphics stream as a graphical element. CD+G allows for the change of colors used on the screen, so that words can be highlighted for singalong purposes. CD+G is mainly used in Japan for karaoke-applications, and never gained much popularity outside this country. However, in Japan quite a few CDs were enhanced with CD+Graphics.

CD+G can be played on CD-Audio players with a Digital Output connected to a CD+G decoder, on most game consoles (like CDTV and 3DO) and on dedicated CD+G players. Although CD+Graphics is technically not related to CD-i, Philips included CD+G playback in all of its consumer CD-i players (CD+G playback is not included in the professional players CDI 180 and CDI 6xx series, except CDI 615). Note that also a very rare variant of CD+G exists, called CD+Enhanced Graphics. The extended graphics cannot be shown on a CD-i player, however the system is downwards compatible with CD+G.

A tool to create CD-Audio discs with CD+Graphics can be found on the Other CD-i tools page in the PC/Windows download section at www.icdia.org. With this tool, you can define a background picture for each track.

5.5 What is CD-BGM?

CD-BGM or CD-BackGround Music is a type of CD defined by Philips, Sanyo and Shinano-Kenshi in the mid 80s. Sometimes the system is being referred to as BMS (Background Music System). CD-BGM is used to store up to 10 hours of audio to use a background music in stores, shopping malls, etc. CD-BGM uses ADPCM level B mono audio to accomplish this. The music was stored in 8 tracks, all of which were divided in titles. Usually there were about 15 titles per track, resulting in about 120 songs per disc (about 8 hours). Although dedicated professional CD-BGM players were made available to play the discs (of which the Philips BMS 3000 was the most well-known), every CD-BGM disc also needs to include a CD-i application to allow for playback on a CD-i player.

It is not defined what features this application should include, as long it allows for the music to be reproduced on a CD-i player. This is why the early CD-BGM discs from Sanyo showed a screen divided in two halves, with the upper half displaying 'start', and the lower half displaying 'stop'. Actually, these discs were the first commercially released discs for CD-i ever. Fortunately, Philips put some more attention to its CD-i application for CD-BGM. It shows a list of all tracks that are available on the disc, which can then be selected for playback. Several hundreds of CD-BGM titles were made by Philips alone. Note: you cannot buy CD-BGM discs, they could only be 'rented' by professional users from selected Philips partners.

An article describing the history of CD-BGM and the features of Philips' CD-i application for CD-BGM discs is available in the Related Technologies section at www.icdia.org.

5.6 What is a CD-i Bridge disc?

A CD-i Bridge disc is a CD-ROM/XA disc which includes a CD-i application for playback on a CD-i player. A CD-i Bridge disc is based on the ISO-9660 file system to allow for the usage on other platforms like PCs or Macintoshes. It is not obligated to store applications for other platforms, but they may be included on the disc. Usually, audio and video are encoded using CD-i encoding techniques like ADPCM for audio or MPEG for video.

Well-known examples of CD-i Bridge discs are Photo-CD, Karaoke-CD and Video-CD, but it is also allowed to use the CD-i Bridge disc 'specification' to make a dedicated disc type, as long as the disc is based on the ISO-9660 filesystem and it includes an application for playback on a CD-i player.

5.7 What is Video-CD?

A Video-CD is a compact disc with up to 75 minutes of VHS quality video with accompanying sound in CD quality. Audio and video are coded according to the MPEG-1 standard and the disc layout is based on the CD-i Bridge specification to allow for the playback on a variety of playback devices like CD-i players and dedicated Video-CD players. The first version of the Video-CD spec was still called Karaoke-CD (see: 5.8 What is Karaoke-CD?) and was set up by Philips and JVC in 1993. Soon after followed the 1.1 spec, in which the name of the system was changed into Video-CD and the spec publishers were joined by Sony and Matsushita. Some years later, the 2.0 version added the ability to store still pictures on the disc and even allows for limited interactivity in the form of menu screens and selection items.

Video-CD became very popular mainly in Asia, as some 40 million Video-CD compatible players were sold by the beginning of 2000. Outside of Asia, Video-CD was mainly used as a prototype tool or as a cheap way to produce DVD-Video compatible discs. Although Video-CD compatibility is not required for DVD-Video players, it is very likely that Video-CD playback functionality is included since every DVD-Video player must be able to decode MPEG-1 as well.

For more information about Video-CD, the difference between Digital Video on CD-i and Video-CD, the various Video-CD versions, the various Video-CD applications for CD-i and other questions, please refer to section 6 of this FAQ: Video-CD on CD-i.

5.8 What is Karaoke-CD?

Karaoke-CD is the old name of the Video-CD standard. It dates back to 1993 when the standard was set up by Philips and JVC and the support of Sony and Matsushita was not yet there (they joined some time later when the name was changed into Video-CD). Karaoke-CD was -as its name already shows- mainly intended for karaoke applications in Japan. The system uses MPEG-1 audio and video, and is based on the CD-i Bridge specification. Therefore, Karaoke-CD is completely compatible with CD-i players among others.

5.9 What is Photo-CD?

The Photo-CD system was defined jointly by Philips and Kodak in 1991. The system allows for the storage of very high quality photographic images on a compact disc. The system is based on the CD-i Bridge specification to allow for the playback of Photo-CD discs on CD-i players, Photo-CD players (an overview of all Photo-CD players is available in the Related Technologies section at www.icdia.org) and other systems.

Photo-CD was introduced as a complete consumer service product. Consumers were able to request for a Photo-CD when they brought their 35mm film to a Kodak photo-finisher for development. The resulted disc contained all of the photos in a variety of image resolution qualities. The disc could be returned to the photo-finisher to add more photo's, up to a total of slightly over 100 pictures. For this, the multi session feature was added to the CD-Recordable definition in the Orange Book.

The pictures on a Photo-CD are coded according to a Kodak-developed compression technique called Photo YCC. This algorithm makes use of the fact that the human eye is far less sensible for color differences than for changes in brightness in a picture. This reduces the size of a scanned picture from 18 MB to 3 to 6 MB per 'Image Pack'. Each picture is stored in an Image Pack, which contains one picture in 5 resolutions: Base/16 (192 x 128), Base/4 (384 x 256), Base (768 x 512), 4Base (1536 x 1024) and 16Base (3072 x 2048). These different resolutions can be used for a variety of purposes: the smallest ones can be used to produce a thumbnail overview on screen, the middle resolution can be used to show the picture in high quality on a TV screen, the 4Base resolution is used to zoom in on a particular area of a picture and the highest resolution can be used to make photographic quality prints. The latter one makes Photo-CD an excellent and durable storage medium.

5.9.1 What Photo-CD variants are available? Do they all play on CD-i?

Kodak and Philips defined 5 different variants of Photo-CD aimed at various types of usage. All of these types were based on the basic Photo-CD specification and are in accordance with the CD-i Bridge specification. All can be played on all Photo-CD compliant playback devices like a CD-i player.

- Photo-CD Master

The 'regular' consumer Photo-CD, as the ones made by photo-finishers. A Photo-CD master contains pictures in up to 16Base resolution.

- Pro Photo-CD Master

Pro Photo-CD is aimed at professional photographers. It allows for the storage of larger film formats than 35mm, for example 70mm. For this, an extra resolution is added to the Image Pack: 64Base which is 6144 x 4096. As a result, these images consist of 25.165.824 pixels, 32 times as much as the photos of a regular digital camera. A Photo-CD player and a CD-i player can play these discs in the regular way, however they make no use of this highest resolution.

- Photo-CD Portfolio

A Photo-CD Portfolio disc contains images in up to Base resolution, which is perfectly suitable for display on a TV screen and still allow for zoom functionality. Photo-CD Portfolio is therefore used as a prerecorded medium to distribute large amounts of pictures (up to about 800) in a suitable way. A Photo-CD Portfolio may include sound in CD-Audio quality, pre-recorded playlists and even selection items on a photo which refer to other photos or playlists. These interactive features can be accessed on a Photo-CD player or a CD-i player when the appropriate CD-i application is stored on the disc.

- Catalog Photo-CD

A Catalog Photo-CD only stores images up to Base resolution. This allows for the storage of several thousands of images in TV resolution. Catalog Photo-CD is rarely used.

- Medical Photo-CD

Another professional Photo-CD variant, aimed at medical use. A Medical Photo-CD can be used for doctors to store CT or MRI scans for later reference.

5.9.2 What are the differences between the various Photo-CD applications for CD-i?

As a result of the CD-i Bridge specification on which Photo-CD was based, every Photo-CD *must* include a CD-i application to allow for the playback of the disc on a CD-i player. So far, Philips is the only company that produced such a CD-i application. A version of it is included with most Photo-CD authoring tools, and it is included on the Kodak PIW Workstation that is used by photo-finishers to make Photo-CDs.

Naturally, Philips continued to improve the performance and features of this application, that's why various versions of it exist. The version that is used on a particular disc is shown when the Exit-function is selected from the main menu. Although many interim versions existed that were used internally within Philips, only a few of them were actually released to developers and Kodak. The most important of them were:

- Version 1.x

The first version of the CD-i application for Photo-CD had a somewhat clumsy layout, and used rather small buttons that were placed on screen all at once when the menu was recalled. It allowed for the programming of photos in any order, for the rotation of pictures, and for zooming at a fixed zoom factor. Furthermore, it could show an overview of pictures on the disc on a thumbnail screen.

- Version 2.3

As from version 2 onwards, the style of the on screen displays and the over-all look of the application was drastically changed. The menu that is shown on screen when a photo is displayed now only displays the main functions, an extra menu can be recalled to access the zoom function and the high/low resolution switch. This switch was added to speed up the loading

of an image. This high/low res setting was valid for all Photo-CD discs (with this version of the application) that were loaded in a particular CD-i player. This 2.3 version was bundled with version 3.0 of the Kodak PIW Workstation software for photo-finishers that was released in late 1992.

- Version 3.1

Version 3.1 added some major functionality and improved performance compared to 2.3. To start with, it supports playlists and the playback of audio as defined for Portfolio Photo-CD. This allowed CD-i users to access the limited interactive features offered by this disc type. The load of an image can be interrupted by the user, and new images are displayed with a top to bottom wipe on top of the previous image, without clearing the screen black at first. The low or high resolution setting is now remembered per individual photo. This 3.1 version was bundled with version 4.1 of the Kodak PIW Workstation software for photo-finishers that was released in August 1993.

- Version 3.2

Version 3.2 includes some performance enhancements to allow for faster generation of the index thumbnail screen. It was the latest commercially released version of the application.

It is clear that a Photo-CD with version 3.x of the CD-i application offers a great improvement in terms of usability and performance. If you plan to make Photo-CDs, make sure that this version or later is included with your authoring package. There was also a version 3.2.1 of the Photo-CD on CD-i application, which allowed for a variable zoom factor, allowing you to zoom in at a very small area of a picture. Since this version is never released to Kodak, Photo-CDs with this version of the CD-i application are very rare.

As an alternative, a small (63 KB) single file application for CD-i players exists. It does not allow for favourite picture selection, nor does it support playlists, but it allows you to use a variable zoom factor to zoom in on a small area of the picture.

The latest commercial release of the Photo-CD on CD-i application (3.2) as well as the alternative application are available for download at the CD-i Application Downloads section at www.icdia.org.

A document explaining how to use all menu functions of Philips' Photo-CD on CD-i application 3.x can be found in the CD-i Technical Documentation / Software section at www.icdia.org.

5.10 Will CD-i play Picture-CD?

There are two completely different systems available currently, both of which are called Picture-CD. One is defined by Kodak, the other one by Corel and Adaptec. A Kodak Picture-CD is used in the same way as a Photo-CD, but the file format is different, and an application for Microsoft Windows instead of CD-i is stored on the CD. As a result, a Kodak Picture-CD is not compatible with Photo-CD players or CD-i players.

However, there are plans to make Kodak Picture-CD compatible with Video-CD 2.0 compliant players like Video-CD players, DVD-Video players and CD-i players by including all pictures as an MPEG still on the disc as well. The Nero Burning Rom CD-R authoring package from Ahead GmbH is known to support this feature from version 5.0 onwards, and it includes a compatible CD-i application to show the pictures in high resolution on TV using a CD-i player (see question: 7.13 How can I play my pictures on my CD-i player? for more info). Please note that Video-CD or CD-i compatibility is *not* a mandatory requirement of a Picture-CD, and hence can not be guaranteed. It is very likely that Kodak will replace the Photo-CD creation service of its photo-finishers with a Picture-CD service.

The other Picture-CD variant is defined by Corel for its Corel CD Creator CD-R package, and was later adapted by Adaptec when the product was sold to this company and renamed into Adaptec Easy CD Creator. An Adaptec Picture-CD is a type of disc with images in Kodak Photo-CD format, but the files are not placed at the sector locations specified by the Photo-CD specification,

required files are missing and a CD-i application is not available. Hence, an Adaptec Picture-CD cannot be played on a Photo-CD player or a CD-i player. Adaptec is likely to use this strategy to bypass the expensive license fees from Kodak.

5.11 Will CD-i play CD-ROM discs?

The term CD-ROM is used for all types of usage of a CD in computer applications. A CD-ROM can contain various filesystems (like ISO-9660, Joliet, Apple HFS, Unix, etc.) or programs for a wide variety of computer systems (Microsoft Windows, Apple Macintosh, Linux, Free BSD, Solaris, BeOS, etc.). A CD-ROM that was made for one particular operating system, cannot be used on another system. There is no such thing as the "CD-ROM system". The difference between the CD-ROM specification in the Yellow Book and all other CD-systems is that only the physical sector format is defined, and not the application of a disc. Hence, a CD-ROM can only be played on a CD-i player when a CD-i application program is stored on the CD. In this case, a CD-ROM is called a CD-i Bridge disc (see: 5.6 What is a CD-i Bridge disc?), but usually these kinds of CDs are not called CD-ROMs on the discs packaging.

5.12 Will CD-i play Sony Electronic Book (Data Discman) titles?

Sony sold a portable playback device in 1991 called Data Discman. It accepted 8 cm CDs in a cartridge, which contained information in the form of text and very simple graphics. The application to show this information on the built-in black and white LCD screen was build in the player. These so-called Electronic Books were used for travel guides, dictionaries and other kinds of information that can be used on the road.

When Sony first announced Electronic Book, they promised to make the system CD-i compatible in the near future. For this, a CD-i application would be included on the discs. But some years later, Sony officially announced to Philips that this was not going to happen. This announcement was never made available to general public. Hence, an Electronic Book disc cannot be played on a CD-i player.

5.13 Will CD-i play Super Video-CD?

Super Video-CD is an extension to the Video-CD specification, set up by the original Video-CD licensees (Philips, Sony, JVC and Matsushita) in 1999. Super Video-CD uses DVD-quality MPEG-2 video on a standard CD which runs at variable bit rates up to double speed (2.8 kbps). This allows for 35 to 70 minutes of high quality video on a regular CD. Super Video-CD is a cheap way of making discs that are playable on compatible DVD-Video players using a regular CD-Recorder.

Since Super Video-CD uses MPEG-2 video compression instead of MPEG-1 that is used in CD-i, and because of the fact that the disc can be played up to double speed of which a CD-i player is not capable, a Super Video-CD cannot be played on a CD-i player. Therefore, the CD-i application that is mandatory for Video-CD is not available on a Super Video-CD.

5.14 Will CD-i play Super Audio-CD?

Super Audio-CD was introduced by Philips and Sony in 1999 as the successor of the popular Audio-CD. The system uses a new audio encoding technique called DSD (Direct Stream Digital), which comes way much closer to the original analogue audio quality than PCM which is used for regular Audio-CDs. To store the large amounts of data that are needed for DSD, a Super Audio-CD uses a DVD-like high density disc.

One of the great features of Super Audio-CD is that it allows for a CD-compatible data layer on a disc. When such a CD layer is available on the disc, it can be played on any CD player, including a CD-i player (in standard CD quality of course). Please note that this CD-Audio layer is a

producer's option, and is not required for any Super Audio-CD. Only discs with this CD-compatible layer can be played on a CD-i player. Look for this information on the CDs case.

5.15 Will CD-i play HDCD, CD-Video, CD-MIDI or CD-Text?

HDCD (High Density Compatible Digital) is an extension to CD-Audio which raises the bit depth of the samples from 16 to 20 bits, allowing for a higher sound quality on players with a HDCD decoder. Any HDCD-CD can be played on any CD-player, including CD-i players. To date, no CD-i player makes use of this extra HDCD-information.

CD-Video (not to be confused with Video-CD, which is a totally different system) is a 12 cm CD which contains 20 minutes of CD-Audio and up to 6 minutes of LaserDisc-format analogue video. The video can only be played on LaserDisc players, the audio can be played on any CD-player, including CD-i players.

CD-MIDI is a CD-Audio disc with MIDI (Musical Instrument Digital Interface) information in the subcode channels. This allows for MIDI-devices like synthesizers to play along with the music on the CD. The applications of CD-MIDI are very rare. The audio of a CD-MIDI disc can be played on any CD-player, including CD-i players.

CD-Text is a CD-Audio disc with the names of songs and performers stored in the subcode channels. This information can be made available on the displays of compatible CD-players. It is very likely that all future CD-Audio discs will contain CD-Text information. To date, no CD-i player will display CD-Text information. The audio of a CD-Text disc can be played on any CD-player, including CD-i players.

5.16 Will CD-i play DVD discs?

No. A DVD is a different kind of disc, based on a high density format. It requires a new physical laser unit to read the discs. A CD-i player can only read discs based on the normal infra-red laser technique: compact discs or CDs. It is unlikely that a combination playback device for CD-i and DVD will ever become available, nor will it be possible to upgrade a CD-i player to play DVD discs since this should require the replacement of the entire disc read-out mechanism.

5.17 Will a DVD-player play CD-i discs?

A DVD-Video player cannot play CD-i discs, since it does not include all of the CD-i logics such as the required operating system in ROM, the CPU and the appropriate audio and video decoding ICs. Most DVD-Video players however can play Video-CDs, but they use an internal playback application instead of the CD-i application that is stored on every Video-CD disc. Hence, CD-i specific additions such as menu screens or subtitles will not be shown.

A DVD-ROM drive is physically able to read CD-i discs, but since a normal PC is unable to play CD-i titles, you won't be able to run them. Refer to section 9 of this FAQ: CD-i on other platforms for more information.

5.18 I'm having troubles playing a CD-Extra (CD-Plus, Enhanced CD). Why?

A CD-Audio disc may contain data tracks, for example containing CD-ROM programs with additional info about the performing artist. However, when such a disc is played on an old CD-Audio player, the data track would not be recognized as such, resulting in the playback of noise. Playing this noise loud could eventually result in the damaging of the speakers.

To avoid this problem, Philips, Sony and Microsoft established a standard which was initially called CD-Plus but which was later renamed into CD-Extra due to trademark-related issues.

Sometimes it's also called Enhanced (Music) CD. The logo is made up of the regular CD-Digital Audio sign with a '+'-mark next to it. The standard is described in the Blue Book.

Such a CD-Extra is a so called "stamped multi-session" disc. It is in essence a multi-session disc like the ones you can create with your CD-Recorder, with the music in session 1, and the data in session 2. Every ordinary CD-Audio player can only read the first session and it will play the music without the risk of playing back the noisy data. A computer with a multisession CD-ROM drive (all drives manufactured after 1992) can access the data in a normal way. And this is where the CD-i "problem" comes in: since virtually all CD-i players (with the exception of some older professional models) contain a multi-session drive, the player reads the latest session (which it is supposed to do according to the multi-session specification) where it wouldn't find any CD-i data nor audio-tracks. As a result, the disc will not play. The CD-i player is too smart to fall for the CD-Extra trick! This problem can not be solved in any way :-(

Remember that a CD-i player *can* play the CD-Audio tracks of CD-ROM discs that contain the CD-ROM data as a regular track. Look for the CD-Extra (CD-Digital Audio+) logo on a disc to verify whether it is a true CD-Extra disc and hence not usable on a CD-i player.

6. Video-CD on CD-i

6.1 What's the difference between a Video-CD and a Digital Video on CD-i disc?

In conjunction with the introduction of the Digital Video cartridge for CD-i players in 1993, Philips published some movies on CD that can be played on a CD-i player equipped with such a cartridge. Although the Video-CD specification already existed at that time, for some marketing-political reasons the movies were released in CD-i format instead of Video-CD. This means that the discs can only be played on CD-i players and not on Video-CD compliant players like Video-CD players, game consoles and most DVD-Video players.

Although the discs looked very similar to 'normal' Video-CDs, Philips used two techniques to make them distinguish from Video-CDs: the physical sector locations of the video-files differs from Video-CD and the used file system is CD-i's proprietary format instead of ISO-9660 which is required for CD-i Bridge format discs like Video-CD. As a result, both playback devices that look for the MPEG-files to play them (such as PCs) and playback devices that are based on simple microcontroller circuits that start playback of video at a defined sector location (like Video-CD players and DVD-Video players) cannot play the discs.

To identify the format in which a movie is published, look at the text in the lower left corner at the front of the disc's inlay. When it says Digital Video on CD-i, it is in CD-i format. When it says Video-CD, it is in Video-CD format. Please beware not to look at the text printed on the plastic of the case itself. Some true Video-CDs contained the text 'CD-i' on the case. The correct format however is always clearly indicated on the inlay. Some 20 or so movies were published in the Digital Video on CD-i format, of which most were re-released in Video-CD format some time later.

Some Asian Video-CD players were able to run some of the Digital Video on CD-i discs as if they were Video-CDs. Please note that these players only play some of the titles indicated as Digital Video on CD-i, but not regular CD-i discs (nor the MPEG video sequences contained on it) which are usually indicated as CD-i Digital Video.

To bypass the file format problem on Windows 95/98 based PCs, a solution was made available in late 1999 with the release of the CD-i Filesystem Driver. When this driver is installed, you can access a CD-i disc in a similar way as a CD-ROM, and you will be able to play MPEG sequences that are stored on it. The CD-i Filesystem Driver is available for free download at the PC downloads for CD-i development page at www.icdia.org. For more information about using the driver, please refer to section 9 of this FAQ: CD-i on other platforms.

6.2 What are the differences between the various Video-CD versions?

Several versions of the Video-CD specification (described in the White Book) exist. All of the versions are interchangeable as far as the video sequences are concerned (e.g. the video on any Video-CD can be played on any Video-CD player regardless of its version), but some discs may contain features that are described in a higher version which are only accessible on a player that supports this higher version of the standard. The following versions of Video-CD exist today:

- Karaoke-CD 1.0

The first version of Video-CD was still called Karaoke-CD. It was set up by Philips and JVC in 1992 to be used mainly in Japanese karaoke-applications. Only the basic video features (like the division of various songs into tracks) were specified in this version.

- Video-CD 1.1

The system was renamed into Video-CD in 1993 to show the broader range of applications in which it could be used. The system is now defined by Sony and Matsushita as well. Some features were added, like the sub-division of a track (an MPEG video sequence) into chapters.

This allowed for the playback of continuous video while still providing the possibility to jump directly to a specific chapter.

- **Video-CD 2.0**

With Video-CD 2.0, introduced in 1994 by all of the original Video-CD 1.1 companies, some very neat features were added, like limited interactivity in the form of menu screens with selection items (comparable to DVD-Video), the use of high resolution MPEG-still images, the possibility of slide shows with or without audio and the possible inclusion of CD-Audio tracks on the disc.

Please refer to: 6.3.2 What version of the CD-i application should be used for the different Video-CD versions? for more information about the use of the CD-i application with respect to the various versions of the Video-CD specification.

6.3 What CD-i applications for Video-CD were available?

To allow playback of a Video-CD title on a CD-i player, every Video-CD disc *must* include a CD-i application. This is a mandatory requirement in all versions of the Video-CD specification. Several of such applications existed, the most important of them were:

- **Video-CD on CD-i**

This software from Philips is probably the best-known CD-i application for Video-CDs. Sometimes it is code-named 'Franklin'. It is used on most (non-American) Video-CDs, and it is bundled with various CD-Recording tools (like Ahead Nero and Adaptec Easy CD Creator). It allows for extensive customization, but it can also be used 'as-is', since it completely adapts itself to the disc's contents. Several versions of this application exist, which are described in more detail in: 6.3.1 What are the differences between the various versions of Video-CD on CD-i? below.

- **Edison**

Edison, developed by Philips Interactive Media of America, was mostly used on American-released Video-CD discs from Philips. The application needs to be adapted by the content developer of a particular Video-CD title to work on a CD-i player, and as such it required extra work to make a Video-CD CD-i compatible. You can recognize the Edison application from its volume option which displays a green indicator on screen.

- **OmniMedia**

OmniMedia from the UK developed their own Video-CD application, which was used on Video-CD discs from Castle Multimedia and EMI Records, among others. As with Edison, it needs to be completely adapted to get it to work on a particular Video-CD title.

- **CeQuadrat**

The CD-i application that is bundled with recent versions of CeQuadrat's CD-Recording tools like WinOnCD 3.6 has been developed by CeQuadrat itself. It does not need to be customized since it dynamically adapts itself to the content of a disc, but it looks rather dull and offers only very limited features (like advancing to the next track). It is expected that future CeQuadrat/Roxio tools (like VideoPack) include an option to replace the bundled CD-i application with the Philips application that can be downloaded from www.icdia.org.

6.3.1 What are the differences between the various versions of Video-CD on CD-i?

As stated above, the most widely used CD-i application for Video-CD discs is Video-CD on CD-i. Of this application several versions exist. The version number of the application will be shown on screen when the application exits. The most important are:

- **Version 1.0**

The first version was especially made for Karaoke-CD. It starts with a short animation displaying the text 'Karaoke-CD'. It adapts itself to the disc's contents, showing the name of the disc and selection boxes with numbers according to the available tracks. The application can be adapted in some limited ways, by replacing the background image from the menu screen, or by replacing the number boxes with boxes with the song's title in it.

- Version 2.0

The program was changed to allow for other applications besides music video or karaoke. The layout of the buttons was changed from the colorfull yellow and red to more quiet shades of gray. Some terminology was changed (like the "Vocals on/off" switch in the settings screen which is now called "Channel 1/2").

- Version 3.0

Complete restyle of the layout of the application, that has been used throughout all 3.x versions. The application now fully supports Video-CD 1.1, for example it allows advancing to chapter points within a track. Display of track number, chapter number and running time using 'on screen display'. It had some new playback features, like displaying successive stills when the pause button is pressed repeatedly. The application can be customized in extensive ways, for example by replacing the background of the menu, by implementing hot-spots within menu screens that advance to video sequences or other menu screens. Minor things like the color of the cursor, the time-out time for the video to begin, and whether or not the introduction sequence should be interruptable could also be defined by the content developer.

- Version 3.01

This version continues the display time on the next disc in a multi-volume disc set, instead of beginning all over again. It allows for CD-i specific subtitling. Scan (search) functions can be enabled or disabled.

- Version 3.1

Search-function now continues when the button is pressed for a given amount of time. 7-speed slow motion function added. Improved the font of CD-i closed captioning. Support for CD-i multi disc titles: the application request the next disc without going through a player reset.

- Version 3.11

Channel selection can be included in the menu screens by content developers (compare to audio selection on a DVD-Video disc). Some minor changes and improvements.

- Version 3.2

Slightly optimized version, minor performance improvements and error correction enhancements.

- Version 4.0

This version of the application fully conforms to the Video-CD 2.0 standard. Customization of menu screens now conforms to the White Book 2.0 standard (background images, menu selections, etc.). Support for the display of high resolution MPEG still images. Support for the playback of CD-Audio tracks on a Video-CD disc. CD-i specific subtitling is still available. CD-i specific customization of background screens and menus as used in the 3.x application has been removed.

- Version 4.1

This version continued the support of the Video-CD 2.0 standard. It now includes support of extended PSD, allowing for hot spot selections in screen images like with the 3.x application (but now in a Video-CD 2.0 consistent manner), instead of only allowing for number selection in the menu bar.

Some interim-releases for the 4.1 version are also available (4.1.1 up to 4.1.7). Minor bugs were fixed and the automatic recovery of video playback in case of a read error was added which is useful in environments where user control is not available (such as with linear in-store video display).

Both the latest Video-CD 1.1 optimized version (3.2) as well as the latest Video-CD 2.0 compliant version (4.1.1) are available for download at the CD-i Application Downloads section at www.icdia.org.

A document intended for Video-CD producers describing how to install and customize the Video-CD on CD-i application version 4.1 can be found in the CD-i Technical Documentation / Software section at www.icdia.org.

6.3.2 What version of the CD-i application should be used for the different Video-CD versions?

When you make a Video-CD, make sure it contains at least version 3.0 of the Video-CD on CD-i application, since the preceding versions do not adapt themselves to the disc's contents. They need to be customized at program level to work on a particular disc. Beginning with version 3.0, when the application is placed on a Video-CD without any customization, it looks for the disc's contents (tracks, chapters, the disc's name, etc.) and presents a menu accordingly.

Version 3.x of the application is especially designed for Video-CD 1.1, it recognizes the tracks and the chapter numbers. Version 4.x is especially designed for Video-CD 2.0, this version displays Video-CD menu structures, stills, etc. When you make a Video-CD 2.0 disc which includes special 2.0 features (like the menu's and stills), and you want to be able to use them on a CD-i player, you must use at least version 4.0 of the application. When you place a 3.x application on a Video-CD 2.0 disc, you will still be able to access tracks and chapters, but you won't see menu screens. This is because the menus in a 3.x application need to be made especially for CD-i, and this is not taken care of by any Video-CD creation tool to date. On the other hand, when you place a 4.x application on a Video-CD 1.1 disc, or on a Video-CD 2.0 disc without any menu screens or stills, you will see the standard version of the application, adapted to the disc's contents.

To conclude: you can exchange both 3.x and 4.x applications on both 1.1 and 2.0 Video-CD discs, but in order to use Video-CD 2.0 enhanced features on a CD-i player, the disc must include a 4.x application. If you make a Video-CD 1.1 disc, or a Video-CD 2.0 disc without the special 2.0 features, and if you have the choice, use the 3.x application. The 3.x application is more stable and generally has a better look than the 4.x application.

Please note: some CD-R tools with Video-CD creation functionality include a version of Video-CD on CD-i that is not adapted to the Video-CD version that is created. For example: Adaptec Easy CD Creator 4 creates Video-CD 2.0 discs with menus but includes a 3.x application. As explained above this works fine, but special conditions apply.

6.3.3 How can I customize the Video-CD on CD-i 3.x application?

Version 3.x of the Video-CD on CD-i application can be extensively customized for display exclusively on CD-i players. This allows for the replacement of the default background image, for the creation of menus with hotspots which direct to other menus or video sequences and for the adjustment of all kinds of settings of the application.

Most Video-CD creation tools do not allow you to make these CD-i specific adaptations. Especially when menu-screens are concerned, this involves heavy knowledge of the format of the image files and menu screens. The way on how to make these screens and menus is defined in the Product Information and Installation Notes manual that is provided with the application when you buy a license from Philips. Contact your CD-R software vendor for a copy when the application was provided with your CD-R creation tool.

Besides the menu screens, there is also a general configuration file called CDI_VCD.CFG which is placed in the /CDI directory on the Video-CD. It is a simple ASCII text file that is being read by the application at startup, which then adapts itself to the given configuration. It contains settings to change the color of the cursor, the type of background replacement, whether the menu bar should be able to be recalled, the timecode to start with on a second disc, the initial track number (on a second disc in a multi-disc set), the initial subtitle language and color, the bumper interruption time, the time out value and whether the scan options should be available. The last one might be important, please refer to: 6.5 Why can't I fast forward or reverse with some discs? hereafter.

6.4 I have a Video-CD. Why won't it play on my CD-i?

It is known that several so-called Video-CDs exist that do not play on a CD-i player. This is mainly the case with certain titles from China and the Far East. Mostly, this is due to the absence of a CD-i application on the disc. As mentioned before, such a CD-i application is a mandatory requirement for a Video-CD, and a disc that does not include it violates the license terms (but this is often the case with illegal discs for which no license fees were paid in the first place!). When no 'Play CD-I' button appears when you load the disc in a CD-i player, or when it does appear but the player resets moments after you selected this button, you can be fairly sure that this is the reason the disc won't play. It has nothing to do with CD-i being unable to play some Video-CD discs (2.0) as is sometimes incorrectly stated in newsgroups among others.

When a disc does include an application and it shows the track numbers, but it won't play the video sequence when you select it or it will 'hang up' the player, this is probably due to the fact that the MPEG video on the disc is not according to the Video-CD specification. It is extensively specified in the White Book how the video and audio should be encoded on a Video-CD. When the video is in a different format it might still play on a PC with a very tolerant video playback application, but it is no actual Video-CD so it won't play on CD-i among others. This is also often the case with illegal Video-CDs from the Far East.

6.5 Why can't I fast forward or reverse with some discs?

To enhance the performance of the scan forward and backward (search) functions in the 3.x versions of Video-CD on CD-i, Philips defined a file format for entry point lists. Such a file contains the absolute address numbers of sectors that contain MPEG I-frames that are needed to display an image when performing a search. For each of the MPEG-files on the disc, an ASCII-file similar called to the MPEG-files (such as AVSEQ01.DAT) should be placed in the /CDI directory. When such files are not present, the application disables the search functions by default.

Since such entry point files are CD-i specific, Video-CD creation software usually does not generate those files. When you still want to be able to use the scan function without putting the entry points on the disc, you should add the line SCAN=ALWAYS to the CDI_VCD.CFG file in the /CDI directory. It is extremely important in this case that the MPEG stream is 100% in accordance to the White Book specification. If MPEG I-frames are more than 2 seconds apart from each other (which is *not* allowed by the White Book), searching will result in a hang-up of the application.

Beware: with most CD-Recording tools it is either impossible to add files to the /CDI directory, or to modify the supplied CDI_VCD.CFG file.

Note: this info is only applicable to version 3.x of the CD-i application, not the 4.x (Video-CD 2.0) application. This version should be able to provide scanning without an entrypoint file, provided that the MPEG stream is 100% according to the White Book standard.

6.6 What is Video-CD 3.0?

Video-CD 3.0 does officially not exist. The only versions of the Video-CD specification released to date by the official Video-CD creators Philips, Sony, JVC and Matsushita are 1.0, 1.1 and 2.0. Some Chinese Video-CD players claim compatibility with Video-CD 3.0. It is unclear what they refer to, or whether all so-called Video-CD 3.0 players refer to the same system. They should at least be able to play 'real' Video-CDs.

6.7 What is CVD or Chao-Ji?

CVD and Chao-Ji are two of the extensions to Video-CD that were developed in China. Both systems use MPEG2 to encode video and hence the discs are not compatible with Video-CD or

CD-i players. Both systems are also not interchangeable with each other. In order to accomplish for a worldwide standard for MPEG-2 on CD, the original Video-CD companies created Super Video-CD. A true Super Video-CD can however be played on both CVD and Chao-Ji players, since it uses subsets of both systems. Refer to: 6.8 What is Super Video-CD? for more information.

6.8 What is Super Video-CD

Super Video-CD is an extension to the Video-CD specification, set up by the original Video-CD licensees (Philips, Sony, JVC and Matsushita) in 1999. Super Video-CD uses DVD-quality MPEG-2 video on a standard CD which runs at variable bit rates up to double speed (2.8 kbps). This allows for 35 to 70 minutes of high quality video on a regular CD. Super Video-CD allows for a cheap way of making discs that are playable on compatible DVD-Video players using a regular CD-Recorder.

Since Super Video-CD uses MPEG-2 video compression instead of MPEG-1 that is used in CD-i, and because of the fact that the disc can be played up to double speed of which a CD-i player is not capable, a Super Video-CD cannot be played on a CD-i player. Therefore, the CD-i application that is mandatory for Video-CD is not available on a Super Video-CD.

7. CD-i Authoring

7.1 How is CD-i authoring generally done?

CD-i authoring involves several steps, most of which should be followed in order, some of which can be done at the same time. Generally, one starts with the design phase. The producer of a disc decides what it should be all about, how the interactivity will take place, what screens the user will see, what audio will be used, etcetera. Then, the assets (audio and video material) will be created. These are usually made using regular video and audio editing software, and then converted into CD-i's audio and video formats. Now, the program code should be written, or -in case a high-level authoring tool is being used- the assets should be placed in their correct order. The program code or scripts then need to be converted to CD-i's real time disc format, this process is usually called disc building (see: 7.2 What is disc building?). This disc building then results in a disc image which can be played back using an Emulator (see: 7.4 What is a CD-i Emulator?), burned onto a CD-Recordable or sent to a manufacturing plant for replication.

7.2 What is disc building?

A critical step in the development of a CD-i title is the so-called disc building process. Because of the fact that CD-i almost entirely depends on its real time behaviour (see: 3.4 What is a real-time system? in section 3 of this FAQ), it is very important that the audio and video are placed in the correct way on the disc. Unlike other non-realtime systems like PCs with a CD-ROM drive which can store large amounts of audio and video data in memory for later playback (and hence requiring more complicated and expensive systems), a CD-i player reproduces the audio and video data in realtime when it is being read from the disc. To accomplish the seemingly similar retrieval of audio and video at the same time, CD-i uses a clever sector format (see What is sector interleaving? in section 3 of this FAQ).

Naturally, this process of placing all the information bits at the correct order is not done manually (although it remains the CD-i producer's responsibility to investigate whether the choice on amount and quality of audio and video will fit in the data stream). The process of the creation of a file that represents the contents of a CD-i disc is called disc building. The resulting file is usually called a CD-i Disc Image. The Disc Image can be played back using an Emulator (see: 7.4 What is a CD-i Emulator?) or burned on a CD-R to check whether its behaviour on an actual CD-i player is as expected.

7.3 What is a CD-i authoring or development player?

A CD-i authoring player is a CD-i player that can play CD-i discs in a normal way, but which has some extensive features especially added for CD-i authoring studios. An authoring player can for example be connected to an Emulator (see: 7.4 What is a CD-i Emulator?) for the retrieval of data as if it was being read from a CD. Furthermore, an authoring player provides for a SCSI-port to connect SCSI devices like harddisks and a CD-Recorder and a coaxial ethernet connector to hook it up in a local network.

There were two different models of CD-i authoring players from Philips. The first model was the CDI 180/181/182 modular CD-i system (which was also the first CD-i system ever released). The CDI-182 Expansion Module added the authoring facilities (the SCSI port, the ethernet port, a parallel port and 1 MB of extra RAM) to the generic system. Later, the CDI 605/00 replaced this system as an all-in-one authoring player. The CDI 605 consisted of 5 MB of RAM, ethernet, SCSI, parallel, extra serial ports and several diagnostic and emulation tools build in ROM. Since both of these players could not be expanded with a Digital Video cartridge, a new version of the CDI 605 was released as CDI 605T/20 which provided space for a Digital Video extension.

Refer to Philips professional and authoring CD-i players in the Complete CD-i Players Overview at www.icdia.org for a comparison.

7.4 What is a CD-i Emulator?

A CD-i Emulator is a piece of hardware that contains a large harddisk and control circuitry to provide a stream of audio, video and program data to a CD-i authoring player in exactly the same way as if it was being read from a CD. The Emulator takes care of interleaving the data, creating the sector format and continuing the feed of data according to the specification as laid down in the Green Book. When a CD-i Disc Image is being created, it can be read by the Emulator and played through the CD-i authoring player for testing purposes. You need either to do this, or make a one-off on CD-R for testing, because you can't test CD-i's realtime behaviour at programming level (the audio, video and program data is not interleaved yet at that time). Since CD-R was just beginning to appear when this CD-i authoring hardware became available (early 90s), and a CD-R disc costed around US\$ 50 a piece, a CD-i Emulator was a very economical solution for studios.

Two versions of the Emulator were being sold by OptImage. Both of them contained at least a 1.2 GB harddisk (enough to keep all data of a disc in its original form and the required space for a full CD-i Disc Image). The Emulator was based on the same version of OS-9 that is used in CD-i players, and they contained 2 MB of memory. The first model was generally referred to as E1 (probably Edition 1), it runs on a 20 MHz 68020 and contained a floppy disk drive which needed a suitable floppydisk to boot the system up, and a lot of confusing connector types at the back. The E2, which was released some years later and runs on a 24 MHz 68340, lacked the floppy disk drive since all required software was build in ROM, and it had a more convenient way of connecting to the CD-i authoring player.

Both versions of the Emulator can also be used for the emulation of other CD-i compatible disc formats like Photo-CD and Video-CD. Some Video-CD studios are known to use a CD-i development player and an Emulator in their quality checks.

7.5 Do I need special hardware to make a CD-i title?

In theory: no. If you have the appropriate CD-i authoring software that runs on a PC (like the Presentation CD package, or Philips' ShowBuilder package for Windows, both available from the PC/Windows downloads page at www.icdia.org), you can produce a CD-i title entirely without any additional hardware besides your PC. Bear in mind however, that the results from these authoring tools are very linear and without much interactive features. Even if you had a tool that provides you a way of creating a more complex CD-i title on a PC, you still wouldn't be able to test the behaviour of it on a CD-i player, since CD-i cannot be "emulated" in any way on a PC. A one-off CD-R would need to be pressed at the various development stages, which would be very inconvenient.

All CD-i titles that you see around are created with either low level authoring tools on a PC, Macintosh, Sun or OS-9 system which was connected to a CD-i development player and emulator, or entirely on a CD-i development player using a high-level authoring tool like MediaMogul. Refer to: 7.7 What CD-i authoring tools were available? for more information about the available tools.

7.6 What is OptImage?

OptImage was the name of the largest company that sold CD-i authoring solutions in the form of hardware and software products and development support. It was set up by Philips, Microware (the creator of the OS-9 operating system used in CD-i) and Sun Microsystems (creator of high-end workstations that were used in CD-i development a lot) in the late 80s. They developed various tools, and from the early 90s Philips and Microware became the owners of the company.

In 1995, OptImage became a wholly owned subsidiary of Philips Media, owning 100% of the company.

OptImage created the tools with which nearly all of the currently available CD-i titles were created. Although other companies created CD-i tools as well (such as ABCD-i from Script Systems), none of them became as popular and widely used as OptImage's Balboa Runtime Libraries and MediaMogul. The most well-known company that created CD-i authoring software besides OptImage was Multimedia Technology Center. Their CDMotion for CD-i and ViaCD-i are fully Windows-based and need no special hardware nor premastering or conversion software.

7.7 What CD-i authoring tools were available?

A wide variety of authoring tools were available from OptImage alone. The authoring software was divided in high-level and low-level tools. High-level meaning that a whole lot of the technical aspects is being taken care of by the system leaving the developer only to concentrate on the creative part of the development process, and low-level tools which require a lot more technical knowledge of the programmer but which allow for a much wider variety of possibilities. Besides these tools, a lot of additional software was available, such as tools for converting PC audio and video formats into CD-i format.

Some of the best-known authoring tools are:

- **Balboa Runtime Libraries**

OptImage created the Balboa Runtime Libraries for programmers who use C. Balboa provides lots of custom written parts of software for CD-i, such as routines for accessing CD-i's video and audio features, visual effects, and MPEG Digital Video. The libraries could be included in own developments. Using a combination of a C compiler for OS-9 and the Balboa libraries, the most advanced CD-i titles (such as highly interactive and complicated games) can be created. Most of the consumer CD-i titles that were available were made using Balboa.

- **MediaMogul**

MediaMogul was a high-level authoring tool that was especially designed with the non-programmer in mind. It runs entirely on a authoring CD-i player like the CDI 180 and the CDI 605, equipped with a harddisk. No additional hardware or software (besides some video or audio conversion utilities on the PC) was needed to make CD-i titles with MediaMogul. MediaMogul is based on a timeline which has rows for audio, video and program commands, so that the user can build his application using a very intuitive chronological interface, much like Macromedia Director works nowadays. The software could be extended with a literally unlimited amount of plug-ins, which were available from OptImage as well as from other companies (of which Interactive Resources, Inc. of Iowa was the most well-known) to provide for such features as playing MPEG Digital Video, controlling other devices like printers or bar code readers, etcetera. Although MediaMogul does not allow for the same complexity to be used as Balboa, excellent highly interactive titles could be produced with it. MediaMogul is especially useful for professional applications.

- **CDMotion for CD-i**

CDMotion from Multimedia Technology Center was positioned as a competing product against MediaMogul. It was entirely Windows-based. No special hardware was required, and all video, audio and image conversion tools were built-in. Some people claim it was much more powerful and easier to use than MediaMogul.

Other programming tools were available (such as Media Show Case from OptImage, HAL90 from Philips Media Italia and ABCD-i from Script Systems), but they were not widely used.

Besides the authoring tools, OptImage also produced some utilities that could be used in conjunction with the programming tools, such as the Image and Audio Conversion Utilities for

Windows and Macintosh (available on the PC/Windows downloads page at www.icdia.org), MediaStockroom (which replaced the conversion utilities as a all-in-one package) and the CD-i plugins for Adobe Photoshop.

7.8 Where can I get CD-i authoring tools?

Most of the CD-i authoring tools from Philips and OptImage are now being sold and supported by Cambridge Multimedia Ltd. from the UK and Rise International from the US. Cambridge Multimedia is a Philips value added reseller of CD-i players and authoring tools for Europe. Apart from selling tools and players, Cambridge delivers various services such as disc labeling and reproduction. Rise International is a Philips value added reseller of CD-i players and authoring tools for the Americas. They sell all OptImage CD-i authoring packages. The Windows-based CDMotion for CD-i and ViaCD-i are available from Multimedia Technology Center.

7.9 What is the easiest way to make a CD-i title?

One of the employees of Cambridge Multimedia, Robin Burrows, is currently working on a Windows application, MoguLike, that allows for the creation of MediaMogul compatible scripts without the need for MediaMogul itself. A demo version of this program can be downloaded at the PC/Windows downloads page at www.icdia.org. Unfortunately, you still need Script2Disc, the software that is needed to build a CD-i Disc Image from a MediaMogul script. This software is not publicly available, so MoguLike is essentially only of use to people who already use MediaMogul.

Another easy way of producing a CD-i compatible title is using the Presentation CD driver for Windows that can be downloaded at the PC/Windows downloads page at www.icdia.org. Presentation CD is in essence a (Windows 3.x) printer driver that allows you to 'print' to a CD-i disc image format. All 'pages' will be added in sequence and are combined with a CD-i application. The created file can then be burned onto a CD using most popular CD-Recording tools. The resulting disc is playable on a CD-i player. Please keep in mind that the driver only supports up to 16 colors due to a limitation in the Windows 3.x printer driver system, but it is fun for presentations on CD-i.

The best way to make a decent looking CD-i title using a Windows systems however is probably the ShowBuilder package from Philips, that can be downloaded at the PC/Windows downloads page at www.icdia.org. It allows you to create CD-i presetions using stills, audio and even MPEG Digital Video directly on a PC. The scripts you provide on the disc can even be changed at runtime on the CD-i player, allowing the user to create his own presentations using the audio, stills and video on the disc. ShowBuilder does not provide for interactive features besides creating a slideshow and browsing through its contents.

Of course, you can also make a Video-CD title to play on a CD-i player. Video-CD creation tools are much more widely available than dedicated CD-i creation tools, and a true White Book Video-CD disc can always be played on a CD-i player. Refer to: 7.11 How can I make a Video-CD? for more information.

7.10 How can I write a CD-i Disc Image file?

In essence, a CD-i disc image can be written using any CD-Recording application that supports writing Mode 2 CD-ROM/XA sectors (which is the sector format that was originally developed for CD-i). However, several different Disc Image file formats exist in the CD-i development community, because some of them include header information for all of the disc's sectors, while others leave the creation of such headers up to the CD-R software. Another issue is the fact whether the authoring tool produces a scrawled or unscrawled Disc Image format. This can result in the fact that a particular CD-R tool can write CD-i Disc Images from one authoring package, but not from the other.

One tool that is known to support most of the CD-i Disc Image formats is Gear from Gear Software, Inc. Using version 4.2 of Gear for Windows, you should use the following settings when writing a CD-i disc:

- CDI 2352 bytes per sector - 2 sec pregap - scrambled
for Disc Images generated by Script2Disc from MediaMogul and ShowBuilder Disc Images
- CDXA 2352 bytes per sector - 2 sec pregap - scrambled
for Disc Images generated by Video-CD Toolkit

WinOnCD is also known to be capable of burning CD-i disc images created by the Philips/OptImage CD-i authoring tools.

Refer to the CDprosupport mirror at www.icdia.org/cdprosupport for more information about writing CD-i discs.

7.11 How can I make a Video-CD?

There are lots of tools available that let you create Video-CDs that can be played back on CD-i players among others. Many standard CD-Recording tools nowadays include a module to create Video-CDs, including Adaptec Easy CD Creator, CeQuadrat WinOnCD and Ahead Nero Burning Rom.

For CD-i playback, it is very important that the Video-CD includes a CD-i application. Although this is a mandatory requirement of the White Book that should be obtained by all Video-CDs, some tools let you create a Video-CD without a CD-i application, although most supply one with the package. For example the default setting of Adaptec Easy CD Creator is to *not* include the CD-i application. Remember to tick the appropriate box in one of the settings screens to include the application.

Other things to bear in mind while developing a Video-CD are:

- Make sure to what version of the White Book your disc should comply. Do you want to include Video-CD 2.0 interactive features and if so: does your playback device or software (e.g. the CD-i application) support this added functionality?
- What version of the CD-i application is included? Does it support the functions you want it to, for example Video-CD 2.0 menus and playlists?
- Do you want to customize the CD-i application by providing scan entrypoint files, subtitling, menu screens, backgrounds, etcetera? Does the Video-CD creation tool support for the adaptation of the CD-i application?

A good tool to use while making full White Book compliant Video-CDs is Nero Burning Rom version 5.0 and up (available from Ahead Software). Nero allows you to create Video-CD 2.0 titles that can even include still pictures and menu screens with thumbnail images (see question: 7.13 How can I play my pictures on my CD-i player? for more info). Bundled with Nero 5 and up is version 4.1.1 of the Philips Video-CD on CD-i application, resulting in full Video-CD 2.0 compatibility on CD-i players.

For more information about the various versions of the White Book Video-CD standard, the various CD-i applications, its versions, the customizations of the application and all other questions related to Video-CD on CD-i, please refer to section 6 of this FAQ: Video-CD on CD-i.

7.12 How can I make a Photo-CD?

The Photo-CD specification is closely guarded by Kodak. The system was set up to provide extra sales opportunities for Kodak photo finishers, and not as a home-made system. Partly because of contractual difficulties in obtaining a license for Photo-CD, most CD-Recording tools do not let you create a true Photo-CD that can be played on Photo-CD players and CD-i players among others. Especially the disc's layout format is a heavily patented standard. This is why some tools let you place images in Photo-CD's picture format (Photo-YCC) on a CD-R, but they do not make these discs compatible with the Photo-CD standard (see Will CD-i play Picture-CD? in section 5 of this FAQ).

Kodak sold a CD-Recording application to create Photo-CDs once, called Kodak Arange-it!, but this software is no longer available. It seems like Kodak is rapidly replacing Photo-CD with their new Picture-CD format which is not compatible with Photo-CD players nor CD-i players.

7.13 How can I play my pictures on my CD-i player?

As you can read in question 7.12, it is nearly impossible for the home user to make Photo-CDs. Fortunately, there is good alternative allowing you to place your pictures on CD and view them on a CD-i player. Using Nero Burning Rom version 5.0 and up (available from Ahead Software), you can include still images in a Video-CD compilation. Such a disc with your photos can then be played on CD-i players (it includes the Philips Video-CD on CD-i 4.1.1 application), but also on PCs, on Video-CD 2.0 players and on most (Video-CD 2.0 compatible) DVD-Video players. This makes your investment in time even more worthfull than making Photo-CDs (which cannot be played on your current or future DVD player and most other equipment).

Just drag your JPG-files to the Video-CD section on the disc and they will be converted to MPEG stills. From version 5.5 onwards, Nero will include an index screen with thumbnails of all pictures that can be selected on the disc!

The MPEG still pictures are encoded in high TV resolution (as long as the source pictures are in a high resolution), but they will be showed in a lower resolution when viewing the disc on a CD-i player. The pictures can then still be viewed in a higher resolution on for example DVD players. Note that the CD-i player needs to be equiped with a Digital Video cartridge to view the MPEG stills, even though the disc might not contain moving video.

CeQuadrat/Roxio WinOnCD 3.7 and up offers similar functionality called the 'Photobook' feature, but although the program claims to make a Video-CD compliant disc, it does not include a CD-i application capable of showing these Video-CD 2.0 enhanced pictures. Future version will allow you to replace the CD-i application by the Philips application that can be downloaded from www.icdia.org.

Remember that in contrast to making a Photo-CD, placing pictures on a Video-CD is not a good solution for storing your archives of pictures. A Photo-CD contains pictures in a very high resolution (over 3000 x 2000 pixels) alowing you to make perfect prints of them, a Video-CD only stores the pictures in TV resolution. Always preserve the original files!

7.14 How can I make a CD+Graphics?

Using CD+G Creator (which can be downloaded from the Other CD-i tools page in the PC/Windows download section at www.icdia.org), you can create a CD-Audio disc with a background picture for each audio track according to the CD+G specification. The tool does not allow you to create moving graphics or colour loops, these features may possibly be included in a future version. Please note that you need a CD-Recorder capable of writing subcode to record CD+G data. Most Plextor models can do this.

8. CD-i Mysteries

8.1 Can I connect a CD-i player to a terminal display?

Yes. Every CD-i player from Philips is equipped with a serial port, either as mini-DIN connector at the back of the player, or it can be made available by connecting a port splitter to the input port of CD-i players with only one input port (like CDI 450, CDI 550 and FW380i). On players with only one port for input devices at the front and one at the back, this port at the back can also be used as a serial port.

The serial port can be used to hook up all kinds of devices to the CD-i player, like a modem, a touchscreen, a serial printer or a display terminal. You can connect a 'real' hardware display terminal like a DEC VT220 or you can use a terminal emulation on the PC (for example Telix or HyperTerm). A detailed description on the layout of the nullmodem cable that should be used can be found at the CD-i Technical Documentation download section at www.icdia.org. Set the port speed to 9600 baud, 8 databits, 1 stopbits, no parity and the terminal emulaton to standard ANSI.

OK, so what can you use this terminal display for? Well, not *that* much. Some CD-i players (most notably professional players) display a copyright message and ROM version indication on the terminal when the player is switched on, but most don't. Some CD-i titles show information on the terminal during the execution of the program. Mainly the CD-i applications developed by CapDisc (such as CD-i Pinball) are known to display status information, probably used for debugging during the development stage.

You cannot give commands to the CD-i player using the terminal, unless you have access to a command shell prompt (this is covered in full detail in the next question: 8.1.1 How can I access a CD-RTOS/OS-9 prompt using a CD-i player?). Otherwise, it's entirely up to the application whether or not it supports the terminal display. Most consumer titles don't.

You can also use this serial connection to transfer files stored in NV-RAM to a PC, or place NV-RAM files from the PC back into a CD-i player. Refer to: 8.1.4 Can I transfer data from the CD-i to my PC? for more information.

8.1.1 How can I access a CD-RTOS/OS-9 prompt using a CD-i player?

CD-i's operating system is called CD-RTOS. It is based on version 2.4 of Microware's OS-9. Every CD-i player resides the kernel of this operating system in ROM, together with other critical system components such as drivers and the player and CD-Audio shell. Usually this ROM is 512 KB in size (some professional players that contain additional tools have double that size).

To access the roots of the operating system you should use a command prompt shell. OS-9 supports such a shell, which is very Unix-like, but since a consumer CD-i player is not intended to be used in conjunction with a display terminal, this shell is not included in the ROM of consumer CD-i players. If you want to access a shell using a consumer player, you need a CD-i disc that includes such a shell which it should execute during the startup of the disc, or after providing such an option in the CD-i application (since you have no other means of starting the shell on a consumer player).

I do not know of any CD-i disc to date that provides the OS-9 shell besides the MediaMogul CD, but if you have any other CD that starts up a shell the further description would be the same. MediaMogul is an authoring tool that is intended for authoring players, but it can also be started on any other CD-i system. When the disc is started, select 'CD-RTOS' from the main menu. Now you will see a shell on your normal TV-monitor. To start up a shell on the terminal display, type this: ex shell<>>>/t1 (the name t1 for the terminal descriptor might be different, use

`mdir -t=desc` to check this out). First load some modules (programs) that might be useful and which are stored on the CD, so you can use them after the CD has been removed. Do this with the `load` command, for example `load dir eject`. Now you can kill all other programs that are running on the CD-i. Check which programs are running and what their process IDs are with `procs`. Then kill the running apps, using for example `kill 3`. Now you can remove the CD with the `eject` command. Make sure not to press the eject-button on the player, since it will then reset and the running applications (including the shell on the terminal) will be terminated.

The things you can do next depend on the commands you have loaded in memory or which are available in ROM. Use the command `mdir -t=prog` to see which ones are available. You can startup the player shell, load another CD-i disc and execute it. You still have full control of the system on the terminal. For example it is possible at all times to check which modules a particular CD-i application is running using `procs`. Some CD-i discs contain extra applications that cannot be accessed using the regular CD-i program that is executed using disc start up. Refer to: 8.1.3 What hidden information is available on some CD-i titles?.

If you have access to a professional CD-i player, things are usually less complicated. The CDI 601, CDI 602 and CDI 605 have the command shell build in ROM and best of all, you can access it in the Settings screen of the player shell. Just connect a terminal display and select the System option in the Settings. A prompt will be displayed on the terminal. To use any commands beside the very few that are internal shell commands, you still need an external source to load them. If the player has a floppy disk drive (CDI 602 and CDI 605) you can load the commands from a floppy disk, otherwise you need a CD with the commands such as MediaMogul. If you have a CDI 180/181/182 system you can load the command prompt from the player shell, but you need a floppy which contains it since it is not available in ROM. It allows you the choice of terminating the player shell or leave it running (the difference between the Chain and Fork options). The professional players CDI 615, CDI 660 and CDI 670 have no command prompt access build in the player shell, the procedure for a consumer player as described above applies.

For an overview of OS-9 command shell commands and their (more well-known) Unix counterparts, please refer to the document about OS-9 and Unix commands at www.icdia.org.

8.1.2 What hidden applications are burnt into the CD-i player's system ROM?

Most CD-i players have additional programs and other modules stored in ROM that you can check out using a terminal connection. If a Digital Video cartridge is installed, which contains its own ROM, even more modules will be available.

One of the things I discovered using some of the early CD-i players based on the Mini-MMC board (CDI 910, CDI 205 and CDI 220/00) is that a service maintenance tool is available in ROM. Just start it by typing `sv` at the prompt (make sure the player shell and other applications have been terminated, since this program needs the CD-i's video display). A screen will show up with a nice cursor in the form of an open end fork! You can check system functions and audio and video features. This program is probably used in the factory to test a player. It's really amazing to see a program appear on your screen that's literally hidden in the player!

Other things that are known to be available in the ROM of the Digital Video cartridge are tools to play a Video-CD using a command prompt and some diagnostic tools. Please note that the availability of modules in ROM varies between the various CD-i players and Digital Video cartridges.

8.1.3 What hidden information is available on some CD-i titles?

Some CD-i discs contain extra applications that cannot be accessed using the regular CD-i program that is executed using disc start up. You can check for other executables by providing a

`dir -e` command at the shell. Every module that has the latest attribute set to x (execute) can be run. Make sure to change the active program directory to the appropriate directory on the CD using `chx /cd/xxx`, where xxx is the name of the directory. Remember that OS-9 makes a difference between upper and lower case letters.

For example using the game Escape from Cybercity, there is a version on the disc that allows for unlimited lives.

8.1.4 Can I transfer data from the CD-i to my PC?

Yes. You can use the CD-i application CD-i'nterlink (which is available for free download as a CD-i Disc Image at the CD-i Disc Images section at www.icdia.org) to transfer files that are stored in the player's NV-RAM to a PC. Make sure that your terminal emulator can receive files using the X-Modem or Z-Modem protocol. Just load the CD-i'nterlink disc in the CD-i player and follow the instructions on screen.

The CD-i'nterlink application can even display a shell prompt on the terminal display, but this is not the standard OS-9 command prompt shell. Only a very limited set of instructions is provided (use the command `cmds` to get an overview of available commands).

8.2 How can I enable/disable the open/close function of the drawer?

Some CD-i players equipped with the first generation player shell (refer to the CD-i Players comparison overview at www.icdia.org for more information) can disable the open/close function of the drawer. When this function is active, the open/close button at the front of the player will not work, and the Open function is not displayed on the player shell's screen. But beware: the open/close function is still working in the player shell when you point the cursor at the usual location of the hotspot! Besides this, the lock mode is not very suitable in critical situations, because the drawer can still be "pulled" out of the player. To set or disable the lock function, turn the player on while holding the Stop-button at the front.

On the CDI 660 and CDI 670, a lock mode is available when you hold the Play and Open buttons while turning the player on. The same conditions apply with respect to the functionality of the open/close hotspot as described above.

8.3 How can I enter the features of the CDI 660/670 key-disc?

The CDI 660 and 670 can be customized in several ways using a dedicated 'Key Disc' that was developed for these players. When you have this Key Disc (which is available for free download as a CD-i Disc Image at the CD-i Disc Images section at www.icdia.org), use the following PIN-codes to access the player's special features (the codes apply to version 1.3 of the Key Disc):

- 2410
Delay the start up time of the player, so that pointing devices that require a longer initialization time (such as touch screens) work correctly.
- 8252
Set the player to lock out the playback of CD-Audio discs or just allow for the playback of certain CD-i titles that are mastered in a special way. Refer to the Technical Manual for more information about this feature.
- 3094
Disable or enable the start up animation of the player shell, set it to neutral (remove the 'Philips' logo) or enter a customized message that should appear each time the player is turned on.

8.4 How can I access an X-rated CD-i title?

Some CD-i titles with X-rated or adult material are protected from unauthorized usage of children by means of an access code. You need to enter this code, which is usually described in the booklet, to access the disc. In some circumstances you can change this code which is then stored in NV-RAM.

Just in case you hid the booklet of a particular title too well, I give you the access codes for some of the adult CD-i titles that have been produced:

- Loving for a Lifetime (Dutch: Sex, je lust en je leven)
6969
- Girls - Serge Jacques
019
- Strip Poker Live
QQQQK
- Uncover featuring Tatjana
1492 - Hereafter you must enter your own code. If you forgot this, just erase the appropriate entry from the Memory or Storage screens in the player shell.
- Voyeur
3333 - Hereafter you have the option to enter your own code. If you forgot this, just erase the appropriate entry from the Memory or Storage screens in the player shell.

8.5 What hidden features are there in other CD-i titles?

Some CD-i titles have hidden features build in. Sometimes they were used for testing, for example so that the tester should not play the whole game to reach a certain point. It's beyond the scope of this FAQ to mention all cheats and hidden options in CD-i titles (especially the ones which give you unlimited lives and the like in games), but some of them are useful for demonstrating a certain title.

- Hotel Mario

Start a new game and make sure you lose all lives in hotel 1, level 1. Then save as 'B_ ' (bee, underscore, space). When you load this game, you can access all hotels, including the spectacular end-level.

- Dark Castle

Start a new game, and perform the following movements with the remote in the 'Great Hall': down, down, down, up, up, up, down, down. Now you can access all levels. The numbers at the bottom of the screen mean: 0-2 'Trouble'-levels, 3-6 'Fireball'-levels, 7-10 'Shield'-levels, 11-13 'Black Knight'-levels.

- The Seventh Guest

When you save a game under the name 'badger', you can select the chattering teeth in one of the corners of the screen. Press an action button to see an overview of all scenes of the game to which you can jump instantaneously.

- Burn:Cycle

Save a game under the name 'JOHN_WHO'. Immediately after you stored this name, all video sequences from the game will be showed after each other.

- Lucky Luke

Pause the game, then press the following keys exactly in this order: up, right, down, left. Now you can select which level to play.

- Space Ace

At the continue-screen at the end of all levels, move the cursor in the upper left corner and press action button 2 for four times. Then move the cursor in the upper right corner and press button 2 for three times. Finally, move the cursor in the upper left corner and press button 1 once. Now you can select a level to play.

9. CD-i on other platforms

9.1 Can I run an interactive CD-i title on my PC?

No. Unlike other CD-formats like CD-Audio and Video-CD, not only the way of encoding the audiovisual material on the disc has been described in the standard, but also the entire playback environment. This includes the operating system, the CPU, the audio and video decoding chips, etcetera. You should think of CD-i as a completely designed computer system instead of just a disc format. You will encounter the same difficulties when you try to run Macintosh software on a Windows PC.

You can however access the contents of a CD-i disc on a PC. Refer to: 9.4 Can I view the contents of a CD-i disc on my PC? for more information.

9.2 Can CD-i be emulated on other platforms like a PC?

It is very difficult to emulate a CD-i player 100% according to the standard on another platform. This is mainly due to CD-i's complex video features, which are all performed in hardware on a real CD-i player. For example a simple hardware fade between two images is not possible with a VGA display adapter. The CPU of a CD-i player (an 68000 at 15 MHz) can of course be emulated on today's modern PCs running at up to several hundreds of megahertz, but this does not make up for the whole CD-i player. To let people still use CD-i applications on their PC, a PC/CD-i board was developed, refer to: 9.3 What was the PC/CD-i card used for? for more information.

Of course you can use CD-i Bridge discs on a PC (like Video-CDs or Photo-CDs), but then you still need a separate PC application to access the data on the disc. A PC shall never use the CD-i application on such discs to run its contents.

Some people and web sites on the Internet claim to be working on a CD-i emulator for some time, but no actual product nor a beta sample has been showed to date. I seriously doubt whether this could really be done, but it would mean an enormous leap for the CD-i system if an emulator would exist for PCs. If you are working on this and you need some information, do not hesitate to contact me.

9.3 What was the PC/CD-i card used for?

A CD-i interface board for both Macintosh and PCs existed, which allowed for full CD-i functionality on a computer system. The card was manufactured by International Interactive Media (I2M) from Israel, and sold by Philips and I2M itself. It contained all of the components that are also available on a dedicated CD-i player, and it did not use any component of the PC itself (like RAM, mouse, etc.). It did not integrate at all with the normal operating system running on the PC. A special version was made that allowed for the shared usage of a harddrive by the CD-i system and the computer, so this one was ideal for CD-i developers. They could for example create assets (audio and video) using their PC tools, and then integrate it into a CD-i application using for example MediaMogul in the CD-i mode.

The PC/CD-i board was very rare, only a very small quantity of these boards were manufactured. It was more expensive than a stand-alone CD-i player.

9.4 Can I view the contents of a CD-i disc on my PC?

A CD-i disc is based on a different filesystem than the ones used for PC systems. Where in personal computing the ISO-9660 format and its Joliet-variant are the most well known and widely used systems, CD-i discs use the filesystem format that is based on CD-i's operating system OS-9. The OS-9 filesystem allows for filenames up to 28 characters in length, for the

mixed usage of upper and lowercase letters and it provides options to indicate OS-9's Unix-style execution or read permission parameters.

Because of this different filesystem, the files on a CD-i disc can not be accessed in a regular way on a PC equipped with a CD-ROM drive. This was not a problem, since a CD-i program could after all not be used on a PC due to its different operating system, CPU and audio and video codecs. However, in some circumstances it would be practical just to check out the contents of a disc, particularly in CD-i development environments. Thankfully, a solution is now available in the form of the CD-i Filesystem Driver for Windows 95/98, written by Vahur Sinijarv from Estonia. This driver is available for free download from the PC downloads for CD-i development page at www.icdia.org.

Once installed, a CD-i disc can be accessed in a similar way as a CD-ROM disc, using for example the Windows Explorer. You can view the disc's name, browse through directories and view the file names.

There are currently some limitations in the Filesystem Driver, please refer to the article I wrote about it at www.icdia.org. Vahur is still continuing to improve the driver, expect a new version to be released soon. Check this site back regularly, since it is the official distribution site for the CD-i Filesystem Driver.

9.5 What is an IFF file?

Usually, all media information on a CD-i disc is stored in one large Real Time File. When this is the case, you cannot use this file on a PC. But sometimes, individual audio and video files are stored on the disc in CD-i's IFF (Interchangeable File Format) format. This is the format that is used in CD-i authoring packages and studios. You can usually recognize these files from the following extensions: .d .cl3 .cl4 .cl7 .cl8 .rl3 .rl7 for video (where d stands for DYUV, cl for CLUT and rl for Run Length Encoding), and .aas .asm .abm .abs .acm .acs for audio (where the second letter indicates the level of ADPCM used, and the latter one indicates m for mono and s for stereo).

9.6 How can I watch pictures of a CD-i disc on my PC?

When pictures on a CD-i disc are stored in IFF format on the disc instead of in realtime files (see: 9.5 What is an IFF file?, you can view images using Robin Burrow's CDiView, or convert the images to standard PC formats using the OptImage Image Conversion Utilities (both available at the PC downloads for CD-i development page at www.icdia.org).

Please note that the CD-i Filesystem Driver for Windows (refer to: 9.4 Can I view the contents of a CD-i disc on my PC?) needs to be installed on the PC to allow it to access a CD-i disc!

9.7 How can I listen to audio of a CD-i disc on my PC?

When ADPCM audio clips are stored in IFF format on the disc instead of in realtime files (see: 9.5 What is an IFF file?, you can convert these into standard PC formats using the OptImage Audio Conversion Utilities (both available at the PC downloads for CD-i development page at www.icdia.org). There is no playback utility available to date that allows you to play them back immediately without converting.

If audio is stored on the disc in MPEG format (usually accompanying MPEG video, but this is not mandatory), you can play it back or convert it into other formats using a wide variety of tools available on the PC platform. You could for example use Microsoft Media Player 6.0 or higher to play the MPEG audio.

Please note that the CD-i Filesystem Driver for Windows (refer to: 9.4 Can I view the contents of a CD-i disc on my PC?) needs to be installed on the PC to allow it to access a CD-i disc!

9.8 How can I view Digital Video sequences of a CD-i disc on my PC?

You can view the full motion video clips that are stored on a CD-i disc using a wide variety of tools, like version 6.0 or later of Microsoft Windows Media Player. This application is available for free download at Microsoft. Media Player allows you to view a wide variety of media formats, including the MPEG audio and video formats used in CD-i among others. CD-i allows for a much broader variety in combining audio and video rates, and hence audio and video quality, than for example Video-CD where the audio and video bitrates are fixed. Media Player plays most of them, however sometimes when an MPEG sequence is interleaved with other material on the disc, the picture may look disturbed.

You can often recognize an MPEG sequence on the directory in which it is placed, for example FMV or VIDEOS. Also, look for the extension .rtf, which stands for Real Time File (and not Rich Text Format!). .rtf-files might be MPEG-video sequences, but also other, non-playable media files. Just try this out by loading the file in Media Player. Note that it is possible in this way to view movies that were released in the pre-Video-CD CD-i format, but also video sequences from other titles like games.

Please note that the CD-i Filesystem Driver for Windows (refer to: 9.4 Can I view the contents of a CD-i disc on my PC?) needs to be installed on the PC to allow it to access a CD-i disc!

10. Copying CD-i discs

10.1 Are CD-i titles still copyrighted?

Yes, they certainly are. It is a common misunderstanding that software for a platform that is no longer available through the regular retail channels is released from copyrights. This is not the case. The same goes for other platforms like Amiga, Atari or MSX. All CD-i titles are copyrighted and may not be copied for illegal purposes such as loan, retail, or rent as long as the copyright owner has not officially declared that a particular title has been released into 'public domain'. Philips sold its entire consumer CD-i catalogue to Infogrames Multimedia from France in 1998, which now owns the rights of virtually all consumer CD-i titles.

Consumer CD-i titles are still for sale through various mail order companies. Please refer to: 11.6 Where can I buy CD-i titles? for more information.

However, it might still be a good idea to backup some or all of your CD-i titles, since it might be increasingly harder to replace them once they got scratched or broken. Therefore, this section of the FAQ gives you some information on how to do this.

10.2 Are CD-i discs copy-protected?

No, there is no copy-protection mechanism for CD-i implemented either in software (CD-i titles) or hardware (CD-i players). Almost all CD-i titles can be copied, and any correct copy of a CD-i title can be played on any CD-i player. A CD-i player can read CD-R discs as if they were normal CDs, they do not need to be modified to accept these discs as is the case with the Sony Playstation.

It may however occasionally occur that a disc can not be copied. This has nothing to do with a possible copy protection, but is the result of the layout of the disc. Refer to: 10.5 Why can't I copy a particular CD-i title? for more information.

10.3 Will every CD-Recorder be able to write CD-i discs?

Most modern CD-Recorder can write a CD-i disc without any problems. Since CD-i uses mode 2 sectors, which is a common sector format in computing environments (it is also used in for example Video-CD and Photo-CD), most recorder support the writing of mode 2 sectors (refer to: 3.6 What's CD-i's sector format? What about mode 1 and 2, form 1 and 2? for more information about CD-i's sector format).

You might check the support for writing CD-i of your recorder by looking on its packaging or in its manual for one of the following indications: Mode 2, CD-ROM/XA, CD-XA, Photo-CD or Video-CD. If the recorder supports one of these formats, it can write mode 2 sector and hence can write CD-i discs.

10.4 What software can be used to copy a CD-i title?

You can use most CD-Recording software that allows you to make one-on-one copies of CDs, as long as this software can make an exact sector-replica of a disc and it supports the reading and writing of mode 2 sectors. Due to CD-i's realtime behaviour and the interleaving of audio, video and program data, it is very important that the software makes an exact copy, and does not reformat the data again by itself.

It is also not possible to only copy parts of a particular CD-i title, nor is it possible to combine several CD-i titles onto one CD-R disc. This is due to the fact that the software on a CD-i disc

refers to absolute sector addresses elsewhere on the disc, which must be present at the exact same location for the disc to be played correctly.

A popular tool that I've successfully used to copy CD-i titles is CDRWin, which is available for free download at www.goldenhawk.com. Please note that CDRWin indicates the CD-i track with a green circle, indicating mode 2, and not with a blue circle which, according to the explanation of the program, should indicate a CD-i track. There is no difference between a mode 2 and a CD-i track, and it is unclear why the program mentions CD-i as a separate track format.

If you load a CD-i disc and no tracks are displayed indicating that the disc would be empty, or only red CD-Audio tracks are shown, you might suffer from the problem that is explained in: 10.5 Why can't I copy a particular CD-i title?.

10.5 Why can't I copy a particular CD-i title?

In some circumstances it might be impossible to copy a particular CD-i title. This might have several reasons, but the two most common reasons are:

- The disc is slightly 'out of spec'. Due to some technical issues, the CD-Recording tool is unable to read the contents of the disc (for example the session is closed as CD-Audio instead of CD-i, so the CD-ROM drive does not return data the proper way).
- The disc contains CD-Audio tracks.

Especially CD-i's with CD-Audio tracks can cause a lot of troubles when trying to copy them. There are two different methods of including CD-Audio tracks on a CD-i disc. The first is by adding CD-Audio tracks after the initial CD-i data track, the second is according to the CD-i Ready format (refer to: 5.2 What is CD-i Ready?). Especially the latter one is difficult to copy, since the CD-i data is included in the pre-gap (the pause sectors) preceding audio track 1. This makes the CD-i data invisible to most CD-Audio players, since they usually skip the pause before track 1. However, most CD-Recording tools also just look at the TOC (Table of Contents) of a CD to investigate what the contents of a particular disc are, and by such they don't see this "hidden" CD-i area.

There are some tools that can be used to read *all* sectors of a disc from the beginning until the end in a raw manner, and then write an exact replica of it. One of these tools is BlindRead from www.blindread.com, which produces a Disc Image file and a cuesheet that can for example be written with CDRWin. Some "difficult" CD-i titles can then be written in the usual way.

10.6 Can I copy a CD-i title to a videocassette?

Yes you can. CD-i does not incorporate an analogue copy protection scheme like Macrovision that is used with some video cassettes and in DVD-Video. Just hook up the video output of your CD-i player to the video input of your VCR, and off you go. If you use a Hi-8 or Super-VHS recorder, and if your CD-i player provides S-Video or Y/C output, use this connection for the best results. Otherwise, use the CVBS output of the player.

Needless to say, all interactivity will be gone when you copy a CD-i disc to a video cassette. Make sure you remove the menu from the screen whenever this is possible. Also, take a close look at the cursor. Remove it from the screen, or point it completely to one of the sides to make its appearance as less disturbing as possible.

11. The current CD-i situation

11.1 Is CD-i still being used?

Yes, CD-i is still widely in use by dozens of companies for their training, point-of-information and point-of-sale needs. Many companies still produce new or updated CD-i titles nowadays and continue to use CD-i for a long time to come. This is partly because of the fact that no real substitute for CD-i with the same level of interactivity is available yet (see: 11.9 What good alternatives are there for CD-i in the professional field?). Of course these companies have already invested a lot in CD-i hardware and production facilities, and it is expected that the phase-out of CD-i will take another couple of years. In the meantime, CD-i does what it is good at: provide high quality, highly interactive video programmes on very economically priced, simple to use units.

11.2 Are CD-i players still being manufactured?

Most of the critical components used in CD-i players (such as its audio and video circuitry) reached end-of-life status and are no longer produced by its corresponding semiconductor manufacturers. Hence, CD-i players can no longer be produced, especially not in low quantities. Philips produced its latest high volume batch of CD-i players in June 1999, and will not start up CD-i production anymore in the future.

11.3 Is CD-i still being sold?

McNo Ltd. from the UK sells consumer CD-i players as well as a whole range of accessories, such as pointing devices and Digital Video cartridges. They deliver worldwide. Visit their extensive website at www.mcno.com. (When you place an order at McNo, make sure to select ICDIA as your source on the checkout page. This will entitle you to receive e-mail support from the New International CD-i Association, the creators of this FAQ and the www.icdia.org website.)

11.4 Can I rent CD-i players?

Professional users willing to rent CD-i players for limited time projects may contact Videotronic at www.videotronic.com for more information on renting CD-i players.

11.5 Where can I buy CD-i titles?

McNo Ltd. from the UK sells hundreds of CD-i titles, their full catalogue is online at their site. They deliver worldwide. Visit their extensive website at www.mcno.com. (When you place an order at McNo, make sure to select ICDIA as your source on the checkout page. This will entitle you to receive e-mail support from the New International CD-i Association, the creators of this FAQ and the www.icdia.org website.)

Please note that there are dozens of companies out there (in the real world as well as on the web) that sell Video-CD discs that can also be played on a CD-i player. Although CD-i compatibility is a key requirement for Video-CD titles, some discs (particularly illegal Asian titles) lack the CD-i application and cannot be played (refer to: 6.4 I have a Video-CD. Why won't it play on my CD-i? for more information). Always check before you buy a Video-CD disc on the Net. The Video-CDs from McNo are guaranteed to be according to the official standard, and as such CD-i compatible.

11.6 What books have been published about CD-i?

A number books have been published in the past couple of years covering CD-i's technical features and the ways it can be used. This list is by no means complete. Check with your books reseller or the publisher to see if you can get hold of a copy.

- Introducing CD-I
Addison-Wesley, 1992
- The CD-I Design Handbook
Addison-Wesley, 1992
- The CD-I Production Handbook
Addison-Wesley, 1992
- CD-I, A Designer's Overview
Kluwer, Second Edition 1988
- Discovering CD-I
Microware Systems Corp., 1991
- The Producer's Handbook of Multimedia Authoring for CD-I
Philips Interactive Media Systems, 1992
- The Producer's Handbook for Multimedia Authoring on CD-I
Philips Interactive Media Centre, Second Edition 1995
- CD-i, Een Introductie (Dutch)
Kluwer, 1992

11.7 Where can I find CD-i related information on the Internet?

There are a couple of very good websites dedicated to CD-i. At first of course :-) there is the www.icdia.org website. This site is the home of the CD-i FAQ 2000 Edition you are currently reading. The latest version of this FAQ can always be found at this site. Furthermore, it provides you with complete overviews of all CD-i players and accessories ever produced, it offers CD-i related software downloads for use on PCs as well as on CD-i authoring systems, it contains various background articles, software overviews and a lot more. Make sure you visit this one when you are searching for any CD-i information. If your question is not answered here, don't hesitate to contact the author.

Then, there are also a couple of other very good CD-i related sites. The French Planete Numerique (at www.planete-numerique.com) is one of the most recognized sources for correct information about CD-i and related platforms.

For a more detailed overview of CD-i websites, please refer to the CD-i Web Links section at www.icdia.org.

11.8 What good alternatives are there for CD-i in the consumer area?

Well, if you want to play video games, you need a game console. If you want to watch movies, you need to buy a VCR or DVD-player. If you want interactive reference titles, you'll probably need a PC. If you want to view your family pictures on a large screen in the living room, you might just need to turn to that goold old slide projector. And if you want to play music, use your CD-player.

As you can see, no real alternative combining all of the features of CD-i has been introduced to date, and certainly not in a standardized manner as with CD-i. The CD-i concept was rather unique and far ahead of its time. Today, most linear video watching (and in the very near future even recording) is vastly moving towards DVD-Video, which provides great image and audio quality (notably surpassing that of CD-i and Video-CD). For video games, there are a few big players, of which Sony with the PlayStation is one of the most important ones. A lot of edutainment and reference titles, as well as very good kid's titles have recently been published on

PC CD-ROM (the CD-i Sesamestreet titles produced in 1991 have recently been ported to PC format in The Netherlands and are now promoted as a unique new way of entertaining and teaching children!).

If you want to have a device that does it all, then just leave the CD-i player in your living room (or make sure you get one!). It can always be used as an Audio-CD player, a Photo-CD player or a Video-CD player. And it plays all of your existing CD-i titles as well!

11.9 What good alternatives are there for CD-i in the professional field?

CD-i became very popular in the professional area. It was widely used in a wide variety of applications, most notably for training and point-of-sale and point-of-information. CD-i is a cheap device, requiring no special training on how to use it, no setup or difficult installation procedures, and it delivers very acceptable, TV-like video and sound.

Unfortunately, no one-on-one replacement for CD-i exists today. PCs are used now and then, but companies are experiencing difficulties in getting the machines up, and most importantly: to keep them running after the malfunction of one of the million components in a PC, or after someone has changed some of the settings, or after an incompatibility issue has occurred, or...

The trend is vastly moving towards DVD-Video, but this system does not support the interactive features offered by CD-i. Some companies offer professional DVD-Video players with enhanced interactive and storage capabilities.