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ABSTRACT

The 1992 introduction of Compact Disc-Interactive (CD-I) technology, the initial obstacles this new technology faces, and its known progress in its first year are explored, focusing on why new technologies are successful or are not adopted. Similar to a VCR, a CD-I player links directly into any television receiver, and each 5-inch disc is capable of carrying 250,000 pages of text per 19 hours of audio per 72 minutes of full motion video or a combination of all 3. Aspects that are examined include: (1) attributes of CD-I as an innovation; (2) advantages and properties of the process; (3) compatibility; (4) complexity; (5) trialability; (6) observability; (7) cost-benefit analysis; (8) potential adopters; (9) rate of adoption; (10) criticisms of the current diffusion efforts; and (11) recommendations for an alternative campaign for communication, marketing, and diffusion. Although it is too early to make a definitive pronouncement on the outcome of the introduction of CD-I, a sufficient body of criticism has emerged to suggest that its launch without full-motion video was a serious drawback that may undermine the whole launch of this new technology. Many new ingredients are needed for an alternative diffusion campaign. The effort highlights the many problems in the introduction of a new technology. (Contains 39 references.) (SLD)

Problems of Diffusion in High Technology: Compact Disc-Interactive (CD-I) - a Case Study

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Problems of Diffusion in High Technology: Compact Disc-Interactive (CD-I) - a Case Study

Abstract

Why do new technologies fail ? Rogers et al (1971-86) have written extensively on the problems of diffusion but with the exception of teletext (Greenberg, 1986), video disc (Klopfenstein,1985, 1986) and personal computers (Dickerson & Gentry, 1983; Ostlund, 1974), few case studies in high technology diffusion have been put forward. In this paper, we analyze the 1991 launch of Compact Disc-Interactive (CD-I), the initial obstacles it faced as a new technology, and chart its known progress in its first 12 months.

Using Rogers' terminology (ibid.), the authors have examined the attributes of CD-I as an innovation - its relative advantages, compatibility, complexity, trialability, observability and cost-benefit analysis; potential adopters of the innovation; the rate of adoption; criticisms of the current diffusion efforts and, finally, recommendations for an alternative communication/marketing /diffusion campaign.

The paper also includes a research proposal to track the diffusion of CD-I over the next several years.

Problems of Diffusion in High Technology: Compact Disc-Interactive (CD-I) - a Case Study

Introduction

The Philips electronics group launched its CD-I player (CD1910, retail circa $1,000) in the United States in October, 1991. Similar to a VCR, it links directly into any television receiver and each five-inch disc (the same size as an ordinary audio disc) is said to be capable of carrying 250,000 pages of text/19 hours of audio/72 minutes of full motion video (FMV) or a combination of all three.

The FMV component was not ready for its initial launch; despite this, Philips decided to go ahead and announced plans to add a "plug-in" FMV peripheral device from Spring, 1992. Some six months later, in October, 1992, Philips announced "by the end of this year, (the company) will release a limited number of full-motion video (FMV) plug-in cartridges...priced at approximately $200 ... (although they) are not expected to sell in large quantities until the latter part of 1993." (Andrew Davidson, manager, advanced development, Philips Interactive Media of America).

CD-I was launched in the UK in April, 1992 followed by a full European roll-out. By the end of 1992, CD-I was available in more than a dozen countries worldwide.

Apart from FMV, the main diffusion problems facing CD-I at the time of its launch were:

(i) **existing competition** from other interactive multimedia delivery platforms such as IBM's Ultimedia, Interactive Video Disc (IVD) and Intel's Digital Video Interactive (DVI). Another recent entry has been CDTV (Commodore Dynamic Total Vision) using Amigavision. Philips also face a somewhat confusing "technology cluster" of other new media on or about to come on the market, such as CD-ROM, MiniDisc (Sony), DAT (Digital Audio Tape), Photo CD (Kodak), HDTV (high definition television) and Sony's portable CD-ROM Player.

(ii) **emerging competitors**: Tandy and Microsoft launched VIS in the Fall of 1992, playing CDs on a non-compatible format to Philips CD-I. Sega and a new company called "3DO" have also announced

non-compatible products for launch in 1993 and the Apple Computer Company has said it will be introducing its own non-compatible CD drives in 1993, although Philips claims Apple CD's will be compatible with its own.

(iii) in turn, this has led to **potential confusion among customer** (as happened with VHS and Betamax with the launch of VCR's in the 1970's);

(iv) **insufficient software** (only 50 titles available at launch) to fuel customer demand;

(v) **unstable pricing**: Radio Shack has already discounted Philips-manufactured CD-I players to $499.95 under its Memorex own-brand name. Goldstar, the Korean electronics company, is scheduled to launch a CD-I player for less than $500 in June,1993, and JVC, Panasonic and Samsung are all planning to produce their own units in 1993.

Overview

The Philips Consumer Electronics Company, whose brand names include Magnavox, Sylvania, and Philco, as well as Philips, has invested over $500 million[1] in the development of Compact Disc-Interactive (CD-I). According to its advance publicity "CD-I is about to change the way the world uses its television sets. With software developed for this new technology, users of all ages can actually interact with the television and tour museums, color and animate cartoons, learn new skills or add a new dimension to games and classic stories - the opportunities are endless."[2]

At stake is the entire worldwide television market (the US, Japanese and European markets alone account for nearly three-quarters of a billion potential consumers), since the CD-I player simply hooks into the back of any television set, similar to a VCR. Philips is predicting sales of 33 million CD-I players worldwide by 1997 with projected disc (software) sales of 231.5 million. By 1999 the US is expected to

[1] Source: Philips spokesman at CD-I One, the first conference of CD-I publishers and developers in Los Angeles on October 31, 1991. The product was launched nationally in the US on October 16 to 1,000 retailers including Sears, Circuit City, Silo, Montgomery Ward, Tandy and Dillards stores.

[2] The Rowland Company on behalf of Philips Interactive Media of America (PIMA).

have 62 million sets in use with a staggering 452 million discs.[3] In short, Philips is banking on a success no less than the innovation of audio compact discs, which it also pioneered and launched in 1982; annual CD sales have now overtaken those of audio tape cassettes in Europe and the US.

From the standpoint of diffusion, the problems facing Philips include a major "glut" of new technology products, which are potentially confusing to consumers, and competition from existing and imminent new electronic products, which could result in a "wait and see" attitude by prospective adopters. This is dealt with in detail in later sections but at this point it is worth highlighting existing literature on common problems encountered in the diffusion of high-technology products. In addition, the diffusion of CD-I was hampered by the non-availability of full motion video (FMV) at the time of its launch, and a shortage of software titles (only 50) available to fuel initial consumer demand.

Survey of existing literature on the diffusion of high-technology products and description of target adopters

An innovation is defined "as an idea, practice, or object that is perceived as new to an individual or another unit of adoption. The innovation-development process consists of all of the decisions, activities, and their impacts that occur from recognition of a need or problem, through research, development, and commercialization of an innovation, through diffusion and adoption of the innovation by users, to its consequences." (Rogers, 1983, p 135) [4] .

Everett Rogers states: "The ultimate consequences of a new communication technology seldom are known or can be very accurately predicted when the new medium becomes available." (Rogers, 1986). An understanding of the factors involved, both in facilitating and impeding the diffusion of CD-I or any other new consumer info-tainment technology, however, can be furthered from an examination of diffusion and marketing research literature on similar high-tech consumer products (Mayo, 1992). Most of the current diffusion literature in the area of high-tech innovations focuses on the personal computer. The three major variables of interest in these studies are:

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3 Source: Philips CD-I sales projections, 1991-1999.

4 Rogers, Everett M. (1983). 3rd ed. The Diffusion of Innovations. New York: The Free Press.

(1) attributes of the innovation itself, (2) properties of the process, and (3) characteristics of adopters and non-adopters (Dickerson & Centry, 1983; Ostlund, 1974).

For our purposes, various characteristics of PC's and other high-technology products can be compared and contrasted with CD-I to gain an understanding of how diffusion of CD-I might occur and how it may parallel or differ from the diffusion of PC's. An analysis of the three aforementioned variables in the literature reveals the following characteristics in diffusion of new technology studies.

Attributes of the innovation

In a comparison not with computers, but with traditional mass media channels such as television, CD-I technology parallels computer technology with respect to the following three "new media" properties as outlined by Dutton, Rogers and Jun (1987) :

(1) interactivity: the degree to which the new communication systems are capable of responding to user commands.

(2) Demassification: the degree to which specialized content can be delivered to different individuals.

(3) Asynchronicity: the degree to which "broadcatch" is independent of broadcast.

These characteristics of new media technologies may simultaneously increase for some, and decrease for others, the attractiveness of adopting such an active media system. Some media users prefer the passive nature of television while others are stimulated by a system which requires interaction (Dutton, et al, ibid). This issue is addressed in the section on relative advantages.

Properties of the process

The process of diffusion is an active procedure, attended to by change agents (sales people) through the use of advertising, promotion, product demonstrations and other means. Research is beginning to address these factors. Marketing researchers Robertson and Gatignon

(1986) analyzed "competitive variables", arguing that these "supply-side" elements have not been included in diffusion research--as if the technology diffuses within a technology vacuum. Factors such as "shake-outs" and price wars are mentioned. In an effort to include marketing variables in the diffusion equation, Robertson and Gatignon list the following 5 supply-side propositions:

Proposition 1: The greater the competitive intensity of the supplier group, the more rapid the diffusion and the higher the diffusion level.

Proposition 2: The more favorable the reputation of the supplier group, the more rapid the initial diffusion.

Proposition 3: The more standardized the technology, the more rapid the diffusion.

Proposition 4: The greater the vertical coordination between suppliers and customers, the more rapid the diffusion.

Proposition 5: The greater the allocation of R&D resources within an industry, the more rapid the diffusion process for new technologies and the higher the diffusion level.

On another front, studies by Richard Olshavsky (1980) on the rate of adoption, reveal that diffusion rates and the product life cycle have been accelerating in recent years. This issue of product life cycles will be addressed in the final section of the paper.

Characteristics of adopters and non-adopters

Given the fact that diffusion studies have failed to find "empirical support" for a model of innovativeness that can be generalized to a wide range of situations, researchers set out to study product-class-specific adopter category profiles (Dickerson & Gentry, 1983). The majority of diffusion studies of computer and other high technology consumer products center around a comparison of the characteristics of those who adopt with those who are non-adopters (Dickerson & Gentry, 1983; Dutton, Rogers & Jun, 1987). Demographic, SES, psychographic characteristics and personal attitudes have been examined. Detailed profiles have been developed of the type of person like to adopt a PC. For example, Dickerson and Gentry

measured a host of psychographic and demographic variables to conclude:

Proposition 1: Adopters are more likely to be home owners, have more education and higher incomes than non-adopters.

Proposition 2: Adopters of home computers exhibit low "origence/high intellectence" traits. (These traits include scientific occupational orientation, and categories such as active and introvert)

Proposition 3: Owners of home computers have more experience with the general product class than non-owners.

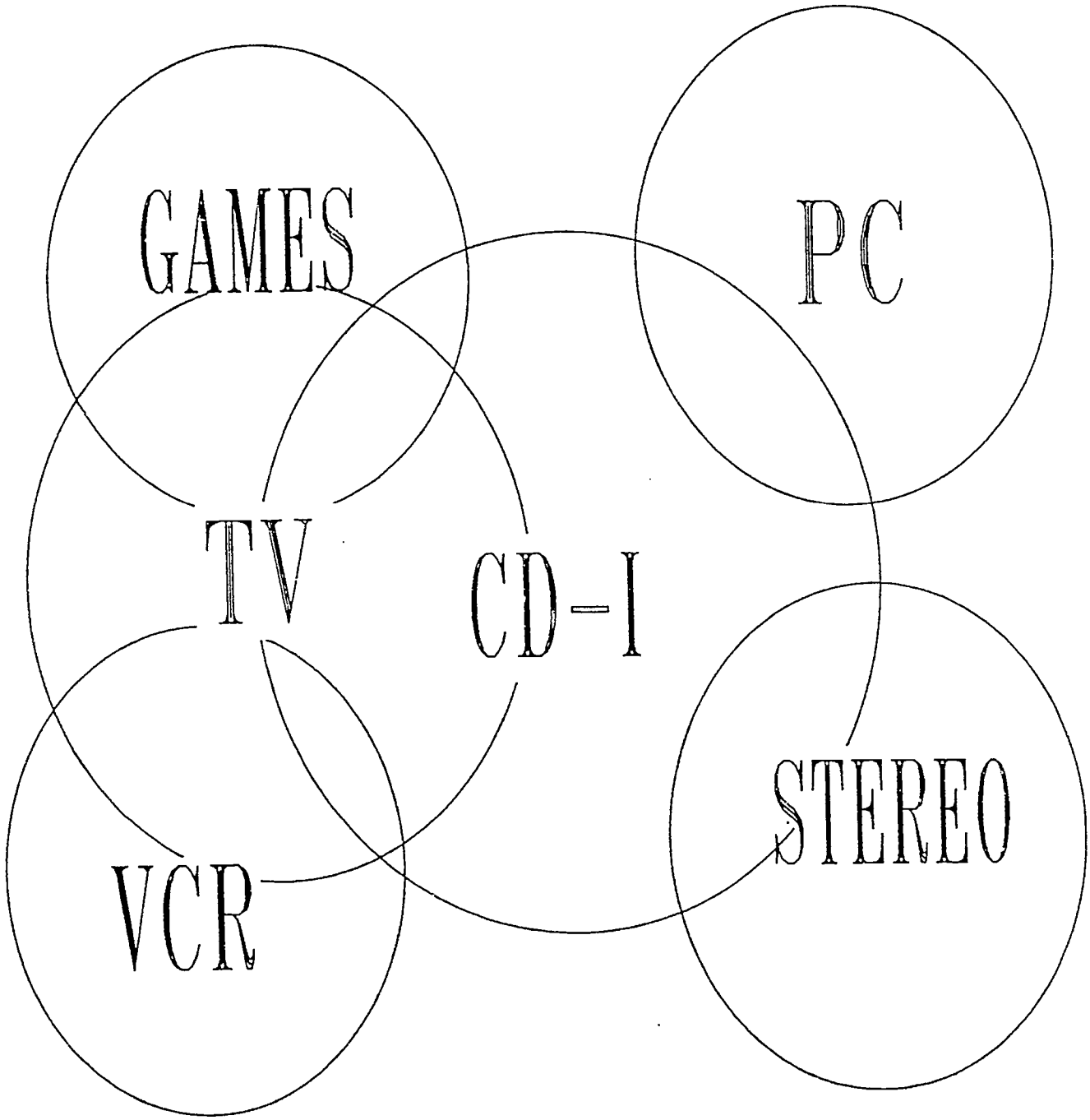
Given the preface that adopter profile characteristics which indicate likeliness to adopt a PC may not necessarily translate into congruent characteristics which would predispose one to adopt CD-I technology, it may be necessary to consider an interaction of product attributes and adopter characteristics to understand or predict adoption of this new technology.

Interaction of attributes, process, adopter categories and market potential

In the area of technology adoption, consumer profile models assist researchers and marketers to understand better a potential market, but only if the specific interaction of these profile models with the adopter categories is clearly understood. For example, based on Dickerson and Gentry's findings, a computer owner would be more likely to adopt CD-I than a non-owner. However, many of the attributes, including complexity, price, etc. which were mentioned as barriers to PC adoption may not exist for CD-I (see section on compatibility and complexity).

The extent to which the various new media products differ, overlap, compliment or cannibalize one another should be taken into account. Thus, CD-I plays a new role in integrating or combining several existing devices into one **(see diagrams on following pages).**

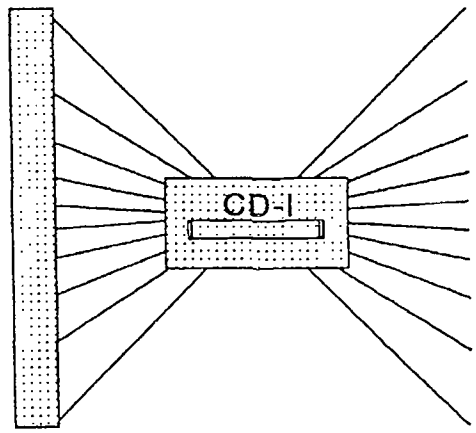
Interaction of the various high-tech consumer products



CD-I Specification

Contributing Media

* Print Publishing
* Electronic Text
* Music
* Audio
* Video
* Film
* Computer Software
* Optical Publishing



Types of Programs

* Interactive Video
* Interactive Audio
* Multi-media Biographies
* Reference Materials
* Large Databases
* Music Plus Visuals
* Talking Books
* Educational Materials
* Surrogate Travel
* Video Editing/Creation
* Advanced Games
* Activity Simulation

Relative advantages

If we use Rogers' description (1983, ibid) of recognizing a problem or need, we can describe CD-I in Philips' terms as a "logical extension in the evolution of the digital disc," [5] which was originally developed in the 1970s and is now available for mass data capture because of further developments in digital optical recording. According to Philips, the drawback in existing consumer electronic products is that they do not provide sufficient interaction between product and consumer (television and audio entertainment systems are essentially passive media). Decades of education studies have illustrated that people learn best when they actively participate in the learning process through interaction, and CD-I's relative advantage is that it provides real-time interactivity through audio, visual and tactile (via remote control) channels of communication.

Furthermore, a survey by The Roper Organization on behalf of Philips[6] found that 57 per cent of parents "embrace the concept of interactive entertainment (and) are interested in the kind of control, provided by (the CD-I system). For example, 55 per cent of parents wish for home electronics that encourage children to become more involved and challenged by what they are watching." (Roper, 1991 ibid).

Citing the same study, Philips rebut charges of "technophobia" pointing out that 47 per cent of US adults said they "look forward to new home electronics products". While not using Rogers' exact terms (ibid), Philips maintain that the perceived attributes of CD-I among potential adopters include:

- CD-I is a leading edge technology which allows its adopter to explore at his or her own pace;

- it enhances education as well as providing entertainment and information;

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[5] First there was Laservision, invented by Philips in the 1970s; next came CD digital audio (now the brand leader), then Compact Disc Video (combining laser disc video and digital audio in compact disc format), CD ROM (Read-Only Memory) and Digital Optical Recording (DOR) allowing massive data capture and storage in professional computing applications.

[6] The Roper Organization: Face-to-face interviews with a nationally representative sample of 1,992 adults, including 600 parents with children age 4-17 living at home, July 6 -13, 1991.

• CD-I is competitively priced with other "similar" electronics products. (At $1,000, Philips' initial list price, the authors would disagree with this statement but with the market having fallen to $500 in some cases and expected to fall below $300 within the next two to three years a "critical' price threshold may well be reached.) Software is priced at between $19.50 and $50.00 per title which is similar to the Nintendo/Genesis games market and also the higher-price "coffee table" book market.

• Philips claims CD-I is both "backward" compatible (you can play audio CD's on the same system) and "forward" compatible (it will be able to play new technologies because of the world-wide standard it has promulgated "for all CD-I". In reality, this is more a hope than a promise and the consumer is likely to be extremely doubtful of such a claim.

• Philips believes CD-I will be used first in the games, entertainment and leisure market and will expand as publishers take advantage of its "Trojan horse" characteristics to introduce more serious educational software, remote learning, business training and retail applications. For example, one of the expected uses of CD-I is its replacement of the printed catalog. It is much cheaper to produce (as little as $1.50 to press a disc) than its printed counterpart and much cheaper to post (postal increases in 1991, combined with the recession, are estimated by trade journal *Advertising Age* to have reduced direct marketing by catalogs by as much as one third).

The Philips argument tends to gloss over a number of highly critical points.

Firstly, having commissioned a consumer survey pre-launch, observers can take a somewhat skeptical view of its findings because of potentially inherent bias, and, secondly, even if one accepts the hypothesis that demand for interactive products exists, why should the Philips' CD- I model be the "ideal" candidate ? The consumer has already been alerted through media publicity to a future generation of "smart"/intelligent TV's which will combine an interactive television, VCR, computer and CD player all in one "box".

Thirdly, how will potential adopters use the new technology ? What are they most likely to pay for ? The success of the film (cable) market, and, in particular, video "film" rentals would indicate that a huge demand exists for full motion video, exactly the factor that was

missing in Philips' initial launch. Furthermore, Pay TV and the advent of fiber optics with consumers able to order "films" or games down the telephone line (and interact with them) raises questions about whether an additional "box of tricks" (namely a CD-I player) is called for at this time. "Wait and see" is, thus, a potentially serious (if not fatal) flaw in Philips' decision to launch without FMV. Similar problems have been encountered with other new media in the past. Klopfenstein (1985, 1986) "found the various market forecasts for consumer adoption of videodisc players were overly optimistic" [7] A similar fate awaited teletext in the US although it has been hugely successful in France and relatively successful in the UK. (Greenberg, 1986). [8]

Martin (1977) pointed out the pitfalls of much technological forecasting. He noted that "it is often difficult for us to look beyond the technological limits in which we currently reside". [9] Twiss (1984) added: "It is far easier to visualize an 'end-state' scenario for when the new product is mature than to assess the path by which it will reach the mature state." [10]

Following on from Twiss, one can argue that even if the CD-I format is adopted on a wide scale it is questionable whether the ultimate *delivery* system will be the same as the initial Philips' CD-I player.

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[7] Klopfenstein, Bruce "Problems and Potential of Forecasting the Adoption of New Media" in Media Use in the Information Age, Ed. by Salvaggio, Jerry L. and Bryant, Jennings (1989). Hillsdale, New Jersey: Lawrence Erlaum Associates.

[8] Greenberg, B.S. (1986). Patterns of Teletext Use. London, UK: Independent Broadcasting Authority.

[9] Martin, J. (1977). Future Developments in Telecommunication. Englewood Cliffs, NJ: Prentice-Hall.

[10] Twiss, B.C. (1984). Forecasting Market Size and Market Growth Rates for New Products. Journal of Product Innovation Management, 1 , 19-29.

CD-I and its competitors (current and potential)

The Philips CD-I player CD1910 was launched in the US in October 1991 with a list price of $1,000, although a discounted market price of around $800 was predicted. [11]

It followed the launch earlier in 1991 of CDTV (Commodore Dynamic Total Vision) by Amigavision for which sales figures are not yet available but are believed to be very low. More importantly, CD-I is some years behind Interactive Video Disc (IVD) and Digital Video Interactive (DVI) which combine a laser disc with CD-ROM storage and are marketed mainly by IBM. The principle drawbacks of both the IBM and Amigavision competing systems are that they utilize a separate computer drive and they don't hook up to a normal TV monitor. Consequently, they are more cumbersome and they are much more expensive. The IBM "Knowledge" system, for example, is priced around $10,000 and includes the Ultimedia M57 SLC computer with 6 M-bytes of RAM and an 80-M-byte hard disc and an internal CD-ROM M-Motion Adapter/a capture and play-back card, a Matrox Illuminator-16 video card and a Pioneer LD-V8000 LaserDisc player.

A more serious competitor for CD-I is the1992 announcement by Apple Macintosh that its next generation of computers (perhaps only a year away) will have built-in CD drives and these will be incompatible with CD-I discs (although Philips maintain Apple has now decided they will be compatible). Apple and IBM have also linked in a joint venture called Kaleida to develop a new operating system and this is being viewed as a precurser to further joint productive efforts which could further damage CD-I's credibility and competitive edge.

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[11] In the event, the price of a CD-I player fell further with Radio Shack in May, 1992 offering Philips-manufactured players under its Memorex own-brand name for $499.95. The Memorex price does not include any software (whereas the Philips' sets are "bundled" with two free tapes worth approximately $50. Otherwise, the players are identical and Philips' consumer service department confirmed in a 'phone call on June 4, 1992 that the "FMV extension will plug into both sets when it's available this Fall or early next year". As previously stated, this latter promise has been revised to a delayed implementation of FMV modules on a limited scale "by the end of this year" (1992) "...(although) the cartridges...priced at approximately $200 are not expected to sell in large quantities until the latter part of 1993." At the CD-I two conference (ibid.) in October, 1992, Philips was suggesting a list price for players of $599 including "bundling" an enhanced version of the CD-ROM Compton's Interactive Encyclopedia on CD-I.

In the Fall of 1992, Tandy and Microsoft launched VIS which offers interactive products on a non-compatible format to CD-I; other non-compatible "games" players have been announced for launch in 1993 by Sega and "3DO" ("three dimensional optics", a new joint venture electronics company comprising Time Warner, Matsushita, MCA, Kleiner Perkins and AT&T.)

Compatibility and Complexity

Each 5-inch CD-I disc (the same size as an audio CD) can carry up to 250,000 pages of text / 7,000 photographic-quality images / 72 minutes of full-screen/ full motion animation (from1993) / 19 hours of speech and four planes of visual effects or any combination of these. Users interact with the discs via a "thumbstick" remote control device similar to a standard TV channel changer or VCR remote. "(They) can control the action on the TV screen and activate various sections highlighted by pointing to and clicking on command areas on the screen (noted with symbols or words). In addition, the user can interrupt the running sequence of a program to recall a certain choice, go back to a previous step, ask for more detailed information, or perhaps request to have the explanation in another language - simply by the press of a button." [12] A simpler, roller ball device is available for children's use.

Philips has made the patents available to Sony, Matsushita and other major consumer electronics manufacturers in a bid to avoid the VHS v Betamax debacle of the 1970's which ultimately led to the demise of Betamax as an alternative VCR format but, moreover, acted as a cautionary tale for a generation of consumers on the notion that technology can fail and that they can be left holding the redundant technology.

The Philips company argues "the (CD-I) technology is evolutionary, stable and flexible to accommodate both existing technologies, as well as future enhancements. It is compatible with a standard television set and audio gear found in nearly every household and requires no technical expertise or learning curve."

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[12] Philips information hand-out, October, 1991. In effect, the "thumbstick" control has already met user criticism for being less sensitive than most games' "joysticks" currently on the market or existing mouse/ rollerball/trackball computer peripherals. Philips is believed to be experimenting with a substitute rollerball device based on its accessory aimed at children.

It claims to be "developed to a worldwide standard to ensure compatibility with all CD-I discs developed, regardless of make, manufacturer or country of origin....the CD-I player will also play three and five-inch audio CD's, CD + graphics discs and visuals, CD ROM-XA "bridge" discs, photo CD's (launched by Kodak in 1992)" and a new generation of Nintendo hand-held computer games.

Thus, using Rogers' diffusion terminology, one could argue that Philips has demonstrated a case that its CD-I innovation is compatible with needs felt by (potential) clients and is part of an existing "technology cluster" where elements of the new technology "are perceived as being closely related". (Rogers, ibid p 226).

It is also being described as not a complex innovation, a useful pre-condition given Rogers' generalization that "The complexity of an innovation, as perceived by members of a social system (its potential adopters), is negatively related to its rate of adoption." (Rogers, ibid p 231).

Trialability

CD-I would appear to fail a crucial test on trialability, "the degree to which an innovation may be experimented with on a limited basis", a factor which "is positively related to its rate of adoption". (Rogers, ibid p 231). In the case of the launch of CD-I it is a "buy" or "not buy" decision and, therefore, its lack of trialability must be looked at as a negative factor, albeit there is precedent for substantial adoption of similar technologies (VCR's, for example, can now be found in nearly 75 per cent of all US households). [13]

One could also argue that the various trade shows where CD-I has been demonstrated in themselves represent early attempts at trialability.

Observability

Rogers (ibid) defines observability as the degree to which results of an innovation are visible to others and details positive consequences. In the case of CD-I, it is too early to adjudicate on its observability but, potentially, it represents hardware/software which can be easily

[13] US Bureau of the Census (1990).

assessed as to its rate of adoption. As in the case of the diffusion of audio CD's or Nintendo games, the spread of the product tends to take on a snowball effect once a critical mass has been reached and the "take-off" point is reached on the diffusion curve. [14]

Cost-benefit analysis

It is too early to suggest a full cost-benefit analysis for CD-I, largely because there are are only 50 current discs (software titles) available with 78 available (including 20 games titles) a year after launch. Only when the software is generally available (and tested) can one fully analyze the cost-benefits of its adoption. The simple question for consumers at this stage is what are the advantages/benefits of being an innovative/early adopter against the costs (likely to fall) and likely competitors (other, possibly better, new technologies) in the near to medium-term future ?

Current diffusion campaign for CD-I and criticisms

Philips decided to go ahead with the launch of CD-I in October 1991 despite the fact that it could not launch with a full motion video (FMV) capacity because of problems with compression algorithms needed to reduce the storage space taken up by moving picture (while at the same time maintaining close-to-broadcast-quality).

The arguments for not postponing the launch undoubtedly stemmed from fears of emerging competition but it is a brave (or foolish) company that launches an innovation in the certain knowledge that it is going to have to recall all units sold in order to add an important element at a later date. Imagine a similar scenario with a motor car where you are going to add and fit a state-of-the-art fuel injection system *after* you have sold the car (and that same fuel system has been heralded in pre-publicity as one of the main advantages of the new model.)

One should also note target adopters are well conditioned to seeing "full motion video" on their television sets and, thus, are likely to be frustrated at its initial shortcomings. In the event, Philips also failed

[14] Past research has generally shown that the adoption of an innovation follows a normal, bell-shaped curve when plotted over time on a frequency basis. If the cumulative number of adopters is plotted, the result is an *s* -shaped curve. (Rogers, ibid, p 243).

to deliver on its promise of FMV by the Spring of1992. At the CD-I two conference in Los Angeles [15], the company revealed add-on modules would only be available in limited supply "by the end of the year...and are not expected to sell in large quantities until the latter part of 1993". Some confusion also remains over whether the MPEG compression system used in CD-I will provide full screen or only partial-screen display.

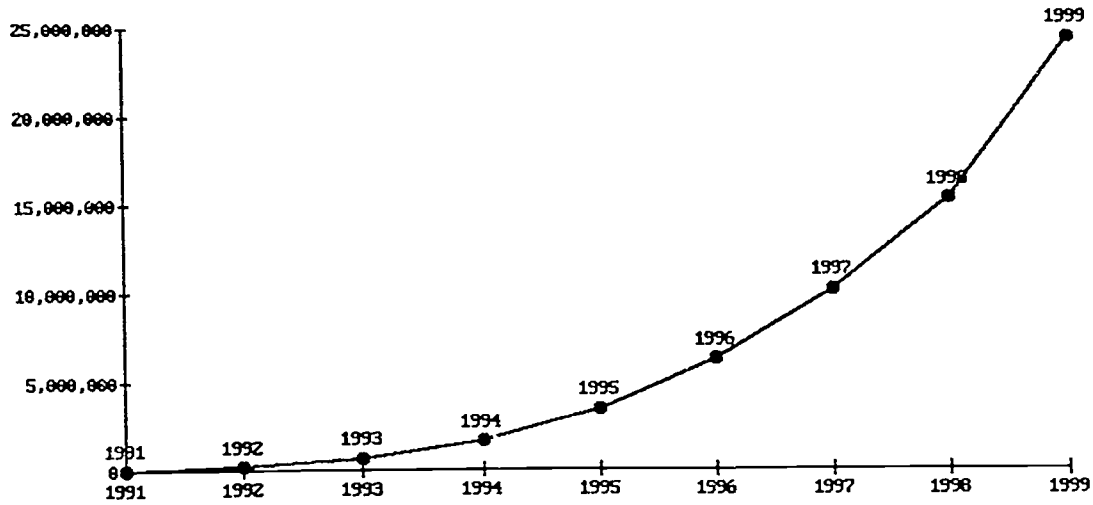
In 1991, Philips predicted the following sales figures:

Philips' projections for sales of hardware

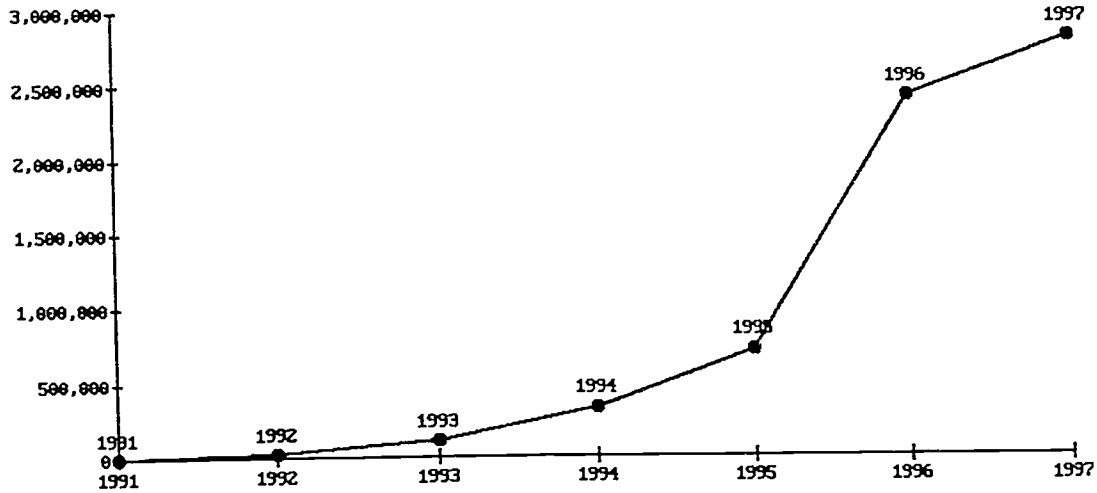
(see graphs on following page)

15 CD-I two, the Second Annual CD-I Publishing and Developers' Conference and Exposition, October 27-29,1992, Los Angeles, Ca.

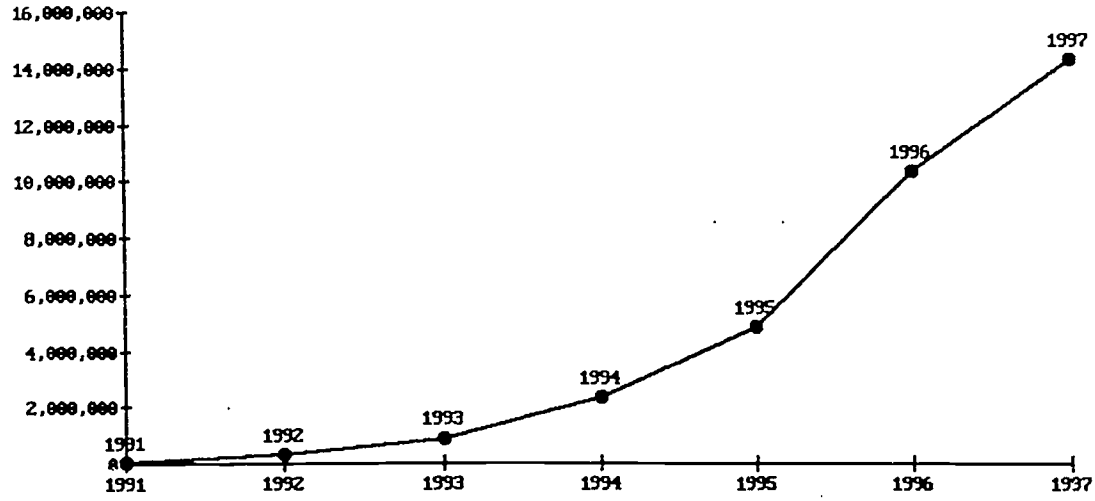
Expected Sales CD-I
United States



Expected Sales of CD-I
Europe



Expected Sales -World
CD-I



Unofficial figures, reported at the CD-I two conference (ibid.) indicated sales of only 60,000 players in the United States 12 months after launch with "around 100,000" expected by Christmas, 1992, after a $20 million advertising campaign. The number of software titles has grown from 50 to only 78, much less than the 200 or so titles predicted. However, a survey of senior retail executives representing more than 25,000 stores, carried out by The Taubman Company, reported that the "hottest" gift for Christmas '92 was the "interactive - CD video system", leading prepackaged gift sets, "step" exercise equipment, latest video games and music albums as the top five items. The survey would appear to run contrary to actual sales figures but this could be a factor of distribution and supply.

The Early CD-I Diffusion Campaign

As part of its initial diffusion campaign in the US:

• Philips formed PIMA (Philips Interactive Media of America) to support software developers (often financially) and regulate standards;

• 1,000 major retailers were chosen for launch with good point-of-sale display material and training for sales staff (but early adverse publicity would indicate this has led to substantial patches of non-availability in various parts of the US, at variance with its national (albeit small) print campaign in newspapers such as The Wall Street Journal.

• New York was chosen as the initial launch platform with celebrities chosen to support available software. The paucity of titles clearly limited the choice: Chubby Checker was chosen to introduce "Golden Oldies Jukebox" and "Cool Oldies Jukebox"; Dick Cavett served as the guide through an interactive museum tour of "The Renaissance of Florence", "Treasures of the Smithsonian" and "Harvest of the Sun: Vincent Van Gogh Revisited" ; and 1991 PGA Champion John Daly challenged guests to a round of real-image interactive golf in "ABC Sports Presents the Palm Springs Open". It was not an auspicious start judging by the muted publicity it received although the launch of CD-I fared better in the specialist computer and business press, partly due to CD-I One, billed as the first CD-I interactive conference and exhibition for publishers and developers in Los Angeles, October 31 - November 2, 1992. At this conference Sony also unveiled the "world's

first portable CD-I viewer" but reaction to the prototype sets was tempered with the realization that they would not be available for "at least another seven months, perhaps even longer".[16]

• CD-I was launched under the Philips brand name designed to provide a fillip to that brand leading to criticism from some retailers that it would have been better to launch under the better known US brands of Magnavox and Sylvania.

• The CD-I launch had to compete with a mass of publicity for other high-technology electronic products, either in production or imminent, a veritable "technology glut". A content analysis of major US newspapers/general interest magazines (including Time, Newsweek, The Economist and Business Week) in October 1991 included:

- **Data Discman** (Sony) - a "Walkman" type device, costing about $430, capable of displaying up to 100,000 pages of printed information ranging from encyclopedias to medical-care or restaurant guides.

- **Mini disc** - a new generation of audio CDs (smaller than standard size) for portable use which can record as well as play sound.

- **DAT** - digital audio tape promising "as original" sound reproduction.

- **Kaleida** - a joint venture between IBM and Apple Macintosh to produce a new computer operating system, the first time the rival computer manufacturers combined.

- **three separate announcements by the CEO of Apple**, John Sculley, (i) that the next generation of Apple Macintosh computers (probably only a year away) would include a CD-port incompatible with existing CDs (including CD-I); (ii) a break-through in voice recognition technology "which would make many current computers (and, therefore, electronic products) virtually obsolete" (words in parentheses - authors' description); (iii) trailing of the "personal assistant" range of 'pentop' computers which could accept hand-

16 Sony spokesman at CD-I One Conference, Los Angeles, October 31-November 2, 1991. Despite this comment, the Sony hand-held players have been selling in Japan in 1992 and are due to be shipped to the US early in 1993, according to New Media magazine (January, 1993). Another portable, called the CD-I Handy Player, manufactured by Kyocera, is also due to go on sale in Japan in 1993.

writing and would be much smaller than the only-just-released Powerbook range of notebook-size computers (themselves substantially smaller than laptops).

- **further advances in CD-ROM** technology with Sony introducing a portable CD-ROM player in December, 1992.

- **VIS.** Tandy and Microsoft have combined resources to produce an interactive player which is incompatible with Philips' CD-I format. Launched Fall, 1992.

- **HDTV**, the soon-to-arrive High Definition Television screens (including video walls) which, unlike their Japanese counterparts, would be digital and offer vastly better quality than existing TV pictures. The Japanese system utilizes analog technology.

- **computers without keyboards** (again using "pen" technology for data entry giving rise to a new 'generation' of computerized blackboards).

- **fiber optics** (the continuing battle between the telecoms and cable operators on who will own the fiber optic links into households which, in turn, will generate new means of "interacting" with one's TV (e.g. voting, direct off-the-screen purchases).

The net effect of the "technology cluster" was overwhelming: Even to the non-computer literate consumer it was clear that the pace of technological change was becoming ever faster.

A pan-European study[17] on Multimedia and the Consumer Market published in March, 1992, concluded "multimedia is but the first step towards even more sophisticated forms of communication like 3-D video and virtual reality..."

The list of new technological multi-media innovations is virtually endless.

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[17] The Multimedia Market Opportunity, Electronics Europe , March , 1992.

"Multimedia is a potentially massive market for computer, consumer electronics, publishing, software and telecommunications communications companies. But it may also prove to be a big money loser for some players." (Electronics Europe, 1992, ibid).

Multimedia Pathway

The report defined the history of multimedia, for which CD-I is the leading edge example, as:

1970s	Slide/Film Audio Tape/Video Tape Speech
1980s	Analog video disc player plus computer
1990s	Digital multimedia player/computer peripheral (e.g. CD ROM)

Multimedia = sound, video, text, graphics, animation + computer power + interaction.

An Alternative Diffusion Approach

1. Re-launch with FMV: Given that CD-I *has* launched we can only proffer an alternative approach for a re-launch. In hindsight, we fear the launch of CD-I may prove to have been premature and Philips would have been better to have waited until its full motion video capability was realized. Further delays have frustrated software developers and consumers alike. By launching in a "semi-prepared" state, Philips is running the real risk of either alarming the consumer or over-hyping its product making what the consumer may feel are "false promises". This leaves the way open for a competitor to enter the market with a "finished" system and "sweep the board".

2. Cushion the Cost: Even at $500, a CD-I player represents a considerable expenditure with discs costing additionally between $19.50 and $50.00 each. Given that VCRs now retail for less than

$300, and CD-I players look very similar, consideration should have been given to a much lower threshold of cost entry. Certainly, Philips' initial list price of $1,000 has been criticized by electronics industry experts as being totally wide of the mark. A re-launch campaign (with FMV) should be accompanied by substantial price reductions and an attempt to reach a comparable pricing level with VCRs. Delays in launching the FMV adapters have meant that Philips has already missed the peak buying period pre-Christmas 1992 and its "imagination" media campaign for non-FMV sets is likely to be unsuccessful.

3. Neutralize/Standardize the Competition: The consumer is becoming confused by the host of new multi-media technologies on offer. No matter how difficult a task, further attempts at standardization have to be made and all new products on the market will have to prove backward and forward compatibility (within obvious limits) if they are to gain consumer acceptance. Philips has already taken the initiative here by licensing the CD-I technology to various other manufacturers; it is more the pity that this "unified" front has failed to materialize in terms of simultaneous launches by several manufacturers

4. Provide a Copyright Framework: This really is a Pandora's box which has yet to be resolved. There is no standard copyright (US or European) on what constitutes "tertiary exploitation rights" (broadcast is primary, video represents secondary) for interactive communication properties. Difficult as such a task is, it should be tackled now by the European Commission (on behalf of EEC countries) and the Federal Communication Commission (FCC) in the US. It is estimated that 46 per cent of all video transactions in the world involve illegal copies. [18] Must interactive communications and CD-I go the same way ?

5. Software - go for the 'knock-out' : More "really useful" software needs to be made available if consumer resistance is to be overcome. Apple's CEO John Sculley described this as a multimedia problem (not just CD-I's). Multimedia still lacks what he describes as "killer software". Examples elsewhere in the computer field would include the spreadsheet program Lotus 1,2,3, Microsoft's WORD and WINDOWS software. Philips, through various associations, is backing the development and publishing of dozens of new titles and

[18] Source: CBS/Fox International (1986).

development software "tools". Further (and continuing) investment is needed in this area lest CD-I face the same fate as Atari Game Systems, which in the early 1980's held nearly 100 per cent of the worldwide TV games market and lost it all less than a decade later to Nintendo and Genesis because they failed to invest in the development of improved "games" software.

6. Make the notion of interactivity mean more: Home users will have to be convinced that an interactive system is a "need-to-have" additional form of regular entertainment /education /information. The Philips' initial research is far from comprehensive. Philips believes that CD-I will be the "Trojan Horse" for home penetration and that even non-computer households will respond to the new "computerized" medium. Will the consumers accept yet another VCR-like consul to accompany the television set or will they wait until an integrated "does everything" model comes on the market ? The late 1990s are expected to see the arrival of "The Intelligent TV", a HDTV set "with enormous processing power, effectively combining the television, CD player and computer in a single box" (Electronics Europe report on Multimedia, 1992 ibid). Philips could well consider insulating itself now from such developments by manufacturing the "all purpose" TV/VCR/CD-I/ Computer box" which could be modified as new inventions come on stream.

The introduction of fiber optics (via telecoms/cable operators) will drastically alter the current market situation although, realistically this will not be completed in the next decade giving CD-I the opportunity of grasping a substantial foot-hold. Philips is on record as saying that it does not expect the mass market for CD-I to take off until after 1995. It points to the success of its audio compact discs (CD's) and says CD-I will parallel a similar diffusion curve.

7. Convert the business user (and the educationalist)

The emphasis to date in all software has been on the entertainment/ children's education market. Further business/ adult training/ higher education titles would stimulate demand. There are very few "must have" titles on sale or in development. Philips needs to treat this as a priority as part of its diffusion campaign.

8. Interact with the right "movers & shakers"

Rogers (ibid) has offered numerous examples of where diffusion attempts have failed because the wrong change agents were used or there was failure to identify the right opinion formers. Philips, through associations such as PIMA (Philips Interactive Media of America) and PIME (Philips Interactive Media of Europe) are taking great steps to identify the (and support) publishers and developers of CD-I titles. But, it is perceived, that a similar weight has not been given on locating the right opinion-formers among the end-users.

In addition, as part of Philips continuing (or alternative) diffusion campaign, attention should be given to:

- Installing CD-I players in museums, libraries, universities, government agencies;

- Offering incentives (joint ventures ?) for businesses who provide training on CD -I;

- Offering grants to educationalists for the same purpose and, perhaps, setting up "user groups" with teachers to develop titles for the classroom;

- Formulating joint initiatives with government on education and training.

9. Employ the right Mass Communication strategy

The launch of CD-I has almost been noticeable for its *lack* of advertising support. Initial advertising in the US appears to have been limited to The Wall Street Journal, The New York Times and retail advertising in various cities where CD-I was available. The first television campaign, using the "imagination machine" as its copy line, broke in the Fall of 1992 and Philips promised more than $20 million in the third and fourth quarters of 1992 to promote CD-I. However, without the availability of the FMV component. the authors are skeptical of any significant success. Point-of-sale displays have been installed in more than 1,000 retail stores but this will have to increase many-fold if the rate of adoption is to be increased.

10. On-going research into the perceived attributes of CD-I among potential adopters: what do they *really* want, how

will they use the new technology; what are they most willing to pay for ?

Philips says it has continuous panels (both focus groups and representative samples) which are being used in the study of CD-I but it is unwilling to release such information. In a project of this magnitude, a better approach might have been to have made the information public and pooled it with other manufacturers and developers.

Such a research program would also be most useful in attempting to explore the consequences (u and dys-functional) of the innovation of CD-I. What, for example, are the implications of CD-I for the school education system ? Will we reach a stage where whole courses will be taught on CD-I and students will take home their discs for work on their home CD-I players ?

What are the implications for the training and re-training of staff ? For the diagnosis of faults (car/airplane mechanics etc.) and for the whole field of medicine (from providing initial medical information to the whole range of diagnostics) ?

11.Tracking study: A proposal for researching the diffusion of CD-I over the next several years

Marketing studies have shown that most consumer products move through what is commonly referred to as a "life cycle" during which the product is

(1) developed (pre-introduction); (2) introduced; moves through the (3) growth stage; (4) the maturity (or saturation) stage; and (5) decline, as new innovations are introduced (Neidell, 1983). During this time, a flourishing product will diffuse through the market.

In order to successfully maximize the market potential, ongoing analyses of the diffusion process are necessary.

Pre-introductory stage

During the pre-introductory stage, the R&D branch of any company must put a prototype innovation through rigorous functional and consumer tests. When the product in its final form is ready for

market testing (Kotler, 1980), several techniques are available:

-Product use tests in which the manufacturer selects a small group of potential customers to utilize the product for a period of time. The manufacturer or researcher employs the use of experimental and trial settings and focus groups to determine customer judgments of suitability and product substitutability (Day, Schoker & Srivastava, 1979).

-Trade shows in which potential buyers can view and use the new product. The marketers can determine how these potential adopters react to various features.

-Distribution and dealer display rooms where the product can be positioned along with other similar and competing products to determine pricing information in the normal selling market (Kotler, 1980).

- Test marketing in selected geographic areas allows researchers to monitor diffusion more closely before national or international roll-out occurs.

Attributes of the innovation (relative advantage, compatibility, complexity, etc.), as perceived by potential adopters, can be determined through the measurements mentioned above.

Introductory stage

The introductory stage is marked by a period of slow sales growth as the product is introduced into the market. While analyses of adopters at this time will not be generalizable to the potential market at large, an understanding of the product and how it is being utilized will indicate whether predictions of the diffusion process are holding true to date.

Who are the early adopters? What characteristics do they possess (i.e.: education level, self-confidence in problem solving)? What other technologies did they consider (identification of competing technologies) before purchasing a CD-I unit? What other technologies do they own? Are they likely to also own a personal computer, or is this purchase seen as a substitute for some other technology?

Research methods at this time should involve the analyses of data received from hardware and software warrantee card surveys. Other research on purchasing behavior can be obtained through the method of Decision Sequence Analysis, where the purchaser is asked to recall the process involved in making the decision to adopt (Day et al,1979; Foxall and Haskins,1986).

The diffusion process can also be tracked by investigating sales patterns: comparison of sales figures with advertising campaigns, etc. This is achieved through scanner data analyses.

Growth stage

The growth stage is characterized by a period of rapid market acceptance. At this point are we moving into the early majority stage? Analyses of adopters and comparison with the initial adopters on characteristics will provide answers. This can be achieved again by the analysis of warrantee card surveys. These data will provide answers about the types of people currently adopting the technology. Sales data will provide information about the level of diffusion.

A re-analysis of competition at this stage is wise, as re-positioning of rival products may occur. (Ostlund, 1974). This may be achieved through product association-based multidimensional scaling"(Aaker & Shansby, 1982).

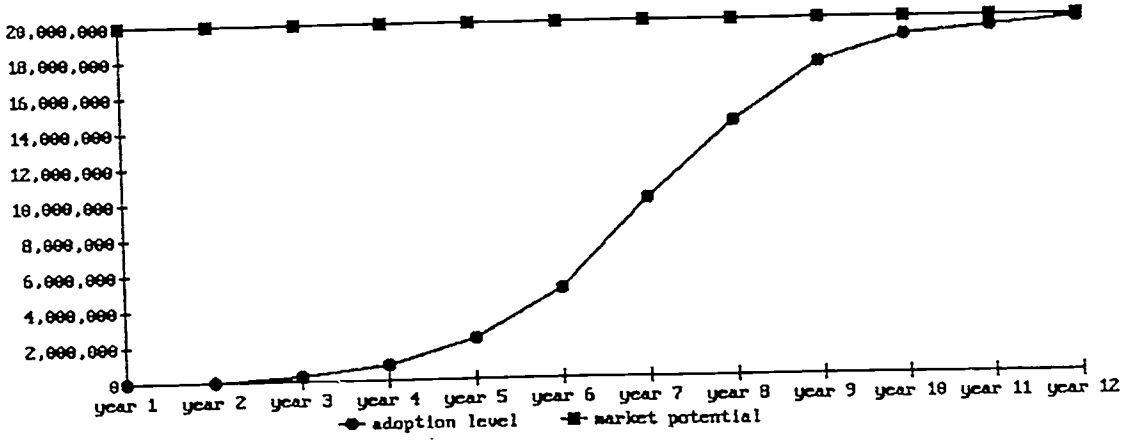
Researcher John Antil (1988) contends that purchase may not be equivalent with adoption, in that some products are purchased but not utilized. He cites the example of the videodisc player business, which failed after several years of dismal sales. Antil warns that a false sense of marketing success can occur because "it is not unusual to see high trial rates followed by a low repeat purchase rate or lower than expected usage rates." He states that adoption should consist of "the acceptance and continued use of a product."

Antil proposes two new stages in the consumer adoption process: consequences and confirmation, and adds "it is what happens during these stages that determines whether adequate levels of adoption will occur." This assessment can be achieved through the use of the follow-up survey, perhaps interviewing users at a specified time after initial purchase. This will determine the level of confirmation which has occurred in product adoption.

Maturity stage

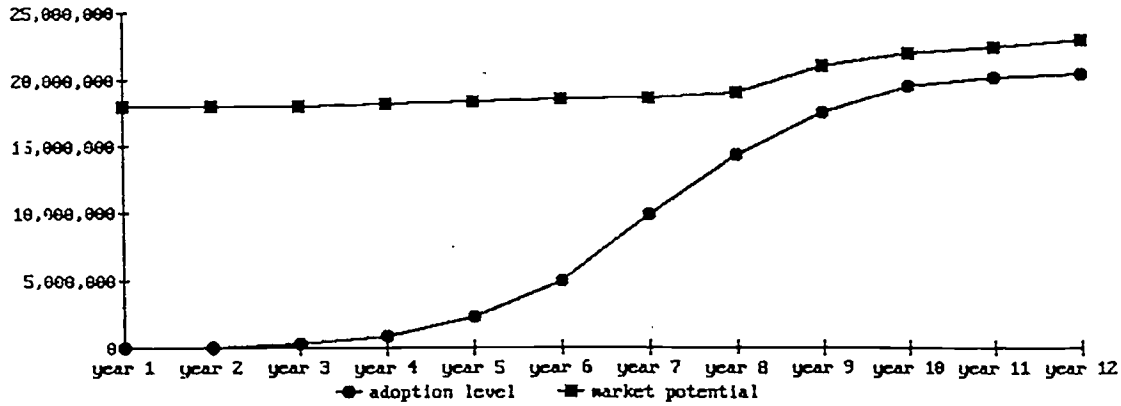
During the maturity stage of a product life cycle, a slowdown of sale growth may be expected as the product achieves acceptance by most of the potential buyers (Kotler, 1908). This is indicated by the top right portion of the s-shaped diffusion curve. It is typical for marketers at this point to develop new product uses or variations (re-inventions) in an effort to revitalize sales. It is at this point that the product may move into new, niche markets (Hedley, 1977), thus raising the level of market potential and altering the shape of the diffusion curve (Mahajan & Muller, 1979). It has been proposed that the market potential curve increases over time, but that at some point, the market potential curve coincides with the product growth curve, as illustrated in the following table **(see graphs next page)**.

Traditional Diffusion Curve



Dynamic Product Growth Patterns

(adapted from Mahajan & Muller, 1979)



Summary and Conclusion

It is still too early to make a definitive pronouncement on the outcome of CD-I from the point of view of its ultimate diffusion success or failure. However, a sufficient body of criticism has emerged in the first 12 months of its introduction to suggest that the launch of CD-I without full motion video was not only a serious drawback but may undermine the whole launch of this new technology.

Furthermore, competition from existing and emerging technologies have created a "technology glut" which threatens to engulf, or at least seriously confuse and discourage, early adopters in the diffusion cycle.

The authors argue that many new ingredients needed to be built into an alternative diffusion campaign. These include reducing the cost of hardware (comparable to VCR's); developing "killer" software (creating the 'need to have' factor); neutralizing the effects of competition by stressing forward compatibility; providing a coherent copyright framework; exposing/introducing CD-I to opinion formers and harnessing user groups (such as teachers) to become effective change agents; increasing advertising support; extending the launch to better known brand names (at least Philips' Sylvania and Magnavox labels if other manufacturers prove reluctant) and, finally, taking advantage of a comprehensive tracking study to provide platforms for decision-making as the diffusion process unfolds.

As a case study, the launch of CD-I provides substantial evidence of the problems of diffusion facing new technologies. On face value, because of its low cost of manufacture (once titles have been produced and formatted), the innovation represents one of the most effective technologies of what Rogers (1986, New Media in Society, ibid, p 25-26) has defined as the present Interactive Communications Era. Whether this potential is achieved remains to be seen; the authors remain skeptical of CD-I's current prospects for accelerated diffusion. It may turn out to be a technology which was launched *before* its proper time. [19]

[19] Since this paper was prepared, Philips has published a net loss for 1992 of 900 million guilders ($485.8 million) compared with a profit of 1.12 billion guilders in the previous year. In 1990 Philips recorded a net loss of 4.24 billion guilders Since the end of 1989, the company has shed

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Baumgartel, H. (1983). Human factors, technology diffusion, and national development. Journal of Applied Behavioral Science, 19 (3), 337-348.

Brown, L., Schneider, R., Harvey, M. & Riddell, J. (1979). Innovation diffusion and development in a third world setting: the cooperative movement in Sierra Leone. Social Science Quarterly, 60 (2): 249-268.

Cheney, G., Block, B. L. and Gordon, B. S. (1986). Perceptions of innovativeness and communication about innovations: a study of three types of service organizations. Communication Quarterly, 34 (3):213-230.

Day, G.S., Shocker, A.D. & Srivastava, R.K. (1979). Customer-oriented approaches to identifying product-markets. Journal of Marketing, 43 (3), 8-19.

52,600 jobs, 17 per cent of its work force, and a further 10,000-15,000 jobs are to be cut in 1993. Sales figures for CD-I have also been revised dramatically. The CD-I Association of North America (whose chairman is Philips' Bernard J. Luskin, head of PIMA - Philips Interactive Media of America), and Philips Consumer Electronics in New England, have confirmed reports (ERT Magazine, UK, Feb. 25, 1993, and Mar. 4, 1993) that total CD-I player sales to date are only 100,000, of which approximately 50,000 are in the US, 40,000 in Europe and 10,000 in the rest of the world. According to information in the the articles, which has been confirmed by PIMA, Philips anticipates sales of 200,000 CD-I players worldwide in 1993, and a 600,000 "target" for sales in 1994, compared to earlier estimates (see page 2-3, and graph) of 33 million sales worldwide by 1997. Philips is also going to offer free gifts (either a free VCR, a 14-inch CTV, or a portable CD player) to registered owners of CD-I players in Europe to compensate for further delays on the implementation of full motion video. As of March, 1993, this has been further delayed to September, rather than Spring '93, the postponed "re-launch" date. PIMA could not confirm whether similar compensation would be offered in the US. A lack of hardware to digitize video, and a corresponding shortage of FMV titles, is being blamed for the latest delay.

Dickerson, M. and Gentry, J. (1983). Characteristics of adopters and non-adopters of home computers. Journal of Consumer Research, 10 (3):225-235.

Both characteristics of innovations and characteristics of adopters were examined in the literature search. Then hypotheses were formed about the psychographic and demographic differences between adopters and non-adopters of computers. The results showed that adopters were more creative and had more experience with a variety of technical products than non-adopters.

Dutton, W.H., E.M. Rogers and Jun, S. (1987). Diffusion and social impact of personal computers. Communication Research, 14 (2):219-249.

This meta-research study focuses more on uses and gratifications of personal computers than it does diffusion rate or level. However demographic stratification is achieved and recommended as topics for future research.

Eyestone, R. (1977). Confusion, diffusion and innovation. American Political Science Review, 91 (2):441-447.

Feick, L. F. and Price, L. (1987). The market maven: a diffuser of marketplace information. Journal of Marketing, 51 (1):83-97.

Certain opinion leaders in the consumer market were identified and found to indeed be influential in influencing the decision making process of other consumers. These leaders who actively sought consumer information were dubbed market mavens.

Fischer, C.S. (1978). Urban-to-rural diffusion of opinions in contemporary America. American Journal of Sociology, 84(1):151-159.

Fliegel, F.C. and Kivlin, J.E. (1966). Attributes of innovations as factors in diffusion. The American Journal of Sociology, 72 (3):235-248.

The object of this study is to specify a set of attributes of innovations, taking into account the differences among innovations which have made for difficult generalizability of diffusion theory. The authors expand on Rogers list of relative advantage, compatibility, complexity, trialability, and observability. The additional conditional attributes include; financial cost, social return, return on investment, financial risk, and efficiency of the product. Communicatability about the new idea was also found to be a factor affecting diffusion.

Foxall, G., and Haskins, C. G. (1986). Cognitive style and consumer innovativeness: an empirical test of Kirton's adaption-innovation theory in the context of food purchasing. European Journal of Marketing, 20 (3):63-80.

An understanding of consumer traits associated with innovativeness gives marketing managers the opportunity to shape new products to for these buyers. The styles of decision making are examined in that those who seek problem solving through innovation are more likely to adopt innovations which they perceive as offering a solution to their problem.

Gatignon, R. and Robertson, T.S. (1985). A propositional theory for new diffusion research. Journal of Consumer Research 11 (4):849-867.

The framework for the application of diffusion theory is investigated: each aspect influencing adoption is re-defined and clarified. Shortcomings of diffusion research are examined including pro-innovation bias of research. Low involvement and high involvement characteristics and differences are outlined.

Greenberg, B.S. (1986). Patterns of Teletext Use. London, UK: Independent Broadcasting Authority.

Hedley, B. (1977). Strategy and the business portfolio. Long Range Planning, 10 (2), 9-15.

Hirschman, E. C. (1980). Innovativeness, novelty seeking and

consumer creativity. Journal of Consumer Research, 7(4):283-294.

Characteristics of innovativeness are analyzed and correlated with a tendency to adopt an innovation. These characteristic tendencies include role accumulation, novelty seeking and consumer creativity.

Hoffman, E., and Roman, P. Information diffusion in the implementation of innovation process. Communication Research, 11(1):117-141.

Katz, E. (1960). Communication research and the image of society convergence of two traditions. Journal of Sociology, LXV(5):435-440.

Klopfenstein, Bruce "Problems and Potential of Forecasting the Adoption of New Media" in Media Use in the Information Age, Ed. by Salvaggio, Jerry L. and Bryant, Jennings (1989). Hillsdale, Jersey: Lawrence Erlaum Associates.

Kotler, P. (1980). Principles of Marketing, Englewood, NJ:Prentice Hall

Lowery, S.A. and DeFleur, M.L. (1988). Milestones in Mass Communication Research. White Plains, NY:Longman.

Mahajan, V. and Muller, E. (1979). Innovation diffusion and new product growth models in marketing. Journal of Marketing 43(4):55-68.

This paper is concerned with diffusion models of new product acceptance. Issues are raised concerning the definition of 'untapped markets' and 'potential markets'. Also the assumption of a constant total population of potential customers over the entire life of the product is questioned. The marketing program of a company does not enter in as a variable in the diffusion process. New comprehensive mathematical models are proposed to include the variables of marketing, advertising and competition.

Martin, J. (1977). Future Developments in Telecommunication. Englewood Cliffs, NJ: Prentice-Hall.

Metcalfe, J. S. (1981). Impulse and diffusion in the study of technical change. Futures, (11/1981):347-357.

The role of demand-side factors in diffusion research is of concern in this study where Metcalfe proposes a mathematical model to account for supply-side variables. When information about an innovation is costly to obtain, potential adopters observe the experience of existing adopters before making that adoption decision.

Neidell, L. A. (1983). Don't forget the product life cycle. BUSINESS, 30-35.

Olshavsky, R. W. (1980). Time and rate of adoption of innovations. Journal of Consumer Research 6 (4):425-428.

This study was done to test the hypothesis that due to shortening product life cycles, the rate of adoption of innovations by consumer is increasing over time. The diffusion rates of twenty-five home appliance innovations were calculated and compared. Results were consistent with the notion that product life-cycles have been shortening and the rate of adoption has been increasing recently. This trend raises serious questions about the assumption that the adoption of innovations is preceded by some type of pre-purchase decision process.

Ostlund, L. E. (1974). Perceived innovation attributes as predictors of innovativeness. Journal of Consumer Research, 1(3): 23-29.

A comparison was made between two innovations to determine differences in rate of diffusion as a factor of the innovation in of itself rather than a function of the potential adopters. This study is very analytical.

Robertson, T.S. and Gatignon, H. (1986). Competitive effects on technology diffusion. Journal of Marketing, 50 (3):1-12.

These authors concentrate on the much overlooked supply-side characteristics in diffusion research. Factors such as

competition, supplier credibility, product standardization, and other factors greatly influence the rate of adoption.

Rogers, E.M. (1986). What are the new communication technologies? Chapter in: Communication Technology: The New Media in Society, NY: The Free Press, 1986.

Rogers, E.M. (1983). 3rd ed. The Diffusion of Innovations. New York: The Free Press.

Rogers, E.M. (1978). The rise and fall of the dominant paradigm. Journal of Communication, 28(1):64-69.

Rogers, E.M. (1976). New product adoption and diffusion. Journal of Consumer Research, 2 (2):290-301.

Rogers, E.M. and Shoemaker, F.F. (1971). Communication of Innovations. New York, NY:MacMillan.

Soete, L. (1985). International diffusion of technology, industrial development and technological leapfrogging. World Development, 13(3), 409-422.

The shortcomings of diffusion theory are discussed. Among these are the fact that diffusion is not a static process where the environment remains unchanged throughout the diffusion process. Also, the notion of clusters of innovations and spurts and lulls of technological growth suggests that there is more of an interrelationship among innovations than the model accounts for. The conclusion is that diffusion does not occur in a vacuum.

Strodthoff, G.,Hawkins, R.P. and Schoenfeld, A. Media roles in a social movement: a model of ideology diffusion. Journal of Communication, 35,(2):134-152.

Thomas, R.J. (1985). Estimating market growth for new products: an analogical diffusion model. Journal of Product Innovation Management 2(1):45-55.

Dr. Thomas proposes steps toward utilizing diffusion models and sales histories to predict diffusion of analogous new products. The problem of most diffusion research is the

inability to predict future diffusion of new items not yet tested in the marketplace.

Twiss, B.C. (1984). Forecasting Market Size and Market Growth Rates for New Products. Journal of Product Innovation Management, 1 ,19-29.

West, P.C. (1984). Status differences and interpersonal influence in the adoption of outdoor recreation activities. Journal of Leisure Research, 16 (4), 350-354.