NORDICITY
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An Assessment of Current and
Future TV Technology
and its Impact on Canada

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Government of Canada
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Ministère des Communications

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I EXECUTIVE SUMMARY

I.1 Introduction

The technological assessment of future TV technologies and their impact on Canada was conducted by Nordicity Group in association with the Canadian Broadcasting Corporation and Kalba Bowen & Associates, on behalf of the Federal Department of Communications. This report contains results of this assessment including: current status of TV technology and research, technological and market forecasts, cultural/societal/institutional, industrial and economic impact analyses, and recommendations for R&D initiatives and applications programs. The following section of this report (II) integrates the study findings, providing an overview of this assessment.

I.2 Methodology

The technology impact study's methodology was developed from 'A Guidebook for Technology Assessment and Impact Analysis' by Rissini et al (1980). Surveys, workshop sessions with industry representatives, academic review, and a StatsCan model provided the basis for the analysis, which was comprised of:

- international survey by personal interview of major research organizations and manufacturers involved in the television field;
- international Delphi survey of some 35 'experts' involved in new television technologies;
- an industry opportunities workshop held with representatives from Canadian industry, broadcasters, venture capitalists, and government representatives;

- academic, industry and follow-up surveys to obtain information on current and potential Canadian industry participants in new TV technologies;
- review of study results by York University faculty members, media industry representatives, and participants at the 1985 HDTV Colloquium in Ottawa;
- economic analysis using the Statscan SERF econometric model.

1.3 Technology Assessment Highlights

Developments in new television technologies are proceeding in the following areas:

1. Improved TV, without changing existing standards (NTSC, PAL, SECAM);
2. Enhanced definition television (EDTV) designed to be compatible with existing scanning standards;
3. High definition TV (HDTV), requiring new production standards and bandwidth reduction techniques for transmission within existing distribution systems;
4. High definition electronic production (HDEP), where all video production would be electronic - replacing film.

The state-of-the art review found significant work in these technologies in the areas of studio production, distribution, and products for in-the-home. Highlights of the findings in these areas are outlined below:

Studio Production

Equipment in the television plant will undergo three major upheavals in the next several years:

- The first of these will be the adoption of digital component signals for conventional 525 or 625 line 4 by 3 displays (ie. the CCIR 601 signal format). Digital processing and recording of these signals will lift many of the current production restrictions, and will yield a higher quality image for distribution.

- High Definition wide screen (5.3 by 3 or so) television will be the next major change, and is the focus of this report. The two events will, however, happen almost simultaneously, during the next three to five years. Broadcasters will have to be extremely astute to make the right technological choices.

- A third major change will involve the construction and manipulation of conventional and (eventually) high definition images by digital computers and will revolutionize program planning and production techniques. The forerunners of these devices are already in daily use.

The state-of-the-art review of studio equipment concluded that:

- The basic production equipment needed for HDTV (in its 1125 line, 60 field form) is available, but the cameras and HDTV recorders still need improvement. Solid state image sensors, for example, are needed to realize the full potential of HDTV production based on an electronic camera. These image sensors are 5 to 10 years away. There has been no attempt to upgrade conventional (4 by 3, 525 or 625 line) production equipment for EDTV production, because the wide screen high line number HDTV signal will be down converted as required.

- Higher Speed integrated circuits must also be developed before HDTV signals can be dealt with in the digital format. Until this happens, the production techniques available in HDTV will not be as flexible as those now becoming available in the PAL/NTSC/CCIR 601 world.

Distribution

The broadcaster has a mix of tools available to distribute conventional, enhanced and high definition signals. No broadcaster will be able to restrict himself to any one of these tools. The state-of-the art review found research in distribution systems at various stages of development:

Traditional Terrestrial Systems

Terrestrial transmitters deliver good signals in rural areas and in many cases, urban areas. Based on preliminary design work, techniques have been proposed that will allow conventional transmitters to provide enhanced definition signals within existing channels.

Cable TV systems can provide the same enhanced signals to high density urban areas. Several proposals for "paired channel" extended definition signal distributions have been made, but to date no trials have been implemented.

Satellite Systems

Several EDTV and HDTV proposals exist suitable for transmission over satellites with current power levels and bandwidth. Several of these proposals have been demonstrated in the lab and some are currently proceeding to field trial. In Canada, a DBS service on 14/12 GHz satellites could be provided with an enhanced definition (or high definition) signal with multichannel high quality sound targetted at remote areas. The most efficient signal format for this task could be selected because this service would not be bound by other existing tasks, such as feeding cable systems within current formats.

Fibre Optic Systems

These systems will be chosen on the basis of traffic density and distance. Multi-fiber cables can transmit very high rate data well suited to video requirements over long distances economically. The only current technical limitation is the lack of optical switches and amplifiers. The development of these devices (the switches are in the lab now) will increase the utility of fiber networks both for long haul and shorter distance applications. If laser stability problems are solved, fibre may be useful within the TV plant for digital video distribution at several hundred Mb/sec.

In The Home

An extensive research and development commitment has been made worldwide in the area of television home consumer products:

Digital techniques are currently being used by some manufacturers to reduce the cost of conventional TV receivers. As the cost of field and frame store memories falls over the next few years, these techniques will be extended to include sophisticated signal processing techniques, based on frame store memories, for the so-called smart receivers. These receivers will greatly enhance the quality of the images produced from conventional signals.

A further extension of the receivers' capability will produce enhanced definition wide screen images from "paired channel" terrestrial or satellite signal sources.

High definition flat panel displays are 10 to 15 years away. CRT's are limited to about 1m diagonal sizes so projection systems show the most promise for large image displays. Product development (via the industrial market) will be required to reduce the price to the domestic market level.

While there remain a few serious technological hurdles to be overcome before a full system transition to HDTV is possible (eg. HDTV digital recording devices, flat panel displays, compact HDTV projectors, high speed digitizers, etc), no breakthrough technology is required for initial implementation of EDTV/HDTV services. The principle obstacles are in product design and manufacturing. These can be overcome over a few years through a commitment to high volume production.

1.4 Technological and Market Forecasts

From the technological and market forecasts, several conclusions are drawn:

Next 5 years

- The first wave of change will be experienced with the replacement of analogue based products with digital products both in the studio and the consumer television market.
- Major broadcasters are expected to commence producing (but not necessarily transmitting) in high definition as equipment prices fall and further complementary HDTV studio products become available.

Next 10 years

- The introduction of higher definition television specialty services will likely pave the way for revised transmission formats and for creating consumer awareness. While the exact entry date of these services is as yet unclear, technically they could proceed almost immediately.

Next 15 years

- Expansion of higher definition services to the home consumer market will likely have occurred by the early 1990s. Based on market projections, these services are predicted to be well on their way to mass markets by the year 2000, with market penetration of 25%-65% in the US and 14%-30% in Canada (based on conservative and optimistic scenarios).

It is not clear how much the digital ('smart') receivers will soak up the consumer demand for higher TV quality. However, for national and commercial reasons, HDTV is likely to be inaugurated by satellite in Japan by 1990, and EDTV in Western Europe in the early to mid 1990s. There is no consensus on a scenario for introduction in North America at this time.

1.5 Societal, Industrial, and Economic Impacts

Conclusions from the impact analyses are highlighted below:

- From a broad cultural/societal/institutional perspective, the impact of new television technologies, specifically EDTV/HDTV, would not transform society but simply reinforce the dominance of television; however, it will transform the television industry;
- The Canadian television industry - broadcasting, cable, program production - will have to invest heavily in production and distribution technology and training to convert to new production and transmission formats as HDTV becomes a significant factor in the international marketplace;

- Impact on the Canadian manufacturing industry will be almost immediate with re-equipping of broadcasting studios in Canada with primarily digitally-based products occurring over the next 5-7 years. Conversion to HDTV will require substantial investment and will affect many aspects of industry involved in broadcasting and transmission. Several opportunities for Canadian industrial involvement in new television technologies exist, primarily in specialty product niches in production and transmission. For example, product niches in production which could be pursued include: distribution amplifiers, cable equalizers, sync generators, switchers and components for VTRs and standards converters. In transmission, several product opportunities exist such as; higher speed digital codecs, optical baseband video switchers, and components for receivers/decoders.

- The economic impact of new television technologies for Canada is expected to result in:

  - huge import bills in receivers alone as HDTV develops as a mass market medium (estimated as high as some $800 million per year by 2000);

  - some 3,000 additional permanent jobs and $200 million in exports could result by 2000 if Canadian manufacturers invest an additional 10% per year (approximately $7m/year) and are successful in expanding their domestic market share of studio equipment from 30-40% at present to 50%;

  - substantial costs for conversion of transmission and distribution systems to new transmission formats;

  - substantial favourable or unfavourable impact on Canadian program production, depending on how quickly Canada can produce in HDTV standards.

1.6 Standards Issues

With respect to standards issues related to new TV technologies it is concluded that:

- It is desirable from the point of view of industrial development to have integrated and compatible family of standards for new television systems;
- Canada should set up a new forum to establish the Canadian positions on new technologies;
- We should enforce the work already carried out by national and international standards committees more vigilantly;
- Canadians should undertake some of the relevant committee work in order to assure that Canadian opinion is included in the deliberations towards new standards.

1.7 Regulatory Issues

The regulatory issues pertaining to the introduction of HDTV services in Canada are considerably more complex than those which arose during the transition from monochrome to colour television. Items which will have to be addressed include:

- policies for the licensing of new EDTV/HDTV services must be determined with respect to new licenses, extension of existing NTSC licenses, allocation of scarce radio spectrum, obligations for the continuation of services in NTSC formats and the treatment of EDTV/HDTV service types;
- policies regarding the Canadian content in EDTV/HDTV traditional broadcasting undertakings, satellite-to-cable services and DBS services;
- the regulatory dilemma associated with potential spillover of US EDTV/HDTV services into Canada;
- special regulatory issues associated with cable delivery of EDTV/HDTV signals such as 'must carry' obligations, simultaneous substitution and priority access on cable systems with finite capacity.

1.8 Recommendations

The first step in addressing issues in new TV technologies from a Canadian perspective is to encourage industry involvement in world television standards development and to increase awareness of on-going EDTV/HDTV development. It is recommended that following the CCIR standards decision in October 1985, Canadian industry representatives be assembled:

- to discuss the implications on Canadian industry of the CCIR meeting results;
- to review R&D and applications programs suggested in this report with reference to the potential role of Canadian industry, and
- to organize an official Canadian standards committee as a focus for Canadian industry and official representation at future meetings in the international forum.

To catalyze immediate research and development requirements it is recommended that a working group be struck comprising key members from the broadcast manufacturing sector, the CBC, DOC (including CRC), selected universities and other organizations with the ability to capitalize on R&D investment from both government and private sources. The DOC and CBC could take this initiative as a follow-up to this study and the hosting of the 1985 HDTV Colloquium.

Canada should consider the development of an EDTV/HDTV applications program over the next few years in order to accomplish several objectives, ie:

- stimulate Canadian product development in transmission, program production, and specialized equipment;

- increase awareness of the implications of HDTV and the change - over of the Canadian delivery system to accommodate HDTV;
- position Canadian organizations to develop new programming services on a North American scale.

A comprehensive applications program should be developed to involve one or all of the service and delivery options. Possible trials include:

- Production Applications
  - The HDTV Studio
  - Wide Screen/HDTV shooting on location
- Service Delivery Applications
  - Telesat's direct-to-home service
  - Wide Screen Specialty service
  - Bandwidth Reduced HDTV Specialty service
  - CN Tower EDTV/HDTV Microwave Distribution
  - Cable System delivery
  - Optical System delivery

1.9 Conclusions

Television service affects all Canadians, thus Canadian content in both television products and services is a major concern with respect to federal government policy. Since EDTV and HDTV will transform the broadcasting industry in Canada, it is important for Canada to do it right. If the best system is not adopted, industrial benefits will be lost; broadcasting transmission costs will be higher than necessary (thus cutting into programming); and Canadian content in TV programming will suffer.

Canada needs:

- to engage the broadcasting, cable, satellite, and supplier industries in planning for HDTV, possibly focussing around another HDTV Colloquium in 1987;

- to begin immediately the institutional arrangements and the incentive programs required to establish an industrial development effort catalyzed by the CBC facilities consolidation in Toronto;
- to plan for the full development of a multifaceted HDTV applications and demonstration project.

As a first step, broadcasting industry representatives have recommended that a Broadcast Equipment Development Board be established and will be approaching the Minister with this proposal in the near future. This is an example of the kind of initiative which is required if Canadian industry is to remain viable as new TV technologies are developed worldwide. However, unless these initiatives are supported by government it is not likely that they will achieve success.

II INTEGRATION OF FINDINGS

The future TV technologies) impact assessment project contained 11 discrete tasks. This section integrates the findings of those 11 tasks providing a summary and conclusion to the whole study.

In this discussion of findings, the section examines cross impacts of TV technologies and draws conclusions that go beyond the boundaries of the 11 tasks of the research project. The purpose of this section is to put the findings into a context as an overview of the subject. Therefore, the section describes the key technological steps, the market factors, the players and the timeframe; it then identifies the main issues for Canada and recommends what to do about them.

II.1 Key TV Technologies

There are basically two groups of technological developments affecting the television industry worldwide. First, there is the conversion of analogue to digitial systems in the production, processing, transmission, and reception of television signals. Second, there is a march toward establishing new television formats, commonly labelled high definition television or HDTV. This term in common parlance normally covers several proposed versions, and can include those referring to enhanced definition television (EDTV).

II.1.1 Analogue to Digital

The home and television studio are the scenes for the conversion of analogue to digital recording and processing of television signals. The chief advantage of digital signal processing and storage, aside from its lower cost (ultimately), is the greater flexibility of production techniques. As well, there is no degradation in signal quality in the transfer of the original production from one stage to the next in its recording, editing and transmission.

An analogous step at the reception end of TV distribution is the increasing use of digital chips in the manufacture of television receivers (ie. television sets). So-called digital receivers are now available, primarily in Europe, but they add no new features to the conventional TV receiver. However, "smart" receivers with digital processing are expected within the next few years. They will improve the picture quality and add other features to television viewing. These smart receivers will remove many of the impairments of the standard NTSC or PAL/SECAM signals now in use throughout the world.

II.1.2 EDTV and HDTV

The concept of EDTV or HDTV involves advancement from existing transmission formats and television standards to provide the consumer with "an enhanced viewing experience". The improvement is not only in the (real or perceived) resolution of the image, but also in screen size and shape - a wider and larger screen, three or more high quality sound channels etc. The objective is to provide the same sense of intimacy with the television image as is found in the movie theatre.

HDTV, and to some extent EDTV, seeks to escape the compromised standards imposed by the compatibility requirement in production and transmission of colour with black and white receivers. HDTV is positioned as the third generation of television quality after first, black and white, and second, colour TV.

II.2 Multiple Advances and a World Standard

The proposed smart receivers are relatively easy to graft on to the present television production/distribution system, since they will be compatible with existing standards. Smart receivers will appear on the market once chip and receiver manufacturers are sufficiently confident of the demand for them - at prices no higher than about 25% premium over high end television sets. This is expected to occur in the early 1990s and possibly before.

The enhanced definition television concept (EDTV) involves transmission in a format compatible with existing scanning standards with pre and post transmission processing providing an enhanced image. There are a number of alternative approaches being researched in Western Europe and North America, particularly in association with the transmission of signals via satellite either direct-to-home or to cable head-ends. The EDTV approach (which can have either conventional or wide aspect ratio) accomplishes most of the enhanced viewing experience objectives of HDTV.

'High definition' television ('HDTV') transmission provides approximately double the number of scanning lines of current systems (ie. 1050, 1125, or 1250). In current transmission proposals, the signals originate with a high definition programming source which is processed to substantially reduce the bandwidth required for transmission. Bandwidth reduced proposals include (i) 2 channel approaches providing 1 channel compatible with existing standards, and (ii) transmission schemes totally incompatible with scanning standards of existing television receivers. However, the actual HDTV receivers could be designed to accommodate both existing standard and HDTV signals.

The threshold for HDTV production (not transmission) standards may be reached at the October, 1985 CCIR meetings. At this time, the four year cycle of standard setting will draw to a close. There is a proposal for a world production standard, based on the Japanese HDTV system (technically an 1125, 2:1 interlacing, 60 cycle specifications). At the recent HDTV Colloquium in Ottawa (May, 1985), the consensus of the standards workshop was that HDTV would become a world standard but not the only one. The workshop also concluded that if a standard is not set this year, the world is likely to divide up into three or more separate standards, repeating the situation that has occurred for colour television.

The purpose of the world production standard is to achieve compatibility in the exchange of programming on an international basis. At present, without a common production standard, broadcasters throughout the world have to transfer foreign programming produced in incompatible formats into their own standards before they can use it. The transmission standards on the other hand can be quite different from the production standards and be tailored to the individual countries. Programming can be easily converted at the studio to the appropriate transmission format.

If a world standard for HDTV production is not achieved, this problem will likely become more serious as more and more TV programming is produced in HDTV rather than film. One consequence, for example is that the conversion barriers for TV programming trade between Canada and Europe will remain, which will reinforce our reliance on US-Canada programming trade.

II.2.1 Introduction Scenarios

Japan

Only the Japanese have a clear-cut, advanced introduction scenario for a complete HDTV broadcasting system. Briefly, it is the announced intention of NHK to begin broadcasting HDTV via satellite in 1989, and retail to Japanese consumers an HDTV decoder/receiver for the yen equivalent of $2500 US. Japanese manufacturers are developing appropriate cameras, tape recorders, and other production equipment to be prepared for that broadcasting start-up. In addition to the receiver, Japanese firms are also developing consumer tape and disc products that could store HDTV programming, and projection type screens to display it. Thus, HDTV could be up and operating in Japan by 1989. The rest of the world would then have access to HDTV via prerecorded tape or disc coupled with an HDTV display device.

It is interesting to note that mass market acceptance of past revolutionary television products in Japan has coincided with the coverage of major events. Rapid take-up of black and white television receivers in the 1950s was triggered by the wedding of the Japanese Prince. Colour television was boosted enormously by the 1964 Tokyo Olympics. The 1989 introduction of an HDTV service in Japan is well placed for mass market acceptance in conjunction with possible HDTV coverage of the 1992 Olympics.

The vision for a staged development into the full HDTV world is perhaps best expressed by Sony. This company is now marketing specialized HDTV systems for corporate and institutional clients. The company does not expect to generate sufficient revenues from such limited markets to provide a return on their R&D investment, but it is a start. Secondly, Sony expects movie theatres or other common gathering places to receive HDTV programming for presentation (in bars, hotels, etc, as well as movie theatres). The third stage is broadcasting to consumers on a direct-to-home or satellite-to-cable basis.

North America and Western Europe

There is no similiar industry coherence in North America or Europe with respect to focussing on a specific television strategy. There is a potential back door way into EDTV through satellite transmission - the so-called MAC (Multiplexed Analogue Component) systems in the planning stage for European DBS services, and their North American equivalents in the US and Canada. The French MAC-based DBS system is apparently still in a go situation, despite the drift toward satellite-to-cable or MATV system arrangements in European programming services.

North American companies proposing direct-to-home services could select an analogue component video service (like a MAC system) for their audio channel and signal scrambling capabilities - and as a byproduct have the potential of being upgraded to EDTV. Australia, in fact, plans to introduce a direct-to-home service to rural and remote areas, using the Canadian-designed B-MAC system of Scientific Atlanta. Though the system was selected by the Australians for other reasons (product availability and multi audio channels), it can be upgraded to EDTV.

It will likely be some entrepreneurial initiative in video retail sales, movie or bar hookup, and perhaps an upgrade from a direct-to-home service that will start higher definition services in North America. Early distribution vehicles for higher definition services which are currently under consideration include:

- BARS - for wide aspect ratio special event sports service
- HOTELS - for a national 'movie' service for major hotel chains where improved picture quality could be a competitive attraction
- COLLEGE COMPUSES - for closed circuit national distribution of movies

As cited in the case of Sony above, these services would eventually develop into a mass market.

II.3 Technological Barriers

Between the November, 1982 and May, 1985 HDTV Colloquium in Ottawa, there was marked advancement in technology and product development. In 1982 all the components from production to display systems were not yet even available for demonstration purposes. By 1985, complete EDTV and HDTV systems could be mounted for demonstration.

While this progress is impressive, there remain some technological hurdles. For example:

- poor temporal response of pick up tubes for HDTV cameras;
- the lack of reasonably priced integrated circuits fast enough to digitally process the HDTV signal ie. at the 74.25 MHz sampling frequency;
- required development of large memory chips to handle the storage and processing requirement of bandwidth-reduced HDTV.

Product development is also required for some items which require application or refinement of existing technologies, for example:

- cable encoders and decoders;
- large screen display devices, both CRT and direct view or rear projection systems.

There are many other product areas which require development as HDTV broadcasting will require a complete production, transmission, reception system to be put into place. It is mainly production and manufacturing obstacles which will be overcome through high volume production - which is in turn dependent on market demand.

II.4 Key Market Factors

In a straw poll taken in the applications at a workshop Ottawa HDTV Colloquium, 22% of the participants said that they would be interested in purchasing a combined 40 inch screen HDTV display/VCR unit at twice the cost of the equivalent standard NTSC receiver plus VCR attachment. This means those interested would pay a substantial premium to watch prerecorded HDTV programming only, since broadcast HDTV was assumed not to be available. The affirmative response rate rose to 60% when the assumption was changed so that the combined HDTV display VCR unit was compatible with conventional television transmission, ie. it could also record and display conventional television.

While this was only a straw poll conducted at the workshop session, the answers are significant in that they indicate a high interest in HDTV, particularly if there is some compatibility with existing systems. The question, which was framed through discussion at the workshop, also indicates a feasible way of obtaining HDTV programming in the relatively near future. Movies shot on 35mm film can be converted to HDTV and would provide the initial stock of prerecorded programming for HDTV if distributed in that way.

In some ways it is astonishing that there has been a combined investment of some hundreds of millions of dollars by major manufacturers worldwide in pursuit of consumer HDTV, with virtually no hard consumer research. It is through the vision and imagination of a few manufacturers and broadcasters, particularly the Japanese, led by NHK, that the investment is being made without any real market substantiation.

In Japan there is a much higher awareness of HDTV than there is in North America (or in Europe for that matter). In fact, in a recent survey of business executives, only 12% of respondents had not heard of the concept of HDTV. Most of those who did were interested in acquiring HDTV receivers once broadcasting started. It is perhaps roughly equivalent to the growing awareness of North Americans to home dishes for individual satellite television reception. At the present time, then, it is impossible to transplant the level of awareness that appears to exist in Japan to the North American context and do any meaningful market research. The straw poll of workshop participants referred to above may be as good as any survey, since the respondents were at least exposed to actual demonstrations of HDTV.

The theory is that once exposed at theatres or bars or whatever, there will develop a strong consumer interest in HDTV. The problem is to determine exactly what features, providing an enhanced viewing experience, will appeal to consumers. There is a general belief that the wide screen will sell EDTV/HDTV. Reliance on improved image quality alone is risky - videodisc has a higher quality of image than a VCR, but the recording capability of VCRs has obviously captivated the consumers' interest more than the image quality of the videodisc.

Digital audio discs or compact discs (CDs) are believed to represent in some respects the equivalent in an HD display/VCR combination. CDs are completely incompatible with conventional audio recorders/players; CDs are more expensive than conventional players; and there was little content available initially. However, as content and price problems are being overcome, CDs are being perceived by the marketplace as attractive consumer items.

Despite the comparison with CDs there is no adequate surrogate whose consumer history is sufficiently analogous to HDTV to predict its market outcome. However, there is a relentless drive by manufacturers and others with huge markets at stake to find the right price/features/content combination. The odds are that they will succeed.

Finally, the personal computer revolution is an indirect stimulus for the development of HDTV. High resolution display of alphanumeric or alphageometric information is critical to the utility of the system or service which is displayed on the monitor. The high definition TV display unit could become the monitor for home information systems. Therefore, the higher quality TV system could integrate the transmission and display of video and data, which would then add to the overall attraction of HDTV.

II.5 The Main Players

The key force behind the drive for HDTV production standards is the strong commercial interest of a few specific Japanese and American organizations. Particularly there is NHK of Japan which has pioneered the HDTV development - beginning over a decade ago - and Japanese consumer electronics manufacturers who are seeking new television markets in view of the flattening of world demand for conventional television receivers. To put it into perspective, the current world demand annually is for some 50 million television receivers, compared to 15 million VCRs. As the existing TV receiver market enters a mature phase, these receiver sales will decline, thus manufacturers are obviously keen to find new products which will create new demand for television receivers.

The American interest in world production standards is governed by its some $1.3 billion annual exports of television products. Such exports can be facilitated by the adoption of a world production standard. CBS in particular has been a major force in HDTV and is possibly aiming at becoming a dominant supplier of HDTV programming, whatever transmission formats are adopted in individual countries.

The proposed world production standard calls for major compromises in PAL/SECAM countries (all of Europe for example). While many of the DBS initiatives in Europe are disintegrating, there is still a major future in satellite television in Europe via the Ku band. The terrestrial distribution system will be a combination of cable, SMATV and direct-to-home, without the need for a high powered DBS system. The adoption by the EBU of the MAC standard for future satellite transmission has been touted as the logical step toward EDTV. While this is accurate, there will have to be a major rationale for actually launching MAC-based systems when conventional Ku band satellite transmission is satisfactory. The need for effective scrambling systems, as in North America, may be a reason. The need for a multilingual programming, for example, might propel some European projects into a MAC format in order to have sufficient audio channels for the multilingual audience. However, even now satellite programmers must wait for a sufficient market to develop through cable, SMATV, or direct to home. A European-wide satellite service can only access at most some 10 million homes which are cabled at the present time.

In North America, the earlier reference to EDTV service development via the back door was made with respect to scrambling technologies for direct-to-home in C and Ku band satellite applications. While there are a few proponents for EDTV/HDTV systems for cable retransmission (by CBS, Philips and Scientific Atlanta) there is yet no evident initiative on the part of programming suppliers (eg. HBO, the networks and specialty channels) or the cable operators for higher definition. All of the three major US networks however do have major stakes in the evolution towards higher definition; CBS from the programming and broadcasting perspective, ABC with its stake in ESPN (a sports network which is a strong EDTV/HDTV service possibility); and NBC which is owned by RCA.

An initiative could also come from the motion picture industry. Movie theatre audiences are getting younger and the studios are seeking new distribution vehicles for reaching a wider audience. While studios are a good prospect, the early initiatives may emanate from elsewhere among the diversity of programming, communications and equipment entrepreneurs.

The challenge for an entrepreneur to reach a mass market for HDTV in the next few years in North America is daunting. For example, a multi-channel direct-to-home service was launched by USCI in 1983-84 using Ku band facilities, but has been discontinued for want of sufficient market demand. It has been roughly estimated that subscription charges for an equivalent EDTV service would have been double what USCI charged customers (ie. about $40 US a month) and that subscribers would have to acquire new display systems. It would clearly be a major risk to launch an EDTV/HDTV service in the next few years, particularly in convincing prospective investors of the potential widespread acceptance of the new service.

II.6 Timeframes for HDTV

Through an international survey of experts in various aspects of TV technology, the basic timeframes for the start-up of EDTV/HDTV were estimated. The broad conclusions are:

- Next 5 years
  Within the next 5 years there will be smart receivers appearing in most markets, a Japanese HDTV launch, and possible theatres/bars entrepreneurial initiatives in North America;

- Next 10 years
  Within 10 years in North America and Europe there should be a start-up of small number of EDTV/HDTV television services on a direct-to-home, satellite to cable or fibre optics distribution basis;

- Next 15 years
  Within 15 years most Western countries should have EDTV/HDTV services in operation and the threshold for a mass media EDTV/HDTV should be reached and well on their way to becoming the dominant TV format, although conventional television should still be providing most TV services.

Governed by these start-up timeframes, the project team made certain assumptions as to market demand at various price levels and replacement cycles. The estimates for households equipped with HDTV receivers by the year 2000 in Canada range from 360,000 to 900,000 and for the US 5.3m to 13.5m. By the year 2000, then, it is expected that EDTV/HDTV would not have displaced conventional television, but that it would be well on the way to becoming the dominant television format.

II.7 Canadian Issues

II.7.1 Societal Impact

From a broad cultural/societal institutional perspective, the major impact of HDTV would be on the broadcasting industry, not on society as a whole. EDTV/HDTV would not transform society, but simply reinforce the dominance of television. As improved television receiver products (which will reduce some transmission impairments) enter the marketplace, and as consumers become aware of higher quality television through specialty services, it is anticipated that they will become more and more quality conscious. This in turn will impact the broadcasting industry as more emphasis will be required on improving transmission quality.

II.7.2 Impact on Broadcasting

For broadcasting, which is a $3 billion industry in Canada employing some 75,000 people, EDTV/HDTV represents a transformative change for the industry. HDTV has the potential for threatening the extensive broadcasting distribution system in Canada, as follows:

- In view of the limited spectrum space, it is likely that off-air transmission of either EDTV or HDTV is not possible; this would eventually make off-air broadcasters obsolete or at least second class broadcasters.
- With possible EDTV/HDTV service implementation south of the border and (spillover of these services into Canada) a serious bypass threat to Canadian service providers could result.
- The HD display/VCR product, available off-the-shelf, could magnify the impact of bypass on Canadian broadcasting services.
- Cable systems will have to invest substantially in upgrading plant (channel capacity, decoder and scrambling systems), and possibly re-equip with optical fibre, switched star technology instead of the existing coaxial, tree and branch topology. In some respects cable is well situated in view of its extensive channel capacity, but there are many investment decisions to be made for cable in order to upgrade to HDTV.

- Telesat's present satellite overcapacity will likely result in conservative planning for the next generation of satellites, making it difficult to engage in future thinking about HDTV needs toward the latter part of the next decade (for which a great deal of satellite capacity might be needed); potentially HDTV transmission may be more suitable at the 22 Ghz frequency.

There is also a major potential impact on TV program production. As HDTV becomes a factor in the international programming marketplace, Canadian program production will be locked out of those markets unless the programming is shot in HD format in the first place. As the prospect of Canadian HDTV nears, Canadian broadcasters will have to invest in the technology and training required to convert to the new formats. Thus, as well as planning for new distribution systems, Canadian broadcasters will have to prepare for producing in HDTV.

II.7.3 Industrial Impact

The industrial impact of new TV technologies will soon begin in earnest. Over the next 5-7 years there will be a major re-equipping of broadcasting studios across the country. 100 million dollars per year is expected to be spent by private and public broadcasters. The requirement is for state-of-the-art studio equipment, primarily digital and participating in this market will be key for Canadian suppliers. Unfortunately, even the traditional 30-40% share of this market for Canadian manufacturers is in jeopardy, unless they make substantial investments in new product development.

In certain aspects of transmission systems (eg. fibre optics R&D by Bell Northern) Canada has the potential to play a role in the development of EDTV/HDTV technologies. The current outstanding example in TV technology development in Canada, is the pioneering work done by

Digital Video systems in B-MAC scrambling/reception systems. While the Canadian TV technology manufacturing industry is not well positioned to compete in the mass production of consumer products (eg. receivers), Canadian manufacturers of studio systems are well suited to competing in world markets, primarily in specialty product niches as they do now. While the potential exists to continue in on even further, this role is required to ensure the participation by Canadian industry in the new emerging technologies.

II.7.4 Economic Impact

The economic impact of new television technologies for Canada is as follows:

- the development of HDTV as a mass market medium would incur huge import bills in receivers alone, estimated as high as some $800 million per year by 2000;
- some 3,000 additional permanent jobs and $200 million in exports could be created by 2000 if Canadian manufacturers are successful in expanding their market share of studio equipment to 50% (from 30-40% at present);
- the trade balance and thus jobs will also be affected in Canada's annual $200 million in imports and $15 million in exports of video programming available in television, theatre and video retail markets;
- the HDTV conversion costs for transmission and distribution systems could be substantial, depending on the introduction scenario and standards selected.

In sum, the main issue for Canada is how the broadcasting industry adjusts to the introduction of HDTV or EDTV. As well, the industrial and economic impacts are substantial in terms of trade balance and important in terms of exports and employment in the manufacturing and program production sectors.

II.7.5 Regulatory Issues

The regulatory issues pertaining to the introduction of HDTV services in Canada are considerably more complex than those which arose during the transition from monochrome to colour television. Items which will have to be addressed include:

- Policies for the licensing of new EDTV/HDTV services must be determined with respect to new licenses, extension of existing NTSC licenses, allocation of scarce radio spectrum, obligations for the continuation of services in NTSC formats and the treatment of EDTV/HDTV service types;
- Policies regarding the Canadian content in EDTV/HDTV traditional broadcasting undertakings, satellite-to-cable services and DBS services;
- the regulatory dilemma associated with potential spillover of US EDTV/HDTV services into Canada;
- Special regulatory issues associated with cable delivery of EDTV/HDTV signals such as 'must carry' obligations, simultaneous substitution and priority access on cable systems with finite capacity.

II.8 What Can Be Done

II.8.1 Awareness

The first step in addressing the issues from a Canadian perspective is to encourage increasing industry involvement in world television standards development, and to increase its awareness of EDTV/HDTV developments. While the broadcasting associations internationally actively discuss the coming of HDTV, there is no Canadian forum for discussing its technical and marketing implications. Broadcasting, cable, and the satellite industry treat HDTV at present as a development over which Canadians have no control. While there is a growing awareness in some elements of the industry, in part due to the consciousness raising as a result of the 1982 and 1985 HDTV Colloquium in Ottawa, it is not enough. An industry awareness process that will lead to greater involvement in international standards and planning for

HDTV may take years before it is effective in bringing the true issues to the board rooms of major Canadian broadcasting and manufacturing interests. It should begin now.

Dissemination of this report is a first step. As well, it is recommended that prior to the CCIR decision in October 1985, Canadian industry representatives be assembled - to discuss the implications of the potential development of a world production standard - review R&D and applications programs suggested in this report with reference to the potential role of Canadian industry, and - to organize an official Canadian standards committee as a focus for Canadian industry and official representation in the international forum.

II.8.2 Research & Development Initiatives

The second major step stems from research and development requirements to launch Canadian industry into new TV technologies. Research and development initiatives of the scale conducted by the major research centres are beyond current Canadian industrial capabilities. There are, however, several product areas well suited to Canadian capabilities, which should immediately be pursued if the Canadian industry is to remain viable with the advent of new TV technologies.

Canadian supplier companies should seek to position themselves at the forefront of digital technology through product development aimed at sales to Canadian broadcasters. While in the past Canadian development was achieved through CBC purchase order, this is no longer possible. A more realistic possibility now seems to be the (co-)funding of technology demonstration projects with various suppliers, or research organizations, such as CRC. The catalyst could be the CBC's Toronto Consolidation Plan. The key investments and decisions required for the development of this plan are as follows:

- allocate some portion of R&D and product development incentives to the broadcaster supplier industry;
- explicitly mandate and finance where necessary CBC's leadership in promoting advanced studio products and systems by Canadian companies;
- equip one CBC studio and crew with HDTV production gear, to get a head start in HDTV experience and the banking of HDTV programming.

Through this endeavour, these affected companies will have state-of-the-art products to sell to other Canadian as well as international buyers. This is a near term opportunity that should be addressed as soon as possible.

Without a coordinated approach to research and development activities it is unlikely the currently fragmented Canadian industry will be able to first capitalize on the market opportunities presented by the requirements of Canadian broadcasters over the next 5 year period. Therefore, it is recommended that a working group should be struck comprising key members from the broadcast manufacturing sector, the CBC, DOC, including CRC, selected universities and other organizations with the ability to capitalize R&D investment from both government and private sources. The DOC and CBC could take this initiative as a follow-up to this study and the hosting of the 1985 HDTV Colloquium.

With a strong engineering organization the CBC could eventually assume a research and development and coordination role similar to the BBC and IBA in England. However, this change in mandate would be a major jump and could not be accomplished to respond to the immediate research and development needs.

In the near term, to enable Canadian industry to make the transition from analogue to digitally based products, the CBC should be equipped to procure the R&D required in advance of product order, thus enabling development of new Canadian products.

While the Communications Research Centre of DOC does not have daily contact with Canadian manufacturers, it has conducted some research in new TV technologies and is familiar with television technology developments. In cooperation with the CBC the CRC would be well suited to act as the procurer for research and development activities. However, to do so, it needs a priority to be set for it and thus an overall HDTV strategy developed.

Preliminary cost estimate for the research and development required to launch Canadian industry into digital technologies is $30 million over the next three year period (with possibly a 50-50 government-industry participation).

II.8.3 EDTV/HDTV Applications Program

The third step toward an EDTV/HDTV program would be the development of an EDTV/HDTV applications program over the next few years. This would accomplish several objectives:

- stimulate Canadian product development in transmission, program production, and specialized equipment;

- increase awareness in the implications of HDTV and the change over of the Canadian delivery system to accommodate HDTV;
- position Canadian organizations to develop new programming services on a North American scale.

A comprehensive applications program should be developed to involve one or all of the service and delivery options. Possible trials include:

- Production Applications
  - The HDTV Studio
  - Wide Screen/HDTV shooting on location
- Service Delivery Applications*
  - Telesat's direct-to-home service
  - Wide Screen Specialty service
  - Bandwidth Reduced HDTV Specialty service
  - CN Tower EDTV/HDTV Microwave Distribution
  - Cable System delivery
  - Optical System delivery

Industry involvement is currently being contemplated by major stakeholders in Canada (eg. BNR, Rogers, Telesat and Cineplex). There is a need for market as well as technical trials. Since there is no clear North American transmission format front runner (EDTV or HDTV?), the selection of one or the other approaches (or both) depends on the detailed planning of the programs and the interests of the industrial and broadcasting participants.

Such a multi-faceted applications program is a major financial undertaking. Preliminary estimates for the program are in the order of tens of millions of dollars. Beyond the R&D and market trials, there would be a commercialization phase, ie. the bringing of new programming services to market for one or more of the transmission systems demonstrated. The investment required would be far more than a

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* All service delivery options should incorporate multi-channel high quality sound.

specific, limited applications demonstration. While it would be a major risk for Canadian investors (including the government) there are potential opportunities for outside financing which have been mooted about in the last 2 to 3 years. The most obvious one is a joint venture with Japanese interests to use Canada as a test market to penetrate the North American market. A fuller development of the applications program would include identification of joint venture interests.

While the general characteristics, benefits, and costs of a broad application program can be sketched, there is a great deal of effort required to put together a comprehensive application program for full government consideration.

To coordinate and manage applications activities a specific applications group would be required within DOC. Under DOC direction actual project implementation could be conducted by an outside user agency such as Telesat's Company 'X' or the CBC.

II.9 Conclusions

Television service affects all Canadians, thus Canadian content in both television products and services is a major concern of federal government policy. Since EDTV and HDTV will transform the broadcasting industry in Canada, it is important for Canada to do it right. Otherwise, industrial benefits will be lost; broadcasting transmission costs will be higher than necessary (thus cutting into programming) and the main Canadian content objectives of Canadian policy will suffer.

Canada needs:

- to engage the broadcasting, cable, satellite, and supplier industries in planning for HDTV, possibly focussing around another HDTV Colloquium in 1987;
- to immediately begin the institutional arrangements and the incentive programs required to establish an industrial development effort catalyzed by the CBC consolidation in Toronto;
- to plan for the full development of a multifaceted HDTV applications and demonstration program.

New TV technologies need the attention of the federal government for industrial, economic, and cultural reasons. They have reached a stage of development that a well planned follow-up effort should begin now.

1.0 INTRODUCTION

This report contains the results of the study of current and future TV technologies and their impact on Canada. The task 1 report ('The Present Status of Television Technology and Research') contained in this document was prepared by the Canadian Broadcasting Corporation (CBC) and provides a state-of-the-art assessment of existing TV technology. Tasks 2 and task 3, conducted by Nordicity Group, based in part on the results of the state-of-the-art assessment, provide a market forecast and technological forecast respectively for key products and services to the year 2000. Following these forecasts the report assesses the impacts of these new television technologies in terms of: cultural/societal/ institutional impact (task 5), economic impact (task 6), industrial impact (task 7). Then the report addresses policy issues for government standards, regulations, R&D requirements and applications programs (tasks 8 to 11) - based on a risk assessment of Canadian initiatives with respect to new TV technologies. Finally, the findings are integrated in an overview assessment of what new TV technologies mean for Canada and recommendations for further action (task 12).

1.1 Scope and Purpose

The purpose of this report as stipulated in the statement of work for the study is to:

1. determine the present status of TV technology developments on an international basis;
2. determine future requirements for each area of TV technology and prepare market projections on a national and international basis to the year 2000 (task 2);

3. forecast the development of the TV technologies themselves also on a national and international basis (task 3);
4. describe the impact on Canadian society that existing and future TV technologies may have from cultural, societal and institutional perspectives (task 5);
5. provide an analysis of the impact of the development of TV technologies on Canadian industry (task 7);
6. provide an analysis of the economic impact on Canada for the development of TV technologies considering the effects on the balance of payments, on the GNP and on employment (task 6).

The first objective requires an in-depth examination of current research and development activities on an international basis to provide a solid starting point for forecast development and impact assessment.

The second objective focuses on the R&D challenges facing the future development of TV technologies. The timeframe for these developments, particularly as to the timing of their availability in the marketplace, is a critical part of the forecast. Thus, the forecast concerns not only the lead times required for resolving technological barriers, but as well judgement as to the investment, production and market decisions of manufacturers, broadcasters and programming suppliers.

The third objective requires a demand analysis which takes into account various national and private investment plans, the timing and technology selection decisions for establishing television transmission formats and standards, the different market structures of broadcasting in North America, Japan and Western Europe, and historical and projected consumer behaviour relative to the new TV and other home entertainment products.

Market and technology forecasts are quite closely linked. Technology forecasts depend on corporate and investor judgements as to market potential for decisions on what support to give R&D efforts. The market forecasts themselves depend on accurate assessments of the pricing and timing of market availability of individual products and whole TV timing of market availability of individual products and whole TV systems. Thus, the market and technology forecasts have been conducted as an interrelated analysis, with the presentation of the technology forecast first, and market forecast second.

The impact assessment first requires an assessment of the cultural/societal/institutional implications since it is the impact with the broadest range. From that overall base, specific industrial impacts of new TV technologies and industrial stimulus policies that could be effective in this area are addressed. The economic impact analysis draws its assumptions regarding Canadian content largely from the industrial impact assessment. This broader economic analysis places the potential positive and negative industrial consequences of new TV technologies into an overall economic and sectoral perspective.

Based on all aspects of the technology assessment, the report discusses possible government policies on standards, regulations, R&D requirements, areas of high risk and applications programs related to development of new television technologies. This is followed by the section on the integration of findings.

1.2 Methodology Overview

1.2.1 Present Status of Television Technology and Research

As stated at the outset, the framework for this study is based on the state-of-the-art review conducted as task 1 in this study. This review consisted of an international field trip in October and November 1984, covering most of the centres of R&D efforts in TV technologies. From that review, the project team identified and categorized the critical technologies which have become the basis for the analysis contained in this report.

1.2.2 Technology Forecasts

In order to have a systematic technological forecast, a Delphi survey was conducted, involving some 35 international experts drawn from the R&D and technical sector of the television and television-related industry. Through a detailed questionnaire, we asked respondents to give the probability of specific technological events occuring in North America, Japan, and Western Europe, and, for some issues, Australia. The structure of the questionnaire and the range of subjects covered was derived from the major technologies as identified in the Task 1 state-of-the-art review.

1.2.3 Development Scenarios and Market Projections

Through the state-of-the-art review, supplementary interviews, and off-the-shelf documentation, an analysis was undertaken of the institutional and economic factors that would inhibit or enhance the development of new TV technologies. Development paths or scenarios for the introduction of new TV technologies were proposed.

Based on assumptions from: (i) the results of the Delphi survey as to availabilty of products and services and (ii) the subsequent analysis of institutional and economic factors, the demand for new TV products to 2000 was projected. The projections considered the nature of the current television marketplace, the historical performance of consumer electronics products in the marketplace (eg. colour television sets, VCRs, and projection TV sets), and the limited actual consumer market research information available.

1.2.4 Cultural/Societal/Institutional Impact Analysis

The methodology and approach to task 5 proceeded from a ten stage progression of smart digital and HDTV systems developments. These development paths provide an analytical framework for the assessment of cultural/societal/institutional impacts. For each stage, first and second order implications have been suggested to provide a basis for overall conclusions. Implications were generated by a combination of expert opinion, a York University faculty workshop, available literature and findings from other project tasks. Finally, first and second order implications were distilled to form broadly based perspectives on key cultural/societal and institutional issues.

1.2.5 Industrial Impact Assessment

An action research approach was taken with respect to the impact assessment, primarily through the convening of an Industrial Opportunities Workshop and follow-up survey of Canadian corporate resources.

1.2.6 Economic Impact Assessment

As no single evolutionary scenario for the development of TV technologies in Canada is clearly evident, a multi-scenario approach has been taken to the economic impact analysis. The StatsCan Socio Economic Resource Framework (SERF) model, specifically designed to facilitate scenario synthesis of possible technology evolution paths, was utilized for this analysis.

1.2.7 Standards, Regulations, R&D Requirements, Risk Assessments and Applications Programs

This policy analysis provides a synthesis of opinions and recommendations put forward by individuals at the industry workshop sessions, and follow-up interviews, further research by the study working group and a broadcasting industry review meeting.

2.0 FRAMEWORK FOR ANALYSIS

2.1 Functional Building Blocks and Evolution Hierarchy

In the state-of-the-art review the technologies examined were categorized in major functional blocks of television system elements, namely:

1) Image Sources:

Devices or components used to generate a television image. The images may be test patterns, single images (or frames), the output of a camera or a graphic generator. The images may be static or dynamic.

2) Signal Processing:

All analogue and digital techniques used to modify the original form of the television signal, for production, transmission or reception purposes; types of equipment include production switchers, two or three dimensional special effects generators, routing and distribution equipment etc.

3) Tape and Disk Recorders:

Devices and media used (or proposed) to store a television signal in the production process (ie. for professional application).

4) Network and Broadcast Transmission:

Techniques used (or proposed) to transmit signals from any source to a destination that is not the intended final viewer, as well as transmission, modulation and demodulation techniques used to transport the signal to the intended final viewer.

5) Receivers:

Self contained devices that include equipment to detect and demodulate (and to reconstruct if necessary) the transmitted signal. This does not include a system of separate tuners/demodulators/monitors, which are considered separately.

6) Display Devices:

   Any of the conventional or proposed variations on cathode ray tubes (CRT's), projectors, flat panel or liquid crystal (LCD) displays.

7) Consumer Accessories:

   Consumer devices that use some aspect of the TV display device, such as consumer VCRs, videodiscs and home computers.

The major improvements within television systems identified for examination in the state-of-the-art review can hierarchically be organized as (i) the "improved PAL/NTSC", ie. retaining the existing transmission format, (ii) the "evolutionary" extended definition television (EDTV) to (iii) the "revolutionary" or "brute force" high definition television (HDTV) that is not compatible with present standards. A brief technical description of these systems follows:

1) Improved PAL/NTSC:
   Great improvements to the currently displayed NTSC or PAL picture can be achieved by the inclusion of suitable digital processing in the receiver, with further improvements obtained by complementary and compatible processing at the transmitter. This technology requires digital frame stores in the receiver and can eliminate flicker, inter-line twitter, dot-crawl and cross-color while extending chroma and luminance bandwidth to the channel limits. The achieved performance is far better than that of today's NTSC standard but stops short of EDTV (see below).

   The so-called "digital" receiver exists today, but this is primarily a television set in which some of the linear integration circuitry has been replaced by digital chips. There is no noticeable improvement in the picture quality. However, there are digital sets that are or about to be available on the market with limited memory capability producing modest improvements to the picture quality. These receivers will have "line" store memory (as opposed to "frame" store) and processing capacity that will eliminate some of the "ghosting", the most noticable defect in TV display systems.

Once memories of about 4 megabits are available, then receivers will have what is called frame store capability and signal processing that enables these so-called smart receivers to double the perceived picture resolution. The result eliminates most of the conventional PAL or NTSC system defects and also provides "picture-in-picture", "freeze frame", "store and recall", "zoom" and other features.

2) Extended (or Enhanced) Definition Television (EDTV):
A television system based on compatibility with the scanning structures of conventional systems (525/30 for NTSC or 625/25 for PAL/SECAM), but using different modulation schemes for luminance and color difference signals which allow much better performance. EDTV is derived from European proposals for "analogue component video" systems, particularly the "Multiplexed Analogue Component" (MAC) variations (B-MAC, C-MAC, D2-MAC). Through conversion of a MAC signal,
consumers with traditional PAL/NTSC receivers would receive a slightly improved signal. Those owning receivers with a direct RGB input will obtain a further improved image which eliminates the majority of impairments associated with existing composite transmission techniques.

An enhanced or extended definition version of the analogue component system is a second evolutionary step in the development of TV systems. With suitable source/display signal processing, the quality level at the display of such signals - including a wider aspect ratio - can approach that of HDTV (see below). A baseband signal bandwidth of 6-7 MHz is foreseen.

3) Bandwidth Reduced HDTV (High Definition Broadcast):
Bandwidth reduced HDTV schemes currently proposed have approximately double the number of scanning lines (ie. 1050/1125/1250) and typically a baseband bandwidth in the region of 7-10MHz (utilizing the satellite spectrum space of one or two conventional TV channels). The signals are those of high bandwidth electronic production (see below) processed by making use of physophysical trade-offs to reduce the required transmitted bandwidth. A sophisticated receiver/processor is required to display the signal. An HDTV system is characterized by high resolution horizontally and vertically and a wide aspect ratio (5.33:3 typical) display.

The MUSE HDTV system based on the Japanese NHK initiative for bandwidth reduction in transmission, represents a revolutionary approach to picture quality enhancement. The MUSE HDTV system provides one channel (8MHz baseband), generating an 1125 line, 60 field/sec, 2:1 interlace HDTV picture. Extra digital signal processing capability and memory are required in a smart receiver (4 frame stores).

Several other bandwidth reduced HDTV proposals are being pursued which are based on a two channel arrangement. The CBS two channel system contains one channel containing a 525 line, 60 field, 4:3 aspect ratio, time multiplexed component and a second channel carrying an additional 525 lines of video but with a 5:3 aspect ratio. The first channel can easily be converted at the receiving end for viewing on conventional receivers. However, when the two channels are matrixed, an HDTV picture results containing 1050 lines and a 5.33:3 aspect ratio. Further PAL/NTSC based two channel schemes have been proposed offering additional scanning lines and wide screen viewing while maintaining existing transmission standards.

4) High Definition Television - Electronic Production
A television system of very high quality capable of quality levels suitable for major film and television productions. The bandwidth of such a system is in the 30-40 MHz region and it is unlikely to be used for any but the most auspicious distribution applications. Much original studio material will in future exist in this form and will normally be "downconverted" to bandwidth reduced formats for distribution. Possibly some full bandwidth distribution may take place using fibre optic links or perhaps optical disks.

This brief technical description of the functional blocks and major television systems provides a framework for the development scenarios of TV technologies.

2.2 Critical Development Questions

Whether new TV technology will be "improved PAL/NTSC", "evolutionary" as in EDTV, or "revolutionary" as in HDTV is to be assessed in the rest of this report. A sequence of critical development questions is put forward as an appropriate introduction.

First, will the consumer market be sufficiently interested in 'features' and 'impairment free' PAL/NTSC signals to trigger major development and production commitment by set and chip manufacturers. If so, what will be the timeframe and resulting price differential between conventional and smart receivers?

Second, given the advent of smart receivers, will there be sufficient consumer interest for broadcasters and programming suppliers to establish new television transmission system and display formats (i.e. EDTV or HDTV)? It may be that the improvements from PAL/NTSC digital television sets will soak up whatever demand that exists for a higher image quality and thus obviate the need for EDTV or HDTV.

Third, if new television systems with superior production/transmission/display formats do come to pass, will the Western world follow a single standard or will separate regions of the world go their own way, similar to the existing PAL/NTSC/SECAM structure of today? In either the EDTV or HDTV proposals, conventional over-the-air distribution of enhanced television is not feasible given the limited spectrum space. Therefore, in either an EDTV or HDTV format a satellite direct-to-home or satellite-to-cable delivered system would be required. Both systems require massive investments in (a) studio and production systems, (b) distribution systems, and (c) in-home decoders and receivers.

Fourth, will the route to new television systems be first stimulated by specialized commercial or entertainment applications? Closed circuit applications for medical, military, office and educational purposes play a critical role in the development of the new technologies. Another specialized application is the distribution of feature films or even live events (like sports) to mini theatres, bars, or hotels via satellite. Through progressive steps, such services might be made available directly to home viewers.

Fifth, will the advent of modular television and home entertainment centre of the future stimulate the demand for higher quality image displays? There is a growing trend for the traditional television set to break into modules (primarily the receiver/tuner, the video display device, and the audio speaker/player/recorder systems), along with the importance of television accessories (ie. the VCR and video disc). Part of this modular TV trend is the need for high resolution display for home computers and videotex/teletext as well as standard alphanumeric presentation of information.

The answers to these questions are complex and affected by technological developments, the initiatives of Western European, North American and Japanese governments, broadcasters, manufacturers, and programming suppliers, and ultimately by the consumers' reaction to the new TV products and services. The next three sections provide an attempt to identify the timeframes for technological and market developments and to draw conclusions about how Canada is likely to be affected by them.

3.0 PRESENT STATUS OF TELEVISION TECHNOLOGY RESEARCH

3.1 Introduction

This section was prepared by the Canadian Broadcasting Corporation, summarizing the status of television technologies and current research activities throughout the world. It is based on interviews conducted on an international basis with major research organizations and manufacturers involved in the television field, as well as an extensive literature search. Due to the sensitivity of some research work, companies have not been referenced in the overview of research activities.

3.1.1 Approach

The information obtained in this review of TV technology and research activities can be classified into eight major topics defined as follows:

- Image Sources

  The devices or components used to generate a television image. The images may be test patterns, single images (or frames), the output of a camera or a graphic generator. The images may be static or dynamic.

- Signal Processing

  All the analogue and digital techniques used to modify the original form of the television signal, for production, transmission or reception purposes. The types of equipment encountered include production switchers, two or three dimensional special effects generators, routing and distribution equipment etc.

- Tape and Disk Recorders

  The devices and media used (or proposed) to store a television signal.

- Network Transmission

  The techniques used (or proposed) to transmit signals from any source to a destination that is not the intended final viewer.

- Broadcast to Consumer

  The transmission, modulation and demodulation techniques used to transport the signal to the intended final viewer.

- Receivers

  Self contained devices that include equipment to detect and demodulate (and to reconstruct if necessary) the transmitted signal. This report does not consider a system of separate tuners/demodulators/monitors to be a receiver. These devices are considered separately under 'Broadcast to Consumer' and 'Display Devices'.

- Display Devices

  Includes any of the conventional or proposed variations on cathode ray tubes (CRT's), projectors, flat panel or liquid crystal (LCD) displays.

- Consumer Products

  Devices that could not be used in a professional application. Any items discussed in this report that could possibly be used in a broadcast application are included in other categories.

These eight topics are further broken down into four sub-headings defined as follows:

- High Definition Electronic Production (HDEP)

  Intended to produce the best possible picture quality and the source for the rest of the system. The signals are frequently in RGB format, with 800 to 1200 lines and bandwidths approaching 30 to 40 MHz.

- High Definition Broadcast (HDBC)

  High line rate broadcast systems that are not compatible with the existing scanning standards. They make use of psychophysical trade-offs to reduce the required transmitted bandwidth. Baseband signals typically occupy 7 to 10 MHz, and therefore unsuitable for studio purposes.

- Extended Definition Television (EDTV)

  These systems use scanning standards that are compatible with the existing 625/50 and 525/60 standards. They offer improved quality through the use of new modulation schemes, such as MAC. The image is usually wider than the normal 4:3 aspect ratio.

- Improved PAL/NTSC (IP/N)

  These signals are compatible with normal PAL and NTSC scanning standards, and the transmitted signals are compatible with (but not the same as) the normal transmission standards. The standard 4:3 aspect ratio is not changed.

The last three of these systems use at least some signal processing in the receiver. The techniques used require varying amounts of memory, from a few lines to several fields worth. Several of the proposed schemes also require that a control signal be broadcast along with the television signal.

Section 3.10 contains information that can not be categorized with the other sections. Much of the technology that will affect television is not being developed for, or is not being currently used in, the television field. There will, however, be "spin-off" effects. Information on developments in other relevant areas, for example, high resolution computer displays, has therefore been included in this section.

To help visualize the relative amount of activity in each of the identified areas, Exhibit 3-1 was developed. The height of the bars gives a very rough indication of the amount of interest in each area. The diagram should not be interpreted too literally. For example, it shows enthusiastic development of sources for the high definition production field, but no activity in the other three areas. This is because the sources being developed for HDTV will also serve the HDBC and EDTV areas, and via down conversion, the improved PAL/NTSC requirements.

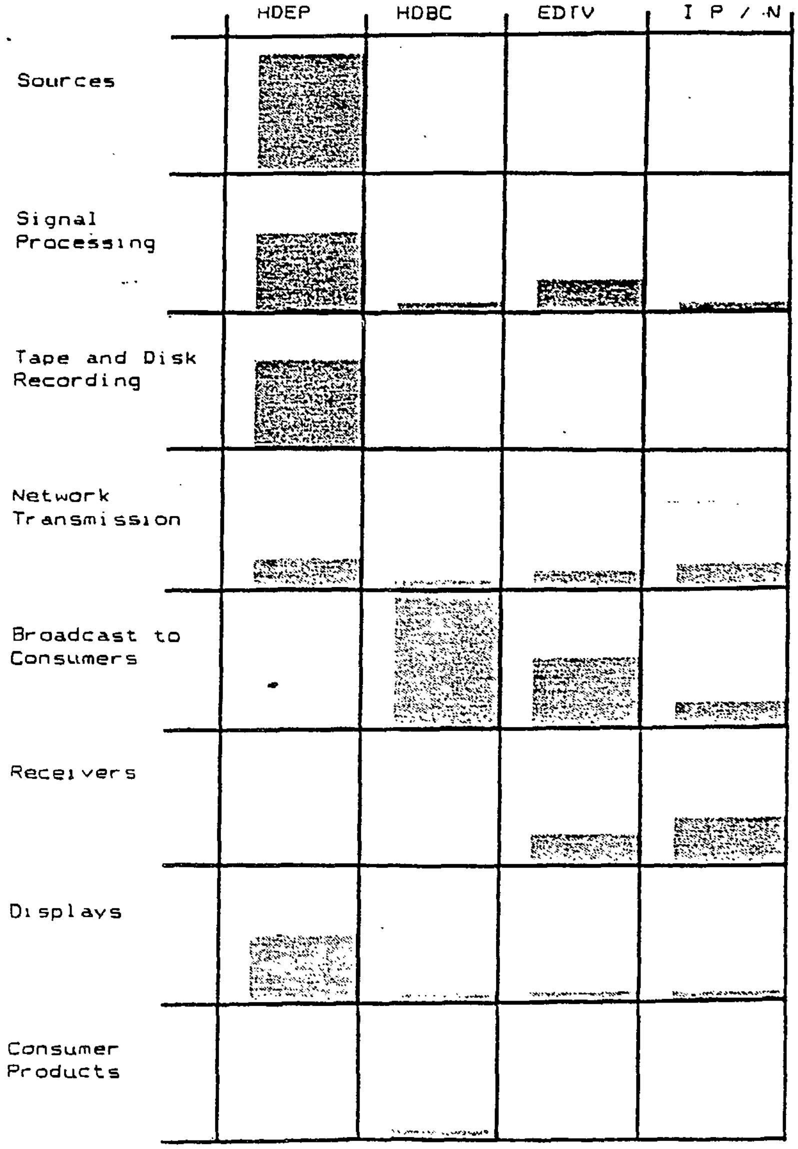
3.2 Image Sources

3.2.1 Overview

Information on high definition image sources is concentrated under the Electronic Production sub-heading, as all the video material intended for High Definition or Extended Definition release is sourced in a "high definition" format. The video material may then be converted into some other format for broadcast (ie. to a two channel compatible format). The images for Improved PAL/NTSC

Exhibit 3-1

Relative Activity in Identified Areas



systems can either be derived from high definition sources or can come directly from existing sources. Key findings in the area of image sources are:

- The majority of the current high definition television cameras use one inch Saticon pick up tubes. They produce a 40% modulation depth at 800 lines. This will soon increase to 50% at 850 lines. The best signal to noise ratio is about 50 dB with a 200 footlambert light level.
- One of the camera manufacturers uses dynamic correction circuitry to maintain focus out to the edges of the image, and to track and compensate for errors in the zoom lens.
- The main problem with Saticon tubes is their lag and smear, or poor temporal response. This, in turn, causes problems with motion detectors and three dimensional filters used further down the chain.
- Solid state image detectors, based on charge coupled devices (CCD's) do not have these problems. It will be five to seven years before CCD based high definition cameras are commercially available.
- A high quality high definition slide scanner is available. It is based on a 2048 element linear CCD array.
- A 70 mm telecine chain that uses a laser scanner is also available.
- Test equipment for high definition television systems will be automated and will be software based.

3.2.2 High Definition Electronic Production (HDEP)

NHK of Japan did the original psychophysical tests to determine the necessary characteristics of an HDTV system and are presently doing research on pickup tubes for HDTV, and have an experimental HDTV telecine using a laser flying spot scanner and 70 mm film. They have also done experiments on HDTV to film transfers using kinerecording and a three color (Technicolor) process.

One manufacturer is using high resolution, low lag 1 inch saticons for HDTV picture sources. They yield 1600 lines resolution at the center and 1200 lines at the edges.

Thoughts from Europe on a production standard include: 50 Hz frame rate matches film and converts well, but has flicker problems; 60 Hz cures the flicker, but may not convert well; 1125 line standard may not be good enough at viewing distances of 3 Hz and less; 80 Hz frame rate is probably too costly to build for the present; subjective assessments of conversion equipment should use images that reflect the temporal performance of future CCD cameras; and HDTV production standards should be written around the performance of these cameras, which will take 2 years or so to establish.

A European manufacturer has a 1249 line 50 field HDTV camera. It uses Japanese 1 inch LOC saticons and optics yokes, and German lenses and electronics. It has a Modulation Transfer Function (MTF) of 100% out to 15 MHz (with aperture correction), and gives a 40 dB Signal to Noise Ratio (SNR) with about 100 footcandles at f2.8. More work will be done to add digital vertical aperture correction, and operational features. This camera produces excellent live material for computer simulation work.

It is unlikely that a Charged Coupled Device (CCD) HDTV camera will be available within the next 5 years. Tube based cameras are not yet up to the performance levels of conventional cameras. HDTV cameras currently cost 3 to 5 times more than 625 line cameras, because the integrated circuits capable of the speed required do not yet exist.

A study has been completed on a high definition film scanner and a chroma keyer. There is no current activity in high definition production equipment, graphics or animation.

Noise and resolution are the major problems with current high definition cameras. Lenses also have to be faster to get useful depth of field with reasonable light levels. Note that NHK demos are usually outdoor sports events. Several suppliers think that CCD's (rather than saticon tubes) are the only possibility for HDTV pickup devices, due to their better noise and lag characteristics.

Some sources predict that the 'professional' quality CCD camera chip will be available within a few years, and high resolution chips within 5-7 years. CCD's will be utilized for conventional applications in the meantime. The main problem is to develop satisfactory processing techniques to produce chips for a geometry of 1 micron and below. Pickup tubes for HDTV must be able to supply good sensitivity to achieve depth of field and low lag and smear. Current tubes are not good enough yet, but new sensors (ie. CCD's) can solve these problems. Motion adaptive and predictor algorithms need low noise signals with low lag and smear to do their job well. Another European manufacturer is currently updating its cameras with 1 inch tubes.

There is also a unique slide scanner for HDTV from this European manufacturer. It uses a 2048 element CCD array, a frame buffer and a disk store. It runs at 1400 pixels per line now, but with more memory, could produce all the proposed HDTV formats. Field scanning and color separation are done with moving mirrors and filters. A flying spot (CRT) version is also available. They are also working on a graphics generator that provides animation and image manipulation. They expect a CCD camera within two to three years (not HDTV). They will build the chips themselves.

Another supplier uses PIN diode gun saticons in their HDTV cameras, and expects to do so until CCD arrays appear. Research into mixed field focus/deflection is on going in efforts to obtain better lag and 800 line resolution at 50-60% depth of modulation.

Yet another group is planning similar tubes for mid 1985 followed by a 2/3" tube in mid 1986. There is presently no work being done on CCD arrays since they will not be practical until 1990.

Another effort in this area includes a manufacturer who is currently producing a high definition camera chain for experimental work. The system produced 35% modulation depth at 800 lines, but will soon be pushed to 50% at 850 lines. It has a 50 to 52 dB SNR. They see

1 inch or 1 1/4 inch plumbicon and saticon tubes will likely be used for the next 5 to 10 years. They are selling their high definition camera and 30 inch 5 x 3 monitor to HDTV experimenters for about $500,000 US.

Another supplier sees the PIN diode gun plumbicon as a good enough pickup device until CCD's develop enough to take over. They currently have a 500 x 600 CCD array.

Another equipment manufacturer has provided modified test signal generators to NHK for their HDTV program. This is part of their general effort to stay abreast of demands for new equipment. Many of the new pieces of test and measurement equipment will be software based. The instruments will be introduced in the fall of 1985.

Another supplier recently demonstrated a high definition camera that gave excellent results. It runs at 200 foot lamberts at f4 with a signal to noise ratio of 46 dB. It uses a special Canon zoom lens with low color aberration, and 1 inch Saticon tubes. It has dynamic registration correction circuits that fix scanning and lens aberration faults. This maintains sharp focus out to the corners of the image, regardless of the zoom length. It does have the temporal problems of the Saticon tube, but would be acceptable in a studio.

The problem is to decide on HDTV standards for image sources without having seen the quality which can be ultimately achieved with the various technologies.

3.3 Signal Processing

3.3.1 Overview

Key findings in the area of signal processing research and development are:

- The lack of a suitable routing switcher for high definition television (HDTV) is forcing planners to make the HDTV production suites self contained, instead of being able to share common facilities.
- Some program producers would like to see an optical routing switcher for HDTV. This will not be possible until an optical gain element becomes available. One manufacturer has shown a prototype solid state optical switch.
- Electronic routing switchers for HDTV will not be practical until a VLSI crosspoint is available. A fast sixteen by eight multiplexer for digital signals does exist.
- Currently available very large scale integrated (VLSI) circuits include a 16 by 8 digital multiplexer, a 100 MHz analogue to digital converter and a 70 nanosec. 10 by 10 multiplier with 16 bit adder input and resultant ports. A 20 MHz low power analogue to digital converter and a 1 kilobit GaAs RAM that has a 1 to 2 nanosec. Access time will be available in 2 to 3 years. Building block chips, such as a/d and d/a converters, serializers and deserializers are in development.
- Production switchers for high definition television seem to be waiting for the digital VTR to be defined. Some suppliers are proposing that the production switcher be composed of a group of frame stores connected by a high speed data bus. Others favor working in analogue components, then converting to the appropriate analogue or digital signal format.
- A prototype all digital production switcher is being built for an experimental studio.

- The best field rate for high definition television has not yet been selected. New proposals for progressive scan systems will be made in mid 1985. One proposal for improving the NTSC signal adds a second subcarrier for a "detail" signal and generates a noninterlaced scan at the receiver.
- Subjective tests have shown that three dimensional filtering and progressive scan can improve standard PAL images by 2 CCIR grades (see CCIR Recommendation 500). A high definition image, in comparison, is 2.5 grades better than the standard PAL image.

3.3.2 High Definition Electronic Production (HDEP)

A British broadcaster is doing research on random access optical disk video editing. Broadcasters will have put Digital Video Tape Recorders (DVTRs) in studios due to lack of digital (preferably optical) routing switchers. A digital editing suite is planned for 1986-1987 and a digital component production switcher is expected in 1990. A central slide store library capable of downloading any of 25000 slides to a control room slide store will be used in these suites.

An American manufacturer predicts that HDEP will use analogue components in the near (and maybe long) term. News and other small productions will probably stay analogue for some time to come, due to the high cost of digital production switchers.

Digital routing switchers require multiple crosspoints in VLSI form to be economic. Routing switchers could be done with 32 level data modulation and wide band analogue switching techniques. Optical routing switchers are currently too expensive.

One British equipment manufacturer interviewed believes that large digital routing switchers are rather difficult. This manufacturer will, however, produce a digital production switcher based on parallel frame stores linked by a fast data base. Control panel layouts, dedicated and assignable, are currently being investigated. This digital method will first be used in post production. Images will be stored in a large central data base, and dumped on low speed data links to image work stations. A central library will cost $0.5 million if it is tape based, or $0.05 million if disk based.

A British broadcaster suggests that studio production will be done in components. Digital signals are preferable, but an analogue system might be easier to convert to HDTV. A serial 250 Mbit/s routing switcher will not be practical until it can be done optically. A bit-parallel routing switcher could be done at 27 Mbit/s but is impractical for sizes above 20 x 20. Signal processing may be done successfully at less than the theoretically optimum 3 x 13.5 Mbit/s. VSLI circuits such as frame stores make sophisticated image processing possible.

K. Powers calls for a worldwide EDTV production standard based on CCIR recommendation 601 (a component video signal format with the same number of samples per line in both the 625 and 525 line standards). Conversion between HDTV, EDTV and NTSC/PAL would then be relatively easy.

A supplier has done the groundwork required to start product development work on a digital studio. They will wait until the DVTR is better defined before developing routing and production switchers and recorders.

German researchers are working on the 50, 60, 80 Hz field rate problem. Conversion from 80 to 50 Hz does not achieve desirable results. A major European manufacturer does not believe that an 80 Hz field is practical. Another group is investigating the 15:1 interlace vertical scan idea proposed by K. Powers. Their work is aimed at picture phones and noise reduction, and seems to indicate that even with very complex processing, some pictures will always fail. Most, however get a grade 4.5. There is no work being done in Germany on high definition production tools (such as mixers, keyers, converters, etc).

A large French supplier is building a switcher package for the experimental digital studio at CCETT. They have four multipliers on a 10 x 10 card, making the equipment large but practical. They also have a routing switcher. It switches a 243 Mbit/s serial signal with a 16 x 8 ECL multiplexer chip. There are serial to parallel and parallel to serial converters contained on 1/3 or 1/2 of a 10 inch square card. The system uses a common clock.

A Japanese manufacturer is developing a 50 Mbit/s codec that runs at a 4 fundamental subcarrier frequenty (fsc) and 9 bits. They will also begin fabrication of a set of A3D, D/A, serializer, deserializer, and multiplier chips in about 2 to 3 years. They are not doing any 3 dimensional filtering work at present.

Another Japanese supplier interviewed recently demonstrated a 20 MHz analogue to digital converter with a power consumption of only 180 mW. A 1 K gallium arsenide random access memory with a 1 to 2 nanosecond access time was also demonstrated. Neither of these devices are commercially available yet. The memory may be available in 4 to 5 years. A solid state optical switch was also demonstrated. It is currently too big and has too much loss to use to build a large optical switcher, but they are continuing work.

With preliminary research completed on the majority of items required for the all digital studio, production of components is now commencing. The first digital electronic production equipment that will become available will have RGB or encoded interfaces on the inputs and outputs. These will be easily removable so the "all digital" signal path can be easily extended as more equipment is added. The development of all digital HDTV suite will lag behind, thus analogue digital conversion will be required for some time to come.

3.3.3 High Definition Broadcast

According to some research HDTV is subjectively 2.5 grades better than standard PAL, when it is seen in a 4:3 aspect ratio. A German researcher's proposal for DBS HDTV service splits the signal between 2 channels and uses only diagonal filtering. It achieves a grade 4.5 on most critical material.

3.3.4 Extended Definition Television

Diagonal pre and post filtering improves 625 line PAL by 2 CCIR grades. Progressive scan also improves standard PAL by about 2 CCIR grades. A compatible signal could be generated from a 1050 progressive scan, 30 frame source. This signal would be interpolated to a 525 line signal with 2:1 interlace. The chrominance and "detail" signals could then be time division multiplexed to reduce the bandwidth enough to transmit the signal. Processing in a smart receiver would restore the original signal.

Digital signal processing can improve luminance-chrominance separation, give sharper pictures, reduce noise and equalize the chroma channels.

The main British common carrier is not active in HDTV work. They view broadcasters as mere users of the new digital network.

One of the digital TV chip sets will soon be available in a version with 1 micrometer geometry for use in the mid-priced receivers. Several other manufacturers can supply 64 or 256 K video memories masked for video operation compatible with these (and probably other) chip sets.

A satellite research group is currently studying sampling and filtering techniques for audio and video signals, image processing ideas for bit rate reduction to 40 Mbit/s, compatibility of NTSC and EDTV receivers with HDTV signals and compatibility of HDTV receivers and NTSC signals. This same group is also working on adaptive processing techniques that can deal with moving images. This will be used in deinterlacing for progressive scan displays. They are also working on interfield interpolators and other processors for the transmit and receive ends of satellite links serving cable systems.

3.3.5 Improved PAL/NTSC

A Japanese manufacturer has a 10 x 10 multiplier with a 16 bit adder port and a 16 bit result port that runs at 14.3 MHz. Another supplier uses unoccupied frequency bands in the NTSC spectrum for an additional horizontal detail signal, and progressive scan to improve the vertical resolution. The horizontal detail signal interferes only minimally with normal receivers. One researcher claims that the use of adaptive filters in the camera and smart receivers using frame store memories provides a tremendously improved NTSC image.

3.4 Tape and Disk Recording

3.4.1 Overview

Results of the state-of-the-art review in the area of tape and disk recording indicates that:

o Disk based memories for data and video signals will be available soon. Systems will offer read only, write once and reusable (erasable) options and they will use the usual compact (audio) disk, optical or magneto/optical technology to record the information. Capability ranges from 500 megabyte read only compact disks that are available now, to optical disk based digital video recorders that will be commercially available within five years.

- Video editing systems based on optical disks will offer virtually instantaneous random access to program segments, thus speeding the editing process.
- An experimental 460 Mb/s digital Video Tape Recorder (DVTR) has been privately shown. Others have said that a similar prototype machine could be shown in mid 1986. All these machines will use tape cassettes. Users want, ultimately, a 120 minute tape capacity.
- According to one supplier, conventional analogue FM recording will offer better quality HDTV recordings than DVTRs "for some time to come".
- Kinerecordings will continue to be important, because 35 mm film is still the most universally accepted program interchange medium.
- High definition Video Tape Recorders (VTRs) will appear between 1990 and 1993, but the spin-offs from their development will greatly improve conventional VTRs before then.
- HDTV and MUSE format video tape recorders for consumers will be available by 1989.

3.4.2 High Definition Electronic Production (HDEP)

The DVTR must debut with 90 minutes for recording time, eventually increasing to 120 minutes. A prototype DVTR (composite or component) will be available mid 1986 or early 1987 and will use cassette tapes. There will be a heirarchy of machines, starting with a high quality, full featured machine. A stripped down version, and a machine for electronic field production (EFP) will complete the family. The composite DVTR will cost about the same as a C format machine. The component DVTR will cost 30% more.

There are predictions of an optical video disk recorder by 1989 and is presently in the research lab. DVTR's based on optical disk will be simple. Optical disks may be used for production and post production by 1990, making tape the mass storage medium.

Betacam (component) tape to 35 mm films transfers will be one possible source of high quality material. Tape suitable for perpendicular recording can be produced economically by vacuum deposition of Co-Cr/Ni-Fe/Ti. A broadcast research organization reports that magneto-optic readout of a TV signal on CR02 magnetic tape gives 45 dB SNR and 300 lines of resolution. They are also working on erasable magneto-optic disks, using amorphous GdCo thin films.

HDTV VTR's will not likely be available until around 1993, but digital technology, optical recording, and vertical (magnetic) recording will vastly improve pictures from conventional VTR's before then. One manufacturer interviewed, however, feels that analogue FM is the way to record HDTV material, and that digital recorders with 9 bit accuracy are "a long way off".

One manufacturer has magneto-optical direct read after write (DRAW) disks for computers. Capacity is 375 Mbytes on a 8" disk and 164 Gbytes on both sides of a 12" disk. Pregrooved disks are used with vertical recording. 1.6 micrometer track pitch is the expected limit. After the data version becomes available, there will be a television version for NTSC and HDTV. The data version will be sold in 1985, for use in the manufacturer's electronic office systems.

Currently a common carrier is developing a video disk library system for their CATV system users. A large Japanese manufacturer is looking at using the compact (audio) disk with 500 Mb capacity to distribute large read only data files. They have also started to work on professional and consumer HDTV and MUSE format video tape recorders.

This manufacturer currently has a 35 mm electron beam kinerecorder available, which uses some processing to change from 30 to 24 frames and to still frame while the color separations are made. Kinerecordings are important because film is currently the most universal interchange medium.

Another manufacturer has lab work going on in vertical recording on oxide and evaporated metal tape, and on optical recording. They predict 3 years of research and two years of development before the appearance of a professional DVTR. A block channel coding scheme associated with this work will be submitted to SMPTE in late 1985. This same research group is also working on read/write optical disks, erasable optical disks and 8 mm tape. Yet another supplier has shown a variety of optical disks at several trade shows, but has not yet disclosed how close to introduction they are. They have not indicated a preference for one technology over another.

Among recently announced items, there is a compact (audio) disk that has been reformatted to store either six thousand 640 x 400 pixel images, 3000 pages of text, or audio, or a mixture of these. An erasable compact disk for data storage that used magneto/optical technology to store about 500 times more data than a normal floppy disk (close to 150 Mbits) has also been announced. A 10 inch "write once" optical disk is currently being shown that can store about 13 minutes (24,000 frames) of NTSC video, using color under techniques. (The color subcarrier is separated, down converted to a lower frequency, and recorded "under" the FM frequency band used for the luminance information). It is not broadcast quality yet. A thermal hard copy unit for video that produces very high quality 3 x 3 inch color pictures, as well as an experimental

460 Mbit/s digital (video) tape recorder has also been demonstrated in the lab. The DVTR uses a C format machine with doubled tape and scanner speeds, 5 heads and normal oxide tape. The luminance signal is filtered to about 20 MHz and sampled at 46 MHz. The color difference signals are filtered to 5 MHz, and recorded line sequentially with a 11.5 MHz sampling rate. The line shuffling used is quite short to avoid having to use frame stores. The concealment rate was about 10 per second after four generations. This manufacturer also had a satic display of perpendicularly recorded media that they claimed was capable of a 100,000 bit per inch recording density, in addition to some evaporated metal tape.

3.5 Network Transmission

3.5.1 Overview

In the area of network transmission the state-of-the-art review found that:

- Several suppliers are working on fiber optic systems for long haul distribution of HDTV signals. These systems are generally capable of carrying a digital HDTV signal without complex bit rate reduction schemes.
- The "bit rate" of digital television signals has to be reduced to fit into the transmission facilities available. Most bit rate reduction schemes seem to work well as long as the picture is not too complex, or if there is not too much motion in the scene.
- Digital codecs are tending towards 9 bit words and sample rates of four times the color subcarrier frequency. This helps to eliminate the artifacts generated when several codecs are cascaded.
- One common carrier is experimenting with a multiple channel, time division multiplexed analogue transmission system.

3.5.2 High Definition Electronic Production (HDEP)

A supplier foresees in-studio production in 3 channel analogue form. They feel that digital transmission and MAC are impractical due to the lack of fast integrated circuits and converters. They are also concerned about the noise and impairments caused by filtering. They are trying level adaptive modulation to reduce cross color and cross luminance effects. This may be cheaper, and as effective, as using frame store based filtering techniques.

A common carrier interviewed plans to use a 150 Mbit/s system to ship bit rate reduced HDTV signals around the country. All network interconnections will be done at the analogue level. They have demonstrated 'broadcast quality' transmission of PAL signals at 68 Mbit/s with 3 codecs in tandem. Picture impairments were quite small. These results bode well for North American NTSC transmission at 44 Mbit/s.

Another organization interviewed is developing a 50 Mbit/s, 9 bit, 4 fsc NTSC codec. They are also working on a 740 Mbit/s fiber optic link, which uses laser diodes, and may be able to reach 1.6 Gbit/s. It is expected that fibre will be cheaper than coaxial cable for distances greater than 30 Km. A fiber optic switching matrix will be available in about 5 to 10 years.

3.5.3 High Definition Broadcast

Digital transmission of HDTV will require bit rate reduction to fit into existing digital networks. For near term use, extended PAL and MAC type systems are advantageous. Satellites are well suited to long haul

HDTV/EDTV distribution, but are currently too limited by spectrum and power for local distribution. Local distribution of HDTV/EDTV (uncompressed) will have to wait for optical fibres.

Kokusai Denshin Denwa (KDD) has a 400 Mbit/s fiber optic system that goes 30 Km between repeaters. They also have a 714 Mbit/s system using PCM coded Y, Cw, Cn components for HDTV signals. It goes 20 Km between repeaters. The system is currently in their R&D labs, so presumably they only have one or two repeaters.

The German National Broadcaster FTZ has essentially completed a digital radio system and the digital feeder links to the system for a stereo radio network. They plan to put 16 channels of compact disc quality digital audio on one 12 GHz television transponder. The service will start sometime in 1986.

3.6 Broadcast to the Consumer

3.6.1 Overview

Results of the state-of-the-art review related to broadcast of higher definition services to the consumer indicate that:

- High definition television requires new distribution media. Satellite to cable is the only method presently available with the potential capability.
- There are several proposals for multi-channel distribution of a high or extended definition signal. The compatible proposals for EDTV use one channel for a standard signal, and the second for the detail or difference signal. The signals are reassembled in a "smart" receiver.

- Psychophysical tests are being made that will result in better bandwidth reduction schemes.

- The high definition signal must fit into one satellite transponder to be economically distributed. Two coding schemes have been proposed, one of which, the MUSE coding scheme, will have a trial run in Japan until 1989 when a full fledged service is proposed.

- The MUSE coding system requires four frames of memory and a good deal of other processing capability in the receiver. The receivers will debut in 1989 at a price of about $2500 US.

- Improved PAL/NTSC "smart" receivers will be available in 1986 to 1987. E-MAC receivers could appear in 1990, if the memory and processing chips are reasonably priced.

- Fiber optic distribution systems are the only ones with enough bandwidth available for non compressed high definition signals.

- The EBU has decided to include a 'signal format' code in the MAC signal to permit a smart receiver to decode several different signal formats.

- Fiber optics are expected to be economical, for the trunk sections of a cable distribution system, but not for the customer drops.

- Distribution of full bandwidth HDTV signals via satellite will have to wait for the 22 GHz band in the 1990s.

3.6.2 High Definition Broadcast

The MUSE system uses a single 24 to 27 MHz transponder for an HDTV signal. The R-Y, B-Y signals are time compressed 4:1 and sent line sequentially during the horizontal blanking period. The whole signal is then subsampled to reduce the bandwidth. The receiver needs 4 frames of memory.

K. Powers has suggested 4 systems that could provide fully compatible signals (ie. standard receivers would display a normal image). HDTV, EDTV and improved PAL/NTSC should be produced as a heirarchy, to make transcoding between all classes of service as easy as possible. He also suggests that a high definition system has to provide more than just higher resolution to be marketable. Doubling the bandwidth is the most that can be justified.

In Japan there have been successful experiments on a 22 GHz low-noise down convertor. They have also run fibre optic transmission tests in Yokosuka in 1981-82. Optical filters, matrix switches and FDM techniques were tested. A fibre optic 'cable' system has been operational since October 1981, connecting 150 subscribers to 2 switching centers. The fibers receive TV, telephone and data signals. Japan will run DBS trials using HDTV signals between 1984 and 1989.

A research group has done experiments on real time processing of 1250 line images to achieve a "moderate transmission rate". In this system, frame stores are used both in the studio and in the receiver. A high definition system has been proposed, based on 525 or 625 lines, that uses pre and post filtering with MAC timeplexing and smart receivers to improve image quality. The system uses 'new FM' channel bandwidths somewhere below 450 MHz.

The Japanese did satellite broadcast tests in 1982 using separate luminance and chrominance components. These were followed by Time Compression Integration (TCI) tests (see MUSE system). Another similar system has been proposed in which an HDTV signal with time compressed and time multiplexed chroma would be transmitted to a decoder that produced either a high definition or a standard baseband signal. This would eliminate the NTSC footprint and also frees the monitor for other uses.

Satellite broadcasting will debut in France within the next few years and use a MAC signal (probably D2-MAC) with 4 channel sound. There will be 6-8 250 W transponders available (on 12 GHz) so 60 to 75 cm receive dishes should work satisfactorily. Flat panel array antennas may replace dishes. The satellite will be launched in 1985 or 1986. Germany will probably follow suit.

The German Ministry of Science and Technology is funding research on HDTV technology and industrial product development. German industry sees a market for large DBS receivers and set top converters. They are planning a 2 channel HDTV distribution system to allow the continued use of conventional receivers, and to be able to transmit (single RF channel) stereo sound.

A DBS service could be implemented using two low power transponders. The same idea could be used for HDTV and EDTV services. There is a need for memory, processing and controller chips, and improved kinescopes before high line rate HDTV becomes a reality. (1989 should see the improved PAL receiver with three fields of storage and motion detection for flicker and twitter elimination. Motion detection is difficult at this point.)

There is some work being done on bandwidth reduction techniques for HDTV that take advantage of the psychophysics of human vision. The target is to develop a system that delivers twice the horizontal and vertical resolution of the NTSC system in less than twice the bandwidth of an

NTSC channel (ie. in less than 12 MHz). The early conclusions are that the chroma channel bandwidth can be narrower than was previously believed necessary, and that the eye is less sensitive to flicker in small areas than it is in larger areas. The detail information can, therefore, be transmitted at a lower frame rate than the rest of the image. High spatial frequency information can, in fact, be transmitted at rates as low as six frames per second. The signals could then be recombined in a frame store in the receiver.

Joseph Nadan of Philips in the US has proposed a two channel system that uses the main channel to transmit a compatible NTSC signal, and the (partially utilized) second channel to transmit the additional high definition information. Another group plans to demonstrate a 5:3 aspect ratio, 800 line, progressive scan system in the near future.

Yet another two channel system has been proposed by CBS in the US. The first (Compatible) channel carries a 525 line analogue component type signal (60 field, 4:3 aspect ratio, time multiplexed component). The second channel carries an additional 525 lines of video but with a 5:3 aspect ratio. (This is not the same as the previously discussed 2 channel NTSC proposal.) When these two channels are matrixed, an HDTV picture results containing 1050 lines and a 5:3 aspect ratio. Line sequential color and time compressed luminance signals are used to fit everything into the bandwidth available. The system was demonstrated in the fall of 1984 with a wide screen projector, a taped shot of the recent Olympics and a live camera shot of moving toys. The videotape showed few artifacts, except for a very granular noise in the highly saturated areas of the scene. There was no apparent noise in the black or white areas of the scene. Because of the line sequential color transmission, fast vertical camera movements caused some "misconvergence" problems. The live camera demo was quite satisfactory. The two channel encoder/decoder is currently a lab prototype occupying a full equipment rack.

NHK plans to transmit a MUSE coded HDTV signal on one transponder of the BS 4 satellite starting in 1989 or 1990. They will follow this with full bandwidth HDTV service on one 22 GHz transponder of the BS5 satellite in the mid 1990s. Two Japanese manufacturers are developing a line of DBS/MUSE receivers, disk players, VTRs and displays for a 1989 introduction.

The MUSE system sampling clock runs at 16.2 MHz (which is sub-Nyquist), but the image is sampled on alternate phases of the clock during a four field sequence, so a stationary image is effectively sampled at 64.8 MHz. The problem comes with moving images. The screen is divided into about 500 segments, and movement detection is used in each of these. If there is movement, the signal is suitably filtered and no intraframe interpolation is done. This reduces the resolution in moving areas of the image. Control information is sent to the receiver to permit proper decoding.

The MUSE system was also shown at the CBS fall 1984 demonstration, with the two channel system, using the same material. The VTR sequence showed the same granular noise in the highly saturated parts of the image. The camera image showed something similar to a fixed co-channel interference pattern. This may have been a temporary problem. Moving horizontal transitions showed some ringing that was caused by the pre filtering used when sampling at sub-Nyquist rates. These same transitions also showed artifacts similar to cross color and cross luminance effects. A demo of the laser telecine feeding the MUSE system was also shown at this demonstration. These showed the color noise problems seen with the VTR, and some banding problems. There were also some time domain interpolation problems with fast moving scenes.

A German research institute has done work on a fiber optic system running at 1.2 Gbit/s, carrying either 8 PAL channels, 2 HDTV channels or 4 PAL and 1 HDTV channel.

3.6.3 Extended Definition Television

EDTV and new distribution media will be slowly introduced during the next decade. A bit rate reduction idea divides the HDTV signal into a standard signal data stream and a detail data stream. It would use 2 transmission channels.

A major European receiver manufacturer has an enhanced TV system that uses two channels. The main channel carries a standard NTSC or PAL signal, so the system is compatible. The second channel carries i) the detail information, ii) the additional (hi def) picture information required for the wider aspect ratio and iii) the control signals required to integrate the two signals into the final wide screen image. Both channels use normal bandwidths, so existing transmission facilities can be used.

Investigations are being done of a 'slightly modified' version of NTSC that permits extended vertical details. Work is underway on various MAC formats for satellite use, a specific format has not yet been endorsed. A satellite group interviewed is working on i) improved NTSC formats ii) MAC schemes using 3:1 and 2:1 chrominance to luminance ratios for DBS applications iii) multiple channel time division multiplexed analogue transmission for network distribution.

A C-MAC satellite system introduced now could be changed to an E-MAC system in future without loss of service to existing receivers. E-MAC quality would be subjectively about equal to that of HDTV. There will be new receivers, with processing to improve the picture quality, in '86-'87. These will be followed shortly by MAC type EDTV systems, using new coding methods (probably using E-MAC).

Another manufacturer interviewed is developing low cost B-MAC decoders for use in a DBS system. They also believe that progressive scan systems are the way to go.

A pay TV distributor in the US plans to use DBS and some form of scrambled MAC system to deliver a higher quality product to its customers. Their Technology Group is watching the current research activity, hoping to find a system that uses the existing distribution system to deliver a compatible high quality signal. The ability to scramble the signal is a priority. They are not convinced that a noncompatible HDTV system has any future in the US.

Fiber optic "cable" TV distribution will probably happen in 4 to 6 years in France, with fiber trunks and coaxial cable to the consumer's home. A large cable network in France currently uses fiber optics for the main trunks.

An American manufacturer is developing a "digital pseudo-analogue codec" that will deliver a full HDTV signal (presumably the 1125/60/2:1 system) on a single satellite transponder. The following ideas for source coding of the detail component of the TV signal have been studied: i) nonlinear, nonadaptive ii) adaptive quantization iii) structure coding. Successful experiments on a 22 GHz low-noise down convertor have been done.

3.6.4 Improved PAL/NTSC

Experiments were made on an improved PAL system that transmits color and luminance detail on alternate lines. This system is easily demodulated and does not suffer cross effects, however does lose diagonal luminance resolution and vertical color resolution.

The German cable system is conventional. There is very little fiber, and no interactivity. Like the British system, they only bring the cable to the house wall. A 1 Mbit MOS RAM chip which will remove some traditional transmission impairments is expected to be in the marketplace by 1986 or 1987.

3.7 Receivers

3.7.1 Overview

On reviewing current research and development pertaining to receivers it was found that:

- Many manufacturers want to introduce the market to high definition television gradually. A progression from improved PAL/NTSC through EDTV (to introduce the wide format image) and finally to HDTV is the favored approach by these manufacturers. Compatibility of the new signal standards with the 0.6 billion existing receivers they consider as very important.
- The evolutionary approach to HDTV is best served by modular systems.
- Good motion detectors are essential.
- One frame of memory should cost $10 by 1989. Image processing chips are also under development. These two components are the core of the "smart" receiver.
- Some smart receivers that improve the NTSC image will appear in 1985. More sophisticated smart sets offering further improvements and features will debut in 1987.

3.7.2 Extended Definition Television

Researchers note three ways to improve TV. First, the Japanese approach, which increases the number of lines and bandwidth. Second, use signal processing that yields a compatible signal, based on pre and post filtering using frame stores. Third, different processing methods can be used for signal generation, transmission and reproduction as required.

One European manufacturer sees an evolutionary approach to extended definition TV, based on the VLSI frame store. They believe that new form must be "saleably different" in order to be a profitable product line. They also foresee a $10 frame store by the late 1980s, permitting a smart receiver that allows compatable signals.

Digital signal processing in a smart receiver can crispen the image enough so that it approaches the sharpness (but not the resolution) of an HDTV image. Temporal filtering can reduce the noise and separate the luminance and chrominance signals almost perfectly. Smart receivers should happen during 1986 to 1987, just as DBS is starting.

The memory and processing chips required for extended definition (and high definition) TV are currently being developed. A large European group has a 308 Kbit CCD field memory chip. This is the heart of the smart receiver.

3.7.3 Improved PAL/NTSC

1985 will see another line of modular TV's. They will have 3 lines of memory to provide noise reduction and adaptive comb filtering that reduces cross luminance. This filter is patented under the name 'Logical Filter'. Some line rate doubling experiments are being performed, based on this 3 line memory.

Smart receivers will eventually become a universal display for TV, computer, videotext, telephone, C-MAC signals, etc.

A vertical blanking interval program integrated circuit code could control a "video center" with receiver VCR etc. Currently one set manufacturer has a 2 chip set adaptive ghost canceller (using CCD memories) that can deal with up to 20 usec delays.

The second generation of digital TV chip sets being pursued will have fewer frills, and be cheaper. They will include teletext and RGB capability (A third generation will be required for HDTV). The ultimate TV, according to one chip supplier, will have a 40 Mbit/s data bus that ties the picture processor, decoder, teletext, etc. to the display.

Digital processing, frame memories and smart receivers should be able to reduce the flicker, cross effects, noise and improve the features of PAL and NTSC systems enough to keep them in the game for some time to come. The price of these new receivers will decrease significantly as volume of production increases.

A modular receiver format, with DBS and PAL/NTSC tuners, a MAC/MUSE processor, and an RGB monitor incorporating field memories and processing could possibly be the best way to go. These could appear in the 1987-1988 time frame.

3.8 Display Devices

3.8.1 Overview

The survey findings in the area of display devices concludes that:

- Cathode ray tube (CRT) displays are limited to about 30 to 40 inch diagonal sizes by mechanical considerations.
- CRT's are not bright enough in large high definition versions.
- Projection systems are the most promising display device now. They can be used for normal and wide aspect ratio displays. Their resolution is currently limited by lens and envelope defects, but a 1 meter diagonal high definition projector should be available by 1988.
- Projector lens cost can be reduced by precision molding a plastic 'skin' over an unpolished glass lens.
- Liquid crystal (LCD) displays will not be good enough for large high resolution flat panel displays for at least ten years. They may, however, be used in projectors.
- Plasma displays do not yet hold much promise.

- A new display technology will be announced in late 1985.
- A prototype gas discharge display has been developed. With only a 6 inch diagonal, it is the largest flat panel yet.

3.8.2 High Definition Electronic Production (HDEP)

One group interviewed specializes in large (ie. auditorium sized) high definition light valve projection systems. They are experimenting with electrostatic deflection in an attempt to improve and simplify the projectors. However, light valve projectors are not yet good enough for a high definition picture. They are advocating an 1125 line, 60 Hz field rate and 2:1 interlace HDTV system with a 5.33:3 aspect ratio.

A Japanese manufacturer recently demonstrated a 55 inch high definition projection system. It uses 3 CRT's and gave rather disappointing results. Their high resolution LCD display was not shown.

There are prototype CRTs up to 40 inches diagonal size, however they are quite deep and not very bright. The 0.32 mm dot pitch of these CRTs can give a resolution of 1200 lines. A professional projection system is also available. Projectors with better RGB light sources will be the first large high definition displays. Flat panel 'CRT' monochrome displays for computers will be practical in a few years. 625 line color displays will not happen before 1995 and HDTV 'flat CRT's' will take until the turn of the century to appear. Direct view CRT's are limited to about 30 inch diagonal size by envelope strength and shadow mask accuracy. Projectors will be used for displays larger than 30 inch diagonal size.

Liquid crystal devices are being investigated for computer, TV and large screen projectors. Speed and color rendition are being worked on. One monitor supplier feels that liquid crystal devices are best suited to projectors, and that electro-luminescent devices are the best bet for flat panel displays.

A Japanese manufacturer is doing research on liquid crystal and plasma displays. Plasma panels are inefficient, and the small (6 inch) LCD panels lack brightness and resolution. Large LCD panels will take about 10 more years to work. It is not expected that LCD or plasma panels will become practical flat display devices in the near future.

There was an announcement of an "efficient projector" based on a beam index tube called an Indextron. As of yet there has been no mention of resolution or quality.

A relatively rough projection lens can be finished with a precision molded layer of plastic. This gives good performance at lower cost. Digital convergence and linearity correction circuitry can cure the geometry problems in projectors, however brightness is still a problem.

There is a good chance of having a 40 inch projection or direct view display within 3 years. Some individuals believe that an 800 (or so) line, progressive scan system is a better system solution than the higher line number interlaced systems being proposed. No matter which high definition system is adopted, the large format displays will be the device that generates the demand for the new service.

A monitor supplier currently has computer displays working at the line scan frequencies of 64 KHz and video signals up to 100 MHz and are working towards boosting this to 200 MHz. Present horizontal drivers do operate at 64 kHz, but not realiably. The speed and power levels required currently cause interference problems, which must be solved.

There is a new display technology being developed by Tektronix. If successful, it will be announced in the fall of 1985. The concept will be used in test and measurement equipment as well as in display devices.

3.8.3 High Definition Broadcast

Current research and development activities in displays have been discussed under section 3.8.2, High Definition Electronic Production.

3.8.4 Extended Definition Television

Current research and development activities in displays have been discussed under section 3.8.2, High Definition Electronic Production.

3.8.5 Improved PAL/NTSC

Current research and development activities in displays have been discussed under section 3.8.2, High Definition Electronic Production.

3.9 Consumer Products

3.9.1 Overview

The survey of research activities in other television consumer products found that:

- Modular receiver systems, built around a smart monitor, will allow the consumer economical access to a variety of services.
- A MUSE/DBS receiver, videotape and disk machines, and display devices will likely be available in 1989.
- Tape may well be the first distribution method available for wide screen, high definition material.

3.9.2 High Definition Broadcast

New television sets are appearing in the form of modules. The display device (CRT or projector) will have RGB or some other component input. It will be fed by a demodulator/decoder that is in turn fed by a cable tuner, satellite receiver, etc. New modules can be added as they are required.

Two Japanese manufacturers are developing a line of DBS/MUSE receivers, disk players, VTRs and displays for introduction in 1989. European suppliers have been hampered in building DBS receivers by the IBA license fee.

Projectors are expected to be available in 1988. Flat panel displays (LCD or electroluminescent) will not appear on the market for eight to ten years. The light valve approach is best for serious projectors. The EBU MAC signal will include a signal format code that can be used by a smart receiver to set the proper demultiplexing parameters. This will allow one receiver to work with several different types of signal.

Set top DBS convertors with RGB outputs are being built in Europe.

3.10 Addendum

This subsection includes further detailed notes and thoughts obtained from this CBC state-of-the-art review:

- The German broadcasters think that by adopting the 1125 line 60 Hz (NHK) HDTV standard, they will be able to sell programs in the huge US market. The technical community expects that the political forces will make this happen. After about two years, however, they expect that this 'standard' will yield to a more realistic system. Before settling on a standard, they want to investigate field rate, new (ie. CCD) pickup devices, colorimetry, transfer characteristics, and coding;
- German industry is looking to HDTV as a way of regaining the 60,000 jobs lost in the TV receiver field in the last few years. They do not want to adopt the Japanese standards and hand the equipment (and receiver) market to them. The broadcasters do not seem to be looking past their own market;

- European manufacturers are trying to develop a new TV system that will generate a new receiver market. While Japan is going the non-compatible route with the MUSE HDTV proposal, other proposals are more compatible with existing standards;

- Many researchers feel that further R&D is required and do not want to rush into an HDTV standard;

- A European manufacturer would like to start with a 5x3 or 5.33x3 screen to attract more new buyers (the Visible Difference), using a E-MAC transmission system. This could also be beneficial for the Japanese, as they are the only source of wide tubes, and production equipment at present;

- The Japanese are not interested in an improved NTSC service in the long run, or in any of the extended television proposals. All the manufacturers have lined up behind the NHK proposal, and see it as the best way of developing a new market;

- A French group will research HDTV for the next four years. They believe that the next wave will be digital component studios. The signal will be distributed in digits to the transmission point, where it will be converted to the appropriate standard for transmission;

- Film may be the most abundant source of high quality material in the early days of HDTV (or IPAL/NTSC) broadcasting;

- One monitor manufacturer's attitude to the HDTV subject is that it may be a flashy, expensive system that few can afford for quite a while. They are concerned that the TV and computer display requirements are diverging; HDTV wants a 5 x 3 aspect ratio, while computer displays are tending to a square format. Ignoring the aspect ratio, the computer displays will lead the way to the high resolution, flicker free displays demanded by HDTV;

- A small research group claims to have done the theoretical work on a compatible high definition broadcast system. They would add about $10 to $20 worth of parts to (or modify a) standard receiver which would then be able to display a normal image or a high definition image when it received their signal. The modification is retrofittable. This report is based on a press release and an interview with a non technical spokesperson. The technical details of their proposed system are not available;

- A large satellite operator expects that the majority of US homes will have cable service in the near future, and that the average viewer will want better sound and visual quality than at present. They are also of the opinion that "millions" of viewers will invest "as much as a new car" is worth to have a "mini theatre" entertainment/information center in their homes;

- There is also interest in HDTV from outside the television industry because of the possible impact on flight simulator and avionic information display work. There is a strong feeling that a relatively high line number, progressive scan system is the right way to go (the computer displays they use are all progressive scan). Any drawbacks of progressive scan systems will be solved by new pickup and display devices. There will be a demonstration of an 800 line, 60 Hz progressive scan system in '85. Fiber optic systems, projection displays, probably based on laser or LCD devices and electronic cinematography could also be useful for these applications. There should also be a strong market for HDTV products in the medical research and educational broadcasting fields;

- Several manufacturers are promoting their extended definition wide screen systems, even though it will be about five years before the market even exists, and probably another five years before it really develops. They feel that the wide aspect ratio and compatibility with existing NTSC or PAL receivers are essential to its eventual success;

- The general feeling in Europe and America is that the display is very important to the success of HDTV. It should be bright, with more than about 800 lines of resolution, have an aspect ratio near 5:3 and be about 1/2 sq. meter in area. Compatibility with existing NTSC or PAL receivers is essential to the introduction of a new service. The backlash against the MUSE system proposal is an indication that the compatibility and interlace issues have not been explored to everyone's satisfaction;

- One major American receiver manufacturer did not participate in the survey, beyond saying that they were watching all the developments, and would respond to consumer desires when the time comes;

- A manufacturer plans to supply test and measurement equipment for HDTV. They fear that some intermediate standard may appear shortly, then be superceded by another fairly quickly. They see a rush towards a standard, with very little involvement of the HDTV program producers and consumers. More industry involvement, or even a legislated technical standard, could avoid a false start;

- In developing the B-MAC system the speed and capacity of switching devices and memories was increased. These devices and A/D convertors have improved as a result of close work with suppliers;

- NHK has originated all the Japanese research in HDTV. Their objective has been to i) launch a new service that will generate new licence fees for themselves ii) and to provide a replacement for the saturated NTSC/PAL receiver market for the Japanese set manufacturers. To this end, they have active research programs from the pickup devices through to the recording and display devices. They have also awarded research and development contracts to the Japanese private sector. NHK has chosen a noncompatible format for their HDTV signal to support these aims and, for obvious reasons, is being backed by the manufacturers. The HDTV service will start in 1989-1990 using MUSE coding on one transponder of the BS4 satellite. Full bandwidth service will start in the mid 1990s using a 22 GHz transponder on the BS5 satellite. NHK plans to introduce the service in commercial locations. Consumer demand will slowly build until the HDTV service takes over from the current NTSC network in 2000 or 2005. The NTSC service will become the 'AM' service;

- CBS hope that the large screen display and 5:3 aspect ratio of the HDTV diaplay will be sufficiently alluring to create a strong demand for the service. They plan to make the transition to HDTV more palatable by pursuing a two channel transmission system. One channel will carry a signal for conventional sets; HDTV receivers will use both channels. A DBS HDTV service would require two transponders;

- Sony is also supporting the 1125 line, 60 Hz field rate, 2:1 interlace HDTV system. Their large light valve projection systems use a 5.33:3 aspect ratio. They are not particularly concerned about compatibility issues and would very much like to see the 1125 line system adopted as a world standard. They feel that the HDTV market will not take off without an accepted signal standard, and that this one can be implemented with existing technology.

3.11 Conclusions

A chart summarizing the development status of key new television products and components is provided in Exhibit 3-2. This section will examine the possibility of implementing each of the three proposed new television services. The first of these is the Improved NTSC/PAL approach that uses some of the techniques that are being developed for high definition television to reduce or eliminate some of the problems of the existing systems. The second new service is extended definition television and the third is high definition television. The High Definition (HDTV) system provides a wider image than normal (with an aspect ratio of about 5:3, depending on the details of the proposal). The Extended Definition (EDTV) proposals provide either 4:3 (standard) or wide screen aspect ratios and do so with a signal that is at least partially compatible with the existing scanning standards. High definition systems use new signal formats.

The implementation of any new television service resolves itself into two major tasks.. The first is the production of the material, and the second is its distribution. The developments and the outstanding requirements in each of these areas will be examined.

For any new improved quality consumer service, the source material in the studios must, of necessity, have greatly improved quality and support the aspect ratio, colorimetry of the downstream systems. It therefore seems probable that a high definition studio system will rapidly emerge with distribution by high definition tape and disk.

Exhibit 3-2

TV Technology Highlights

RESEARCH & DEVELOPMENT - CURRENT STATUS

	PRELIMINARY RESEARCH	**INITIAL DESIGN/ PROTOTYPES**	**FIRST MODELS AVAILABLE IN MARKETPLACE**	**CURRENT RESEARCH ACTIVITY**
STUDIO SYSTEMS				
● Image Sources				
Cameras		HDTV: Cameras - (Research on saticon tubes to improve temporal response)		Japan
		- (Charged coupled arrays to reduce lag and smear)		Japan/US/France
Telecine Chains		HDTV: Telecine (Will wait for standards) (70mm now available)		Japan/France
● Signal Processing				
Video Switchers		Digital switchers: will preceed HDTV		Japan/US
	HDTV switchers: VLSI cross points, optical gain elements/blocks require research			Japan/US/France

▪▪▪▪▪▪▪▪ Time line indicating current development status

TV Technology Status Highlights
(continued)

RESEARCH & DEVELOPMENT - CURRENT STATUS				
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY
STANDARDS CONVERTERS FOR TRANSMISSION	Awaiting standards developments			
● Tape and Disc Recorder **VTRs**		▪▪▪▪▪▪▪▪ HDTV VTR: analogue available	▪▪▪▪▪▪▪▪	Japan
	▪▪▪▪▪▪▪▪ (Digital: (Key to A/D studio conversion) - research to increase data storage capacity from 120 minute max)	▪▪▪▪▪▪▪▪		Japan
Optical Disc	▪▪▪▪▪▪▪▪ (Optical tape: development for data storage)	▪▪▪▪▪▪▪▪		Canada
	▪▪▪▪▪▪▪▪ Optical Disc: research to increase storage capacity from 10 minuite max	▪		Japan/US

▪▪▪▪▪▪▪▪▪▪▪▪ Time line indicating current development status

TV Technology Highlights
(continued)

RESEARCH & DEVELOPMENT - CURRENT STATUS				
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY
NETWORK BROADCAST/ TRANSMISSION				
• Digital Transmission/ Signal Processing	▬▬▬▬▬▬ - Little work on codecs for A/D conversion - Some research on motion detection alogrithms - research required on optical switchers for fibre transmission	▬▬		Japan, Germany
Analogue Component		▬▬▬▬▬▬ (C-MAC, B-MAC D2-MAC etc)	▬▬▬▬ (1985 B-MAC installation Australia)	Canada, UK, Germany, US
Enhanced Analogue Component	Research for evolution to wide aspect ratio	▬▬▬▬▬▬	▬▬	Canada, Germany
Bandwidth Reduced HDTV				
1 channel	▬▬▬▬▬▬ (MUSE - Expo 86 trial)	▬▬▬▬▬▬		Japan
2 channel	▬▬▬▬▬▬ CBS 2 channel component based on-going research; lab demos	▬		US, Germany
	▬▬▬▬▬▬ Philips NTSC 2 channel proposal at conceptual stage	▬▬		US

▬▬▬▬ Time line indicating current development status

TV Technology Highlights
(continued)

RESEARCH & DEVELOPMENT – CURRENT STATUS				
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY
IMPROVED CONSUMER PRODUCTS				
● Receivers Line Store			■■■■■■■■■■ (comb filters available now 2 chip set with ghost cancellation & 3 lines of memory – 1985 introduction)	US, Japan, Germany
Field Storage	■■■■■■ (Research on image processing awaiting reduction of cost of memory)	■■■■■■		Japan, Germany, Holland
Frame Storage	■■■■■■■■■■ (MUSE preliminary prototype receiver generated – 1989 introduction ? cost of frame store $10 in 1989?)	■■■■■■■■■■		Japan, Germany, Holland
● Displays 30"-40" CRT wide aspect ratio)	■■■■■■ (Research to improve brightness available within 3 yrs?)	■■■■■■		Japan, US

■■■■■■■■■■ Time line indicating current development status

TV Technology Highlights
(continued)

RESEARCH & DEVELOPMENT - CURRENT STATUS

	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY
HDTV Projection	▬▬▬▬▬▬ (Research to improve lens and envelope effects - 1m high available within 3 yrs?)	▬▬▬▬▬▬		Holland
Flat Panel	▬▬▬▬▬ (LCD's lack brightness/resolution plasma - inefficient gas discharge - max size of prototype - 16")			Japan, US
● Other Products **VCRs**	(No significant R&D - spinoffs expected from component VTRs)			
Videodisc	(To follow studio video discs)			

▬▬▬▬▬▬ Time line indicating current development status

Satellite, terrestrial broadcast, etc will follow soon afterward as soon as the consumer equipment base to support them is available.

In industrial and institutional applications, the terminal costs are not as important. EDTV and HDTV could thus begin operation as soon as the application justifies the investment. Likely areas of interest are training, simulation, and medical imaging applications.

From the distribution point of view, the choice of Improved NTSC/PAL, EDTV or HDTV will depend strongly on the consumer economics prevalent at the time.

3.11.1 Improved PAL/NTSC

Production

Improved PAL or NTSC signals can be generated from several sources. There are several methods of producing a signal for an improved system. One possible method is to down convert an HDTV signal, if that HDTV signal is hierarchically related to PAL/NTSC signal being produced. Another proposal takes the signal from a 525 or 625 line progressive scan, 4:3 aspect ratio camera, and filters this signal to eliminate the vertical aliasing and cross effects in the final 2:1 interlaced signal. The high frequency detail information modulates a second subcarrier and is recovered in the receiver in this scheme. Alternatively, great improvements can be made with processing in the receivers to eliminate the decoder and display related errors of present receivers.

Challenges

- Reduce the cost of high definition sources. HDTV cameras currently cost 2 to 3 times as much as a standard camera, because they are built from discrete components. Integrated circuits fast enough do not exist yet. Lenses must be faster (larger) and more accurate. The pick up tubes are not sensitive enough and have poor temporal response.
- Develop the signal processing chips required for the filtering and interpolation schemes proposed.

The rest of the production processes for an Improved PAL/NTSC system are unchanged. The same production switchers, recorders etc. can be used, providing that they do not reprocess the signal and reintroduce artifacts that were eliminated earlier.

Distribution

The improved systems leave the broadcaster and cable operator with their distribution facilities intact. The existing network and transmission equipment is compatible with the 'improved' signals. The difference is in the receiver. To take advantage of the potential image quality, the transmitted signal is processed in a "smart" receiver.

The top-of-the-line receivers are now using comb filters to reduce cross color effects. This basic processing will be extended to noise and cross luminance reduction using filters based on a three line memory. Another receiver is using adaptive filters (based on CCD memories) for ghost reduction.

These are examples of some of the improvements that can be made by fairly primitive smart receivers. The full implications will be realized when adaptive filtering and processing techniques based on frame memories are developed.

The following challenges and milestones are included here since the memory and signal processing techniques referred to will probably be heavily used in improved PAL and NTSC receivers.

Challenges

- Develop multiple field or frame sized memories, and the processing and support chips to go with them.
- Develop motion detection algorithms to drive adaptive filters and progressive scan (deinterlace) converters.
- Broadcasters should decide if they want to use the improved version of the existing system with their existing distribution facilities, or wait for new distribution channels for the 'wide screen' signals.

Milestones

- Video memories in 64, 256 and 308 kilobit capacities are available now. Note that one frame of NTSC requires about 400 kilobytes of memory.
- One field of memory will cost about $14 in 1989.
- Smart receivers with at least one frame of memory will be available in late 1987. They will cost 30% to 40% more than present receivers.
- One signal processing chip was announced last year. Others are "under development", and may be announced by 1987.

3.11.2 Extended Definition Television

Production

The same signal sources are used for extended definition television as for high definition television. The difference is in the ways the signals are processed before transmission. An EDTV service uses a 625 line, 50 Hz or a 525 line, 60 Hz scanning standard, but uses new modulation schemes to improve the system performance.

High definition telecines and slide scanners that provide adequate signals have been demonstrated, but the temporal response of the live cameras available is not good enough for some of the proposed interpolation schemes (ie. deinterlacing) to really work well.

The intelligent choice of a signal format should take into account the performance of the image pick up device. Unfortunately, these are not expected to appear until 1990 to 1992. The rest of the production chain, such as the switchers, special effects units and digital tape recorders, are partially in limbo until the signal format is decided upon. A component analogue production chain has been proposed as a solution to this problem. A component analogue production switcher, for example, has already been shown. The advantages of the digital production process would be lost. At the end of the production process, the signal could be converted into the most convenient format for the next step.

35 mm film may be a good source of high quality material during the initial stages of a high or extended definition service.

Challenges

- Develop a signal format to stimulate developments in other parts of the production chain. A hierarchy of signals developed from CCIR Recommendation 601 has been suggested.
- Develop or simulate live signal sources with good temporal response to help with the selection of a signal format.
- Reduce the cost of high definition sources. HDTV cameras currently cost 2 to 3 times as much as a standard camera, because they are built from discrete components. Integrated circuits fast enough do not exist yet. Lenses must be faster and more accurate.
- Develop the signal processing chips required for the filtering and interpolation schemes proposed.

Milestones

- A high definition digital tape recorder has been shown in prototype form. It will be available in five to seven years. Other announcements quote availability dates between 1990 and 1993. Prototype analogue HDTV recorders, using FM modulation, are available.
- Erasable optical disk data recorders will be introduced in later 1985, with the television version "to follow shortly". Capacities in the order of ten minutes of high definition material would make these first machines interesting for editing applications.
- Consumer level high definition projectors will be available in 1988. Prototypes of higher cost professional projectors have already been demonstrated.

Distribution

None of the broadcasters' existing distribution channels are suitable for an extended definition television service. Several schemes have been proposed that use one channel of a conventional cable system for a "compatible" signal and a second channel for the additional information required to create the wide screen, high definition image. The same concept could be used with two DBS channels. The main problem is delivery of the signal to the cable head end. The advantage of the two channel proposals is that the compatible channel can be used by conventional receivers.

European DBS service will likely start in 1986, using a MAC signal format (for the French service). This is, technically, an extended definition service, even though it does not give a wide screen image. The E-MAC proposal could add the wide screen feature. The EBU MAC signal format includes a coding ID signal that would allow smart receivers to select the appropriate decoder and display format.

Some sources say that an American DBS service may start in two years, with a MAC signal.

Challenges

- Do more psychophysical research to help develop the most efficient bandwidth reduction methods.
- Develop multiple field or frame sized memories, and the processing and support chips to go with them.
- Determine the practicality of multi channel cable distribution.
- Develop motion detection algorithms to drive adaptive filters and progressive scan (deinterlace) converters.

Milestones

- European DBS service will start in 1986, with MAC transmission.
- Video memories in 64, 256 and 208 kilobit capacities are available now. Note that one frame of NTSC requires about 400 kilobytes of memory.
- One field of memory will cost about $14 in 1989.
- One signal processing chip was announced last year. Others are "under development", and may be announced by 1987.

3.11.3 High Definition Television

Production

HDTV has been proposed in a number of distinct guises:

a) As a source medium for film production,

b) As a release medium for films to cinemas,

c) As a universal TV studio production standard for later conversion to the appropriate national broadcast standard.

d) As a consumer level entertainment medium, with initial distribution by tape and later by optical disk, fiber optic cable network and finally by satellite broadcast.

At the present time, the principal effort in Japan and in a large US entertainment conglomerate is focused on (d), in the short term, with (a) through (c) as secondary issues. This has resulted in large economic and political pressures being brought to bear on the generation of standards with attendant large risks of inadequate technical evaluation. In Europe, HDTV is viewed as a source for EDTV and hence the attention is focused on compatibility, standards conversion, distribution and receivers. Improvements in lenses, pick-up tubes and display equipment made for HDTV are also influencing new equipment designs for conventional 525 and 625 line system designs.

It seems likely that HDTV production will start with the NHK 1125 line, 60 field, 2:1 interlace and 5:3 aspect ratio. It will be aimed at consumer material where the lack of conversion from camera to receiver may offset the disadvantages in compatibility and production quality. For more critical applications, other standards based on sequential scanning are likely to evolve.

Challenges

Even though a lot of progress has been made and improved conversion equipment has been demonstrated in the lab, the following problems remain:

- Compatibility with 60 Hz systems such as PAL, SECAM and DBS C-MAC. The January 1985 demonstration of a motion adaptive conversion algorithm does not completely resolve the economic or technical difficulties.
- Present display systems are relatively low resolution and mask the defects of an interlaced scan system. As the displays improve to show the available HDTV performance, very costly converters will be required in each receiver to eliminate these defects.
- Camera tubes have inadequate spatial and temporal response. The sensitivity also needs improvement. CCD arrays may solve these problems, but are a large development and economic risk.
- Optical devices and lenses need great improvement, but are near the limits of current technology already.
- Digital recording and processing at 400 to 600 Mbits per second is not a trivial problem.

Distribution

A High Definition service requires new distribution channels. One of the major reasons for developing the high definition concept was to develop a new consumer marketplace. An incompatible television system would give the Japanese another opportunity to attack the 60% share of the 'high end' receiver market still held by the American manufacturers.

A DBS service is the preferred distribution method. The wide bandwidth HDTV signal requires sophisticated bandwidth compression schemes to fit the signal into a 27 MHz wide transponder. Japan will run DBS trials, using a MUSE coded signal from now until 1989. There are also experiments aimed at putting a full bandwidth high definition signal on a 22 GHz transponder in about 1995.

Kinerecordings on 35 mm film may be a good way of distributing HDTV material among broadcasters. 35 mm film is currently the most universal interchange media. Tape is the other possible distribution method. MUSE coded VCRs and video disk players will be on the consumer market in 1989.

Challenges

- Do more psychophysical research to help develop the most efficient bandwidth reduction methods.
- Develop multiple field or frame sized memories, and the processing and support chips to go with them.

- Develop motion detection algorithms to drive adaptive filters and progressive scan (deinterlace) converters.

- Develop a display device capable of creating a 1 to 2 square meter image with enough resolution and accuracy to match the capability of the HDTV system.

Milestones

- Video memories in 64, 256 and 208 kilobit capacities are available now. Note that one frame of NTSC requires about 400 kilobytes of memory.

- One field of memory will cost about $14 in 1989.

- One signal processing chip was announced last year. Others are "under development", and may be announced by 1987.

- DBS receivers, VCRs and video disk players for MUSE coded signals will be on the consumer market in 1980.

4.0 TECHNOLOGY FORECASTS

This section describes the Delphi survey approach to the preparation of a technology forecast, and forecasts the development of future TV technologies based on the results of the survey.

4.1 Methodology

As seen in the state-of-the-art review, within the television community, several schools of thought are currently being pursued for the development of possible enhanced and high definition television services, with several diverse opinions existing regarding the technological outcome of these developments. For this reason, it would be difficult to predict when any one particular television technology would be sufficiently advanced and available in the marketplace based solely on discussion or conjecture. A forecasting method known as the Delphi Technique has come to be accepted as a valuable method of systematically obtaining expert opinion on future events.

4.1.1 Survey Technique

The Delphi technique is used to obtain expert advice anonymously by asking specific questions on future technological events, collating the information, and then feeding back the results to each participant to obtain reaction to the results from the first round. The results of the second round are then collated to indicate areas of consensus and divergence. Essentially the Delphi forecasting technique lets the expert put together the technological forecast through convergence of the experts responses. (If a clear divergence of opinion exists it can indicate where high risk technical areas lie.)

The Delphi survey technique is particularly well suited for forecasting in the field of television technologies as it provides to individual experts in the field who are dispersed throughout the world, insight of others who have different perspectives of the various aspects of television technologies.

4.1.2 Sample and Questionnaire Design

The experts asked to participate in this television technology forecasting exercise were drawn from those individuals who are involved in some aspect of television technology standardization and/or development, who maintain good contact with industry and institutional research and development laboratories, both nationally and internationally. Sixty-five individuals were approached, with an excellant rate of participation achieved - 35 respondents. Exhibit 4-1 provides a list of the Delphi forecast participants. Respondents provided representation from Canada, the United States, England, France, Germany, Japan and Australia.

The questionnaire (see Appendix A) was structured to elicit responses on potential evolutionary and 'step' changes in TV technology within the context of improvements within existing systems, production, new transmission formats and related products. Respondents were requested to indicate the probability of various developments occuring by the years 1985, 1990, 1995 and 2000, using a percentage scale of 0 to 100 where 0% means impossible, 100% means certain and 50% means 'a 50-50 chance' of the particular development occuring. Where relative convergence of opinion was obtained, the median of the responses is used to indicate the joint forecasted probability of entry points and development paths for the various products and services.

Exhibit 4-1

TV Technology Delphi Forecast Participants

Annegarn, Marcel	Philips Research Labs	Eindhoven, Netherlands
Chouinard, G.	Communications Research Center	Ottawa, Ontario, Canada
Day, A.G.	Canadian Association of Broadcasters	Ottawa, Ontario, Canada
Favreau, M.	Thomson Video Equipment	Gennevilliers Cedex, France
Felix, M.	Ampex Corporation	Redwood City, CA, USA
Glenn, E.E.	New York Institute of Technology	Dania, FL, USA
Goody, L.C.	Telecom Canada	Ottawa, Ontario, Canada
Gressman, Rudy	European Broadcasting Union	Brussels, Belgium
Hamilton-Piercy, Nick	Cablesystems Engineering	London, Ontario, Canada
Hara, Dr. E.	Department of Communications	Ottawa, Ontario, Canada
Johnson, Tim	Ovum Limited	London, England
Kimura, Dr. Tatsuya	Mushashino Elect. Communications Lab	Tokyo, Japan
Kline, D.D.	Panavision Electronics	Tarzana, CA, USA
Kohler, Dr. T.R.	Philips Laboratories	Briarcliff Manor, N.Y., USA
Koyama, Dr. Masaki	Nippon Telegraph & Telephone	Yokosuka E.C.L. Yokosuka-shi, Japan
Mathias, H.	Panavision Inc.	Tarzana, CA, USA
Nasse, D.	CCETT	Cesson Sevigne, France
O'Reilly, R.	Canadian Broadcasting Corporation	Ottawa, Ontario, Canada
Parkinson, P.	Cable Telecommunications Research Institute	Ottawa, Ontario, Canada
Peek, Dr. R.H.	Philips International B.V.	Eindhoven, Netherlands
Poirier, Roger	CCTA	Ottawa, Ontario, Canada
Powers, Dr. K.H.	RCA Corporation	Princeton, N.J., USA
Quinn, S.F.	Canadian Broadcasting Corporation	Montreal, Quebec, Canada
Sabattier, J.	CCETT	Cesson Sevigne, France
Stenger, Dr. L.	Fl der DBP bein FTt, F115	AM Kavalleriesand 3 61 Darmstadt, FRG
Suzuki, Norio	NEC Corporation	Kanagawa, Japan
Tarnai, E.	Bell Northern Research	Ottawa, Ontario, Canada
Thiele, A.N.	Australian Broadcasting Corp.	Sydney, Australia
Thorpe, L.J.	Sony Broadcasting Company	Ridgewood, N.J., USA
Toth, Arpad	BNR Inc	North Carolina, USA
Walker, E.A.	Communications Research Centre	Ottawa, Ontario, Canada
Wedam, W.F.	RCA Laboratories	Princeton, N.J., USA
Wendland, Prof. Dr. B.	Lehrstuhl Fur Nachrichtentechnik	D-4600 Dortmund 50, FRG
Yamagishi, J.	Sony Corporation	Kanagawa-Ken, Japan
Yamamoto, Dr. H.	K.D.D. R&D Laboratories	Tokyo, Japan

A matter of particular concern in this exercise was ensuring that the answers provided would determine the likelihood of the 'take-off' point of a new product or service in the marketplace. Often considerable time lag can exist between when a technological innovation is completed in the research laboratory, to when a related product or service is available in the marketplace. To overcome this possible 'gap' in the forecast, respondents were asked when a particular product or service related to a specific technological development would be available in most outlet stores carrying 'high end' or an expensive line of products (in the case of consumer products), when a particular product would be widely utilized (in the case of broadcasting or motion picture industry), or when a particular service would be offered to consumers.

Each question which related to a particular event requested an explanation of any underlying assumptions for the responses, such as particular technological innovations which would be expected to either restrict or permit the resulting product or service to become viable.

4.1.3 Second Round

The first round questionnaire response data was processed to provide respondents with a feedback second round questionnaire containing:

- the median probability (ie. the middle response);
- the middle range of probabilities (ie. the 'interquartile range' - quartiles 2 and 3 - around the mean or average of the responses);
- the reasons for individual's answers which lie outside - both below and above - the interquartile range.

The respondents were then asked to examine the first round responses and adjust their initial response, if influenced by the first round set of responses. Results of the first round analysis are provided in Appendix B (final round results are summarized in this section).

Most of the questions requested probability of occurrence either by geographic region or country with participants instructed to respond for the area or areas with which they were most familiar. The majority of participants provided predictions for several or all of the regions addressed.

The following subsection provides a summary of the issues addressed in the Delphi survey.

4.2 The Delphi Survey Scope - Technologies Examined

In the Delphi survey for the forecasting of future television technologies, the possible introduction of key new products and services were addressed under the following major categories:

- Improvements within existing systems:

  The first set of questions were targetted at determining how far improvements in image will go as a result of new generation consumer television products. Products addressed in this section of the questionnaire included receivers and VCRs.

- Studio systems:

  The survey sought to determine the likelihood of the various products required for high definition television being purchased for use by major television producers. Equipment items included in the functional blocks under 'image sources', 'signal processing' and 'tape and disk recording' were addressed.

- <u>New transmission formats:</u>

  The questionnaire addressed the possible formats and transmission modes which could be adopted for network and broadcast transmission.

- <u>Related products:</u>

  The questionnaire also attempted to establish the likelihood of the introduction of various consumer products related to the new transmission formats discussed (receivers, displays and consumer product functional categories).

- <u>Applications:</u>

  To complete the possible evolutionary scenarios for higher definition television products and services, the potential for introduction of several service possibilities (like motion picture HDTV production, HDTV distribution of motion pictures to theatres via satellite, HDTV service to mini theatres, etc) was also included.

By indicating the expected probabilities of future implementation for the various higher definition products and services within the above categories, each respondent essentially prepared an individual technological forecast. By compiling all respondents forecasts, a composite forecast can be developed, with the median responses used as a proxy for the likely outcome of events. While complete convergence (ie. convergence of median and mean of the responses) was not achieved for all questions (due to a few responses out of the central range), generally the median responses provide a suitable benchmark for representing the majority of opinion expressed. Results of the joint forecast are <u>only opinions</u> and they reflect the views of those involved in <u>technological development</u>. However, they do provide excellent insight into this group's views of the future, and make a useful contribution to the development of market entry and evolutionary scenarios.

4.3 TV Technology Forecast

4.3.1 Highlights of the TV Technology Delphi Forecast

The overall consensus from the Delphi forecast indicates that the panel believes that there will be a growing trend over the next five to fifteen years towards higher definition television. Within some regions, consensus was achieved on the expected technologies to be adopted and implementation dates, while for other regions, the evolutionary path is not quite as clear.

Highlights of the Delphi forecast are provided graphically for each region in Exhibits 4-2 through 4-5. A brief discussion of these highlights is provided below with reference to the different evolutionary paths predicted in each major region.

Digital television will be making its way into the international marketplace throughout the next five to ten year period, with features and image improvements offered through increasingly complex picture manipulation capabilities. From the production side, opinion is that the majority of major broadcasters will follow a trend towards production quality improvement with most high definition production equipment components available and utilized for specialized production needs occuring in most regions as early as 1990. Popularity of HDTV production in the motion picture industry is also forecasted to grow over a ten to fifteen year period.

Exhibit 4-2

TV Technology Forecast Highlights - Japan

TELEVISION PRODUCT SERVICE	PROBABILITY OF AVAILABILITY IN MARKETPLACE			
YEAR	1985	1990	1995	2000
Digital Receivers				
- Line Storage	I	III	III	III
- Field Storage		I	II	III
- Frame Storage		I	II	III
Other Consumer Products				
- HDTV VCRS		I	II	III
- HDTV Projection Display			I	II
Purchase of HDTV Equipment for HDTV Production				
- HDTV Cameras		II	III	III
- Use of HDTV Equipment by Major Television Producers			I	III
Number of Hidef Services				
- More Than 1 Hidef Service To Home Consumer		I	II	III
- More Than 2			I	III
Distribution of Higher Definition Television				
- MUSE				
- DBS/SMATV		I	III	III
- Satellite to Cable (HDTV Distributed Directly to Consumer)			I	I
Other Services				
- Distribution Special Programs/ Feature Films to Mini Theatre			I	II
- Distribution Special Live Events to Movie/Mini Theatres			I	I
- Industrial and Institutional Use			I	II

LEGEND: Delphi forecast median probabilities:

I - 50-75%
II - 76-90%
III - 91-100%

NOTE: Median probabilities less than 50% not indicated

Exhibit 4-3

TV Technology Forecast Highights - Europe

TELEVISION PRODUCT SERVICE	PROBABILITY OF AVAILABILITY IN MARKETPLACE				
YEAR	1985	1990	1995	2000	
Digital Receivers					
- Line Storage		III	III	III	
- Field Storage		I	II	III	
- Frame Storage		I	II	III	
Other Consumer Products					
- HDTV VCRS		I	II	IIII	
- HDTV Projection Display			I	II	
Purchase of HDTV Equipment for HDTV Production					
- HDTV Cameras		I	II	III	
- Use of HDTV Equipment by Major Television Producers			I	II	
Number of Hidef Services					
- More Than 1 Higher Definition Service To Home Consumer			I	II	
- More Than 2				I	
Distribution of Higher Definition Television					
- Analogue Component Video					
- DBS/SMATV		I	I	II	U.K.
		I	I	II	W. Europe
- Satellite to Cable (Converted to Conventional Signal)		I	I	II	U.K.
		I	I	II	W. Europe
- Satellite to Cable (Analogue Component Video Distributed Directly to Consumer)			I	II	U.K.
		I	I	II	W. Europe
- Enhanced Analogue Component Video(EPCV)					
- DBS/SMATV			I	II	U.K.
			I	I	W. Europe
- Satellite to Cable (EACV Distributed Directly to Consumer)				I	U.K.
				I	W. Europe
- Bandwidth Reduced HDTV				I	
- DBS/SMATV				I	U.K.
				I	W. Europe
- Satellite to Cable (Converted to Conventional Signal)					U.K.
					W. Europe
- Satellite to Cable (HDTV Distributed Directly to Consumer)					U.K.
				I	W. Europe
Other Services					
- Distribution Special Programs/ Features Films to Mini Theatres				I	U.K.
				I	W. Europe
- Industrial and Institutional Use			I	III	

LEGEND: Delphi forecast median probabilities:

I - 50-75%
II - 76-90%
III - 91-100%

NOTE: Median probabilities less than 50% not indicated

Exhibit 4-4

TV Technology Forecast Highlights – **North America**

TELEVISION PRODUCT SERVICE	PROBABILITY OF AVAILABILITY IN MARKETPLACE				
YEAR	1985	1990	1995	2000	
Digital Receivers					
– Line Storage	I	III	III	III	
– Field Storage		I	II	III	
– Frame Storage		I	II	III	
Other Consumer Products					
– HDTV VCRS			I	III	
– HDTV Projection Display			I	II	
Purchase of HDTV Equipment for HDTV Production					
– HDTV Cameras		I	III	III	U.S.
		I	II	III	Canada
– Use of HDTV Equipment by Major Television Producers			I	II	
Number of Hidef Services					
– More Than 1 Higher Definition Service To Home Consumer			I	III	U.S.
			I	I	Canada
– More Than 2			I	II	U.S.
				I	Canada
Distribution of Higher Definition Television					
– Analogue Component Video					
– DBS/SMATV				I	U.S.
				I	Canada
– Satellite to Cable (Converted to Conventional signal)			I	I	U.S.
				I	Canada
– Satellite to Cable (Analogue Component Video Distributed Directly to Consumer)			I	I	U.S.
					Canada
– Enhanced Analogue Component Video					
– DBS/SMATV				I	U.S.
					Canada
–Bandwidth Reduced HDTV					
– DBS/SMATV				I	U.S.
				I	Canada
– Satellite to Cable (HDTV Distributed Directly to Consumer)				I	U.S.
					Canada
Other Services					
– Distribution Special Programs/ Features Films to Mini Theatres			I	II	U.S.
			I	I	Canada
– Industrial and Institutional Use			I	II	U.S.
			I	II	Canada

LEGEND: Delphi forecast median probabilities:

I – 50-75%
II – 76-90%
III – 91-100%

NOTE: Median probabilities less than 50% not indicated

Exhibit 4-5

TV Technology Forecast Highlights - Australia

TELEVISION PRODUCT SERVICE	PROBABILITY OF AVAILABILITY IN MARKETPLACE			
YEAR	1985	1990	1995	2000
Digital Receivers				
- Line Storage		II	III	III
- Field Storage		I	II	III
- Frame Storage		I	II	III
Other Consumer Products				
- HDTV VCRS				I
- HDTV Projection Display			I	II
Purchase of HDTV Equipment for HDTV Production				
- HDTV Cameras		I	II	III
- Use of HDTV Equipment by Major Television Producers			I	II
Number of Hidef Services				
- More Than 1 Higher Definition Service To Home Consumer			I	II
- More Than 2				I
Distribution of Higher Definition Television				
- Analogue Component Video				
- DBS		I	II	III
- Satellite to Cable (Converted to Conventional signal)		I	I	I
- Satellite to Cable (Analogue Component Video Distributed Directly to Consumer)				
Other Services				
- Distribution Special Programs/ Features Films to Mini Theatres				I
- Industrial and Institutional Use			I	III

LEGEND: Delphi forecast median probabilities:

I - 50-75%
II - 76-90%
III - 91-100%

NOTE: Median probabilities less than 50% not indicated

In Japan, the DBS MUSE (bandwidth reduced HDTV) trial scheduled for the fall of 1985 will likely have developed into a full fledged service offering to home consumers by 1990. In fact, the forecast points to more than one HDTV service to home viewers being offered. At the 1985 HDTV Colloquium held in Ottawa, Dr. Fujio of NHK announced plans to have a MUSE receiver and decoder available on the market retailing at $2500 (US) by 1989. Forecasts for higher definition services in the United Kingdom and Western Europe however show an evolutionary approach through initial adoption of an analogue component based system possibly as a DBS and/or satellite to cable service between 1990 and 1995. Evolution towards an extended definition service to home consumers is expected by 2000.

The forecasts developed by Delphi respondents for the North American market did not reflect a consensus indicating that a number of possible evolutionary scenarios exist.

While forecasts do indicate the expected availability of more than one higher definition service to home consumers between 1990 and 1995, possibly via both DBS and cable distribution, the dominant technology is not certain. Forecasts indicate possible early introduction of an analogue component based option with implementation of either an extended EDTV or bandwidth reduced HDTV option in some form within ten to fifteen years. The possibility for introduction of high definition services in the mini theatre market prior to consumer introduction, and/or video retail market, both in the United States and Canada was highly favoured.

The entry scenario for Australia reflects current implementation of the medium powered DBS service (using B-MAC) in the fall of 1985. No clear path towards higher definition services in Australia was suggested.

Complementing or preceding the introduction of higher definition service consumer products such as video cassette recorders and projection displays are also forecasted to be introduced over the mid to late 1990s.

4.3.2 Detailed Discussion of Delphi Survey Forecast Results

In the following subsection, a more detailed discussion of the Delphi forecast results is provided under the questionnaire headings. The underlying technical and market related issues influencing the possible introduction of the various television system components are discussed, with reference to information obtained in the state-of-the-art review, the median probabilities of occurrence determined from the Delphi responses and the numerous comments provided in the Delphi survey.

4.3.2.1 Improvements Within Existing Systems (Question 1.0)

To determine how far improvements will go within existing systems respondents were asked to predict when new generation receivers and VCRs with capabilities of increasing complexity would be available in most retail stores carrying 'high end' consumer television products. The medians of the responses for this category are provided in Exhibit 4-6.

Exhibit 4-6

Delphi Forecast Results

Improvements Within Existing Systems (Question 1.0)

% Likelihood of Product Availability in Marketplace

(Median of Responses)

		RECEIVERS					VCRs
			SPECIAL FEATURES				
Location	Year	Line Storage Capabilities	Picture in Picture	Teletext	Field Storage	Frame Storage	
Japan	1985	50	20	15	0	1	0
	1990	100	80	84	70	50	50
	1995	100	100	100	90	80	80
	2000	100	100	100	100	100	100
Europe	1985	40	10	95	0	0	0
	1990	95	80	100	55	50	50
	1995	100	99	100	90	80	80
	2000	100	100	100	100	100	100
North America	1985	50	10	10	0	0	0
	1990	100	80	50	50	50	40
	1995	100	100	99	90	80	70
	2000	100	100	100	100	100	95

The limiting constraints in the development of receiver products offering improvements in image quality and additional features will be the availability of digital chips - at required memory capacities and prices suitable for product introduction. The subjects covered are line storage capabilities, special features, and field/frame storage capabilities, and are discussed in turn below.

Line Storage Capabilities

The survey results indicate that receivers with line storage capabilities which will eliminate cross effects and ghosting will be available in the marketplace as early as the end of 1985 in Japan and North America (50% median probability with several supporting comments from manufacturers). Delphi responses for Europe indicate a time lag (20% median probability in 1985) or possible bypass of this product as the advantages offered by this capability are more apparent with NTSC than with PAL or SECAM transmission. This prediction was supported in the manufacturing interviews conducted in Task 1. During these interviews a Japanese manufacturer indicated that receivers with a 2 chip set adaptive ghost canceller will be on the market this year. Modular television sets with 3 lines of memory are also planned for introduction in 1985 by yet another manufacturer.

Special Features - Picture-in-picture

The majority of responses reflect the expectation that consumers will find 'features' very attractive thus the belief that options such as 'picture in picture', 'store and recall picture' and 'zoom' will be packaged with receivers having field and frame store capabilities as soon as LSI and VLSI chips are available in mass production. As indicated in the state-of-the-art review, laboratory demonstrations are expected shortly, with international introduction of receivers with 'picture in picture' features anticipated within the next five year period. As indicated in Exhibit 4-6 responses indicate median probabilities of 80% for introduction by 1990.

Special Features - Teletext

Teletext capabilities in receivers on the other hand, will be a common feature available in the European marketplace in 1985 where subtitling is required (95% median likelihood of occurrence). However, they will likely not be offered as a standalone feature in either Japan or North America (rather as part of feature packages offered in the new generation digital receivers as discussed below).

Field/Frame Storage Capabilities

The majority of responses indicate that receivers with field storage capabilities (2 Megabits of memory) could be available in the marketplace in 1990 (70% median probability in 1990 in Japan with Europe with North America possibly lagging as indicated with 55% and 50% likelihood), however several comments indicate that receivers with field store may be followed shortly or even bypassed by receivers offering additional capabilities as a result of full frame storage capacity (4 megabits of memory required).

Feedback from Delphi respondents in Japan reflect that the technology is currently under development in Japan (as these products will be required to complement the broadcast of the NHK HDTV system presently committed for experimental service trial in the fall of this year). Once the cost of the technology drops, products for use within current standards will also be available. In the Task 1 industry survey, a Japanese manufacturer conducting research on image processing chips predicted the cost of one frame of memory would fall to $10 (US) by 1989. In accordance with this prediction, Delphi responses indicate that introduction appears likely within the 1990 to 1995 time period with the median responses ranging from 50% likelihood in 1990 and approximately 80% likelihood in all countries by 1995.

VCRs With Full Bandwidth Composite Signal

As current video cassette recorders do not reproduce the full 4.8 MHz/6 MHz video signal, the potential exists for image improvements within current standards. The majority of Delphi responses, however, indicate that improvement in VCR image is not likely, except when complemented by higher definition formats and/or change in aspect ratio. Based on the comments provided, the 50% probability of introduction in Japan and Europe by 1990 and 75-80% likelihood by 1995, reflect the fact that these VCRs would not be PAL/NTSC/SECAM based. This expected outcome is also reflected in the Task 1 state-of-the-art survey, as no manufacturers indicated any current research on VCRs utilizing composite signals. However, development of component VTR's between 1990 and 1995 will generate spin-off improvements for conventional VCR's. Several Delphi respondents also believe that a new generation high definition

VCR could be a forerunner in the marketplace to the broadcast of higher definition services.

4.3.2.2 Studio Systems (Question 2.0)

It is generally believed that over the next few years major broadcasters will follow a trend towards improvement in television production quality. Initially this trend will involve replacement of retiring equipment with component and digital based items, with perhaps a special studio dedicated to specialized quality production. Some initial program origination and post production HDTV products (eg. cameras, monitors, VCRs, processors, edit controllers) are available from Sony at premium prices today. The state-of-the-art review indicates on-going research on major components which will be required for the HDTV studio. Respondents to the Delphi survey were asked for their predictions on when specific equipment items required for high definition production would be purchased by major broadcasters. Exhibit 4-7 provides the medians for the probabilities indicated for these studio system equipment items. Several comments expressed concern over standards adoption, with the likely outcome being several different standards in the various regions.

HDTV Cameras/Video Switchers/VTRs/Optical Links

Most comments provided state that it is expected that high definition cameras, video switchers and VTRs will be purchased initially as a package for specialized production by major broadcasters. These comments are supported by the response median probabilities of occurrence for all of these items, falling between 60% and 80% in most

Exhibit 4-7

Delphi Forecast Results

Studio Systems (Question 2.0)

% Likelihood of Product Utilization by Major Television Producers

(Median of Responses)

		PRODUCTS FOR HDTV PRODUCTION						
Location	Year	HDTV Cameras	Video Switchers & Special Effects	VTRs	Optical Disc Recorders	Telecine	Optical Links	Standards Converters for Transmission
Japan	1985	15	0	15	0	0	0	0
	1990	80	75	80	40	50	75	50
	1995	98	90	90	60	90	90	90
	2000	100	100	100	99	100	100	100
Europe	1985	5	0	0	0	0	5	0
	1990	70	60	70	20	40	60	45
	1995	90	85	90	50	60	80	90
	2000	100	99	100	90	100	100	99
United States	1985	20	10	20	0	0	10	0
	1990	70	70	70	30	50	80	50
	1995	95	90	94	50	90	90	90
	2000	100	100	100	99	100	100	100
Canada	1985	0	0	0	0	0	5	0
	1990	50	50	50	20	30	60	30
	1995	90	80	85	50	70	80	90
	2000	100	95	95	85	90	100	100

regions by 1990 (with Canada slightly less likely at approximately 50%).

The questionnaire did not address when digital HDTV VTRs would be utilized. The state-of-the-art review did reveal an experimental 460 Mb/s digital VTR now in existence. However, the general consensus is that FM analogue recording will be the route to HDTV recording developments for some time to come.

Optical Disc Recorders

It is generally predicted that VTRs will continue to provide for studio recording needs until long playing discs or optical tape recorders become available. During the state-of-the-art review, some activity was found in optical disk recorder research. While read-only optical disc players with a 10 minute capacity are used for specialized segments today (eg. at Lucus Films) most current research is focussing on optical disc and optical tape recorders for data storage. It is expected that after completion of the non-erasable data version recorders, research will move on to erasable systems and increasing storage capacity for NTSC, then HDTV, optical disc systems. As shown in Exhibit 4-7, Delphi responses only indicate a median probability of 60% in 1995 in Japan with other regions around 50%. By the year 2000 however, an 85% probability response reflects the general view that the technical difficulties associated with long playing optical discs for video use will have been resolved.

HDTV Telecine

Telecine's for conversion of 35 mm film to high definition video format are predicted to lag behind HDTV production equipment acceptance. As determined in the manufacturer interviews, the best field rate for high definition television has not yet been selected. While NHK currently has an experimental telecine based on 24 frames/sec, further work will follow after standards have been established. Median probabilities of occurrence 50% or less in all regions for introduction by 1990 reflect current uncertainties regarding the standards issue. The Delphi results predict that their use is more likely to be adopted in Japan and the United States between 1990 and 1995 (90% likelihood by 1995) than in Europe (60% likelihood by 1995).

HDTV Standards Convertors for Transmission

Several comments in both the manufacturer interviews and Delphi survey suggest that convertors for transmission will also likely follow higher definition production by three to four years after standards in the various regions have solidified. The median probabilities of approximately 50% in Japan, Europe and the United States in 1990 (with Canada at 30%) and all regions with a 90% median probability by 1995, reflect this lag.

4.3.2.3 New Transmission Formats (Question 3.0)

Not only are several different formats proposed for the delivery of higher definition television services but also a variety of options are available for the distribution medium which could be employed. The Delphi survey addressed the possible delivery options under each format proposed, as follows:

- Analogue Component Video
- Extended (or Enhanced) Analogue Component Video (EDTV)
- Bandwidth Reduced HDTV
- NTSC, PAL/SECAM Compatible 2 Channel Systems

In the survey, respondents were requested to indicate their views on the probability of a programming service being delivered utilizing these various transmission options. Each transmission format was subdivided by delivery option: DBS/SMATV, or satellite to cable (either converted at the cable head-end for conventional signal distribution or passed directly to the subscriber in the new format). The median responses for these various options are found in Exhibit 4-8.

Analogue Component Video - Enhanced Analogue Component Video - Bandwidth Reduced HDTV

As would be expected (due to the differing thrusts towards higher definition television in some of the regions), a marked difference was realized in the Delphi responses for the implementation of analogue component based proposals versus the Japanese MUSE bandwidth reduced HDTV proposal - for the different regions. To facilitate the development of implementation scenarios, the Delphi responses for Questions 3.2 through 3.4 are discussed under the following regions: Japan, United Kingdom, Western Europe, United States, Canada, and Australia.

Exhibit 4-8

Delphi Forecast Results

New Transmission Formats (Question 3.0)

% Likelihood of EDTV/HDTV Broadcast
(Median of Responses)

SYSTEM	DISTRIBUTION MEDIUM	FORMAT	YEAR	JAPAN	UNITED KINGDOM	WESTERN EUROPE	UNITED STATES	CANADA	AUSTRALIA
NTSC, PAL/ SECAM Compatible 2 Channel Systems	DBS/SMATV		1990	0	0	0	10	0	0
			1995	5	5	5	10	10	0
			2000	10	10	5	10	5	0
	Satellite to cable		1990	0	0	0	10	0	0
			1995	0	10	10	20	10	0
			2000	5	10	10	20	10	0
Analogue Component Video (eg. MAC)	DBS		1990	10	50	50	30	5	50
			1995	10	70	70	40	30	80
			2000	15	90	90	50	50	100
	Satellite to cable - converted at cable head-end to conventional NTSC/PAL/SECAM signal		1990	5	50	50	40	20	20
			1995	10	70	60	60	30	70
			2000	10	80	80	60	50	60
	Satellite to cable - video analogue component signal distributed directly to subscribers		1990	0	25	50	20	20	0
			1995	10	75	75	50	30	30
			2000	10	80	80	75	40	40
		C-MAC or equivalent		0	50	30	0	0	0
		B-MAC or equivalent		10	50	70	70	50	100
		Other		0	10	10	20	10	0

New Transmission Formats (Question 3.0) (continued)

DISTRIBUTION SYSTEM	MEDIUM	FORMAT	YEAR	JAPAN	UNITED KINGDOM	WESTERN EUROPE	UNITED STATES	CANADA	AUSTRALIA
Enhanced Analogue Component Video	DBS/SMATV		1990	0	20	25	10	0	0
			1995	10	50	50	30	10	0
			2000	20	80	75	50	10	0
	Satellite to cable - enhanced analogue component video signal distributed directly to subscribers		1990	0	20	20	10	0	0
			1995	0	40	40	30	10	0
			2000	0	55	60	50	20	0
	Other		1990	0	5	5	0	0	0
			1995	0	5	5	0	0	0
			2000	0	5	5	0	0	0
		4/3 aspect ratio		20	40	30	40	25	40
		5/3 aspect ratio		33	40	55	60	40	30
		Other		0	40	40	50	40	20

New Transmission Formats (Question 3.0) continued

DISTRIBUTION SYSTEM	MEDIUM	FORMAT	YEAR	JAPAN	UNITED KINGDOM	WESTERN EUROPE	UNITED STATES	CANADA	AUSTRALIA
Bandwidth Reduced HDTV	DBS/SMATV		1990	60	5	5	15	5	5
			1995	95	20	29	40	20	35
			2000	100	50	50	70	50	40
	Satellite to cable - signal from a compatible channel only distributed via cable to subscribers		1990	10	0	5	10	0	10
			1995	20	10	10	20	10	10
			2000	30	15	15	40	15	10
	Satellite to cable - HDTV distributed directly to subscribers		1990	20	0	0	0	0	5
			1995	40	20	20	20	10	35
			2000	70	40	40	60	30	40
	Other		1990	0	10	10	0	10	10
			1995	10	20	20	20	10	10
			2000	10	40	10	20	40	20
		MUSE		78	20	20	40	20	20
		CBS Format		0	0	0	10	10	0
		DBP/FTZ		0	0	30	0	0	0
		Other		30	80	50	50	60	25

Japan

Median responses for the implementation of an analogue component based system in Japan show less than a 10% chance of occurrence in all years (See Exhibit 4-8). Responses also indicate the chance of the implementation of any enhanced analogue component video system in Japan is also negligible. Responses from Delphi participants in Japan indicate a commitment to bandwidth reduced HDTV for national distribution, with no implementation of an analogue component based options anticipated. By 1990 responses provide a median 60% probability that a bandwidth reduced HDTV DBS service will be in place. An overwhelming 95% median probability of implementation is indicated by 1995. As indicated earlier this expectation is supported by the announcement of Dr. Fujio of NHK at the 1985 HDTV Colloquium that a full fledged 'MUSE' service to home consumers would be operational by 1989.

Satellite to cable distribution options for Japan did not receive significant support in early years, however median probabilities of responses at 70% for distribution of the bandwidth reduced HDTV signal directly to cable subscribers was determined for the 2000 period.

As would be anticipated, responses favour the bandwidth reduced HDTV transmission option with the median response at 78%.

United Kingdom

Delivery of an analogue component based DBS service may occur as early as 1990 (the median Delphi response was 50% for 1990, as shown in Exhibit 4-8). By 1995 however, most respondents expect this service will be in place (median response at 70%). The possibility of a satellite to cable distribution option was also favoured, with either conversion at the head-end to conventional signals or direct cable delivery of the analogue component signal to the subscriber. Responses were less optimistic that an enhanced analogue component system would be operational in early years, but expect an evolution to an extended definition system over the next ten to fifteen year period. Median probabilities of enhanced DBS implementation are 50% by 1995 and 80% by the year 2000. Cable delivery for an extended service was not as favoured, with a maximum median probability of implementation of 55% by the year 2000.

The median responses for adoption of a 4:3, 5:3 or 5.33:3 aspect ratio enhanced service were all 40%, indicating that no clear consensus exists among the respondents. At this time, opinions within the expert community favour several different possible MAC formats.

Implementation of a bandwidth reduced HDTV service in the UK received some support in later years (DBS delivery median at 50% for 2000) with some comments suggesting a possible move from enhanced systems to other systems providing further definition at that time.

Western Europe

As indicated in Exhibit 4-8, responses for Western Europe followed a similar pattern to those for the United Kingdom. While the first round responses had indicated a possible time lag for service implementation in Western Europe, the final responses converged with expectations similar to those for the United Kingdom.

United States

In the United States, where no national initiative for a higher definition television service has been put forward, it is still unclear which path towards higher definition services may be adopted. As indicated earlier, while CBS has been researching a 2 channel 'analogue component type' bandwidth reduced delivery proposal, the manufacturer interviews did not reflect any consensus to date within the industry. The uncertainty of this issue is reflected in the responses which do not clearly converge on any one scenario. In the 1990-1995 time frame respondents indicated that delivery of an analogue component service is anticipated (with median probabilities ranging from 40%-60%).

What is interesting to note, is that first round responses indicated an equal likelihood of an extended analogue component system existing in the year 2000 as a bandwidth reduced HDTV service (50-60% median probabilities). However, after the second round responses, the bandwidth reduced option was slightly favoured (50% median for enhanced analogue component system, while a 60%-70% median probability of a bandwidth reduced delivery option by 2000).

No clear conclusion can be drawn on the expected aspect ratio with median probabilities indicated as 40% and 60% for the 4:3 and 5:3 aspect ratio options respectively. As to the type of HDTV service, responses were also split between a MUSE based service and an 'other' option for a delivery scheme which has yet to be proposed.

Canada

Responses for the introduction of a higher definition service in Canada follow a similar pattern to those of the United States. All median probabilities for service implementation are slightly lower than for the United States, suggesting a possible few years time lag for the introduction of services in Canada.

As for the United States, no one delivery option was selected. Rather, respondents indicated that by 1995 several of the delivery options are possible, with median responses of 30-50% likelihood for analogue component and bandwidth reduced delivery scenarios suggested, by the year 2000.

Australia

As indicated by the state-of-the-art review and by Delphi respondents from Australia, a medium powered DBS service (using B-MAC) is scheduled for implementation in the fall of 1985 in Australia. While several respondents revised their responses after the second round of the survey, several other Delphi participants who may not have been aware of these plans in the first round, did not revise these responses. Thus, the median probabilities of 50% for implementation by 1990, and 75-80% for implementation by 1995 appear to be lower than expected.

NTSC, PAL/SECAM Compatible 2 Channel Systems

In the state-of-the-art review, some research interest was found in the area of 2 channel NTSC based systems. The premise behind this work is that a wide screen 2 channel service may provide an acceptable quality versus price compromise to home consumers. For example, Joseph Nadan of Philips in the United States suggests that this arrangement might be utilized for the last leg of delivery of higher definition services over cable television systems with conversion from an enhanced definition or HDTV signal received via satellite at the cable head-end. As NTSC, PAL/SECAM 2 channel systems do not offer improved quality for satellite video transmission (as analogue component transmission systems do), little interest (less than 10% median probability of occurrence) exists for this delivery option for DBS or SMATV use in the Delphi survey.

It was somewhat surprising that more interest in the delivery option for cable distribution was not shown by Delphi respondents. Marginal interest (10-20% probability) for implementation in the 1995-2000 time period was expressed. It is suggested that this result be treated with caution, as the majority of respondents may not be familiar with cable distribution issues.

4.3.2.4 **Related Products - (Question 4.0)**

To determine expected developments in consumer television products, respondents were asked to indicate their views on the possible availability of improved and new television products in most retail outlet stores by 1985, 1990, 1995 and 2000. Exhibits 4-9 and 4-10 provide a summary of the resulting median probabilities.

Exhibit 4-9

Delphi Forecast Results

Improvements to Existing Products (Question 4.0)

% Likelihood of Product Availability in Marketplace

(Median of Responses)

		IMPROVEMENTS TO EXISTING PRODUCTS		
FORMAT	YEAR	Video Cassette Recorders	Video Disc	Consumer Video Cameras
NTSC/PAL/SECAM 2 channel systems	1985	0	0	0
	1990	0	0	0
	1995	10	2	0
	2000	0	0	0
Analogue Component Systems	1985	0	0	0
	1990	20	20	10
	1995	50	50	30
	2000	60	50	50
Enhanced Analogue Component Systems	1985	0	0	0
	1990	20	10	10
	1995	40	40	10
	2000	50	50	20
Reduced Bandwidth HDTV	1985	0	0	0
	1990	10	10	5
	1995	30	35	20
	2000	50	50	30

Exhibit 4-10

Delphi Forecast Results

Display Devices

% Likelihood of Product Availability in Marketplace

(Median of Responses)

		DISPLAY DEVICES							
		CRTs		Projection Displays			Flat Panel		
		40" Diagonal	5/3 Aspect Ratio	Current CRT Quality	HDTV Quality	CRT Based	LCD Based	Gas Plasma	Other
	YEAR								
Not Indicated	1985	0	0	0	0	0	0	0	0
	1990	10	20	30	10	10	10	5	0
	1995	40	50	60	30	20	25	30	10
	2000	30	80	80	80	40	50	40	30

Improvements to Existing Products

As discussed under improvements within current standards, consensus among the experts is that VCR improvements will likely complement revised distribution formats (but could be format independent). For this reason there was some confusion among respondents on this question about when format specific VCRs would be in the marketplace. Comments provided in both the state-of-the-art survey and earlier in the question under current standards, indicate that spin-offs from research on component VCRs for studio use will greatly improve VCRs as early as 1990. During the 1990-1995 period, VCRs supporting higher definition will likely enter the marketplace (the median responses of 30%-50% in this question reflect respondents' uncertainty on which format will dominate). Respondents' views were divided between analogue component based systems and bandwidth reduced HDTV VCRs, with median probabilities for occurrence ranging between 30% and 50% by 1995 and 50%-60% by the year 2000.

Probabilities of the responses for video disc players were 35-50% in 1995 with a 50% likelihood indicated for the introduction of video disc record capability (either analogue component based or bandwidth reduced HDTV) by 2000. These responses appear consistent with the state-of-the-art interviews reflecting a slight lag for consumer product introduction behind studio products.

While analogue component video cameras for home consumer use achieved a median likelihood of 50% for introduction by 2000, other formats did not receive significant support from Delphi participants.

Display Devices

Several comments from Delphi participants suggest that the drive towards higher definition television services will be supported by consumer appetite for wider aspect ratio and larger screen display devices. Respondents are not terribly optimistic however, on early introduction of radically new display technologies in the marketplace, with none of the higher definition display devices receiving much support before 1995. This likely reflects the fact that higher definition display devices are still undergoing research with several technical difficulties yet to be overcome. In the state-of-the-art interviews, a few individuals however, suggest that 30"-40" wide screen CRTs and 1 metre high projection display (with improved RGB light sources) should be available as the first display devices for HDTV home viewing as early as 1990.

Several negative comments were received in the Delphi survey regarding widespread marketplace acceptance of 40" diagonal CRTs (as they are very cumbersome). A median probability of introduction of 40% in 1995 falls to 30% by the year 2000 (as shown in Exhibit 4-10) as improved projection displays and possibly flat panel displays were predicted to become available.

Most respondents predicted projection displays with significant improvements over current quality (with luminance and chrominance equivalent to current CRTs) will be available by 1995 (60% median probability), with support growing for availability within fifteen years (90% median probability by 2000). The availability of HDTV quality projection displays received marginal support for introduction by 1995 (40%) with expectations significantly higher by 2000 (80% median). These responses reflect an area of uncertainty within the technical community as to exactly when and which display product will provide higher definition to home consumers.

Although interest in the development of flat panel display options was expressed, several technical difficulties were raised in the Delphi survey. These difficulties were supported in the state-of-the-art review with all researchers pessimistic about achieving suitable plasma, LCD or gas discharge, large flat panel display within the next 10 years. Median Delphi responses reflect these expected obstacles, with all flat panel options receiving median responses of less than 50% by 2000.

4.3.2.5 Other Applications (Question 5.0)

As the possibility for several different entry scenarios for higher definition television services exists in each individual region, the last section of the Delphi survey was dedicated to the various applications and service options which may evolve.

Delivery of Higher Definition Television

Question 3 addressed the potential implementation of higher definition television services by technology option. This question sought to obtain respondents' opinions on the number of services which would likely be offered.

The median of responses achieved approximately a 50% median probability that more than one higher definition service would be available by 1990 in Japan, and 1995 in Europe, the United States and Canada. More than two services attained at least the same probability of existance with a five year time lag. The majority of responses expect the services will be programmed for a partial day initially, with 12 hours per day of higher definition programming expected by 1995 (see Exhibit 4-11).

Motion Picture Utilization

Within the next 10-15 years respondents expect use of high definition television production to become increasingly more popular within the motion picture industry (as can be seen in Exhibit 4-12, a 50% median probability was indicated for production of at least 15% of films by 1995, and 92% achieved by 2000).

Theatrical Distribution/display Via Satellite

One possible application suited to full bandwidth high definition television distribution involves the delivery of motion pictures to movie theatres via satellite.

Currently, projectors are not capable of HDTV projection on screens of 'movie theatre' size. However, respondents indicated current technical limitations will likely be overcome with availability of HDTV projectors for industrial use expected by as early as 1990 (median response at 50% for 1990 and 84% by 1995 - see Exhibit 4-13).

Exhibit 4-11

Delphi Forecast Results

Other Applications (Question 5.0)

% Likelihood of Hidef Delivery to Home Consumers

(Median of Responses)

	YEAR	NUMBER OF HOURS	JAPAN	EUROPE	US	CANADA
More than one hidef service to home consumers	1990		50	5	25	1
	1995		75	50	60	50
	2000		100	85	100	70
More than two hidef services to home consumers	1990		20	5	10	0
	1995		50	25	60	20
	2000		95	75	90	50
Minimum number of hours per day	1990	4				
	1995	12				
	2000	12				

Exhibit 4-12

Delphi Forecast Results

Other Applications (Question 5.0)

% Likelihood of Motion Picture HDTV Production
(Median of Responses)

	YEAR	PROBABILITY
HDTV motion picture production utilized widely	1990	30
	1995	50
	2000	80
Over 15% of feature films produced using HDTV	1990	20
	1995	50
	2000	92

Exhibit 4-13

Delphi Forecast Results

Other Applications (Question 5.0)

% Likelihood of Theatrical Distribution Via Satellite
(Median of Responses)

	YEAR	International	JAPAN	EUROPE	US	CANADA
HDTV projectors available	1990	50				
	1995	84				
	2000	100				
Theatrical distribution of feature films via satellite (over 15% of movie theatres)	1990		5	3	10	0
	1995		20	20	30	18
	2000		50	50	60	30
Storage for theatrical needs:						
- video recorders	1990	15				
	1995	50				
	2000	50				
- optical disc players	1990	10				
	1995	30				
	2000	50				
- optical disc recorders	1990	0				
	1995	15				
	2000	30				

The actual service application however did not receive overwhelming enthusiasm with median likelihood of existence ranging from 30%-60% throughout the various regions by the year 2000. Should downloading for a service of this nature be required, it is moderately likely that VTRs will be available in 1995 (50% median for 1995 and 2000). Comments also suggest a service could develop with high definition video cassette or video disc distribution. Video disc players may be available by the year 2000 (median response of 50%), however, once again respondents were not optimistic with respect to HDTV video disc machines with record options.

Distribution to Mini Theatres

As evident from Exhibit 4-14, the experts believe enhanced or HDTV service possibilities for special programming delivery to mini theatres, hotels, pubs and bars, exist with a median 60% likelihood of implementation in Japan, the United States and Canada by 1995. As noted in Exhibit 4-14, the possibility of at least one enhanced or high definition service for delivery of feature films to mini theatres also received some support from Delphi respondents. Introduction of these types of services in Europe however is not expected to be as likely.

Special Event Closed Circuit Distribution

Another service implementation possibility includes high definition video broadcasting of special live events via satellite to either movie or mini theatres. Commercial implementation of this service scenario achieved moderate support, with a 50% median response for Japanese and United States implementation by 1995 and implementation by 2000 between 45 and 75% in all regions.

Exhibit 4-14

Delphi Forecast Results

Other Applications (Question 5.0)

% Likelihood of HDTV Distribution to Mini Theatres

(Median of Responses)

	YEAR	JAPAN	EUROPE	US	CANADA
Special programming to mini theatres (hotels, bars, pubs) via satellite	1990	30	15	30	10
	1995	60	30	60	60
	2000	90	60	90	75
Feature films to mini theatres via satellite	1990	24	10	20	10
	1995	56	26	50	50
	2000	78	50	70	70
Live event broadcast to movie/mini theatres	1990	20	10	20	10
	1995	60	25	50	40
	2000	60	50	70	70

Industrial and Institutional Applications

Sales of closed circuit higher definition systems for special exhibits, training, etc, are predicted to exceed 200 systems per year in most regions before 1995. Median probabilities indicate over 70% chance of occurrence in most regions by 1995 (with Canada at 50%) and over 80% in all areas by 2000 (see Exhibit 4-15).

4.4 Summary - TV Technology Status and Forecast Highlights

The current status of TV technology review and the Delphi technology forecasts give a realistic sense of the technological forces behind the trends in TV and related video technologies. Exhibit 4-16 provides highlights of the Current Status review along with a relative sense of timing for market entry of key products and services as forecasted by Delphi participants. For the purpose of this summary, the Delphi median response of 50% (or greater) likelihood that the product or service will have entered the marketplace by the year shown, has been depicted for the various regions.

Through examination of these highlights, it is evident that development and market entry of certain components will likely precede others. With the advent of improved digital processing techniques and associate drop in processing cost, products at various evolutionary stages could coexist with relatively little inconvenience. For example, with improved A/D conversion both analogue and digital components can coexist in the studio, high definition production can be down converted to any one of the various transmission formats; and with increased memory and processing capabilities at the receiving end, consumer products could be

Exhibit 4-15

Delphi Forecast Results

Other Applications (Question 5.0)

% Likelihood of Industrial and Institutional HDTV Use

(Median of Responses)

	YEAR	JAPAN	EUROPE	US	CANADA
Industrial and institutional use (sales exceeding 200 systems per year)	1990	20	30	50	10
	1995	75	70	75	50
	2000	90	90	90	80

Exhibit 4-16

TV Technology Status and Forecast Highlights

	RESEARCH & DEVELOPMENT - CURRENT STATUS				TECHNOLOGY FORECAST (Delphi survey - 50% median probability of market entry)			
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY	1985	1990	1995	2000
STUDIO SYSTEMS								
o Image Sources								
Cameras		HDTV: Cameras - (Research on saticon tubes to improve temporal response) - (Charged coupled arrays to reduce lag and smear)		Japan Japan/US/France		J/E/NA		
Telecine Chains		HDTV: Telecine (Will wait for standards) (70mm now available)		Japan/France		J/NA	E	
o Signal Processing								
Video Switchers		Digital switchers: will preceed HDTV		Japan/US		J/E/NA		
	HDTV switchers: VLSI cross points, optical gain elements/blocks require research			Japan/US/France				

LEGEND - ——— Status of Development
J - Japan
E - Europe
NA - North America

TV Technology Status and Forecast Highlights (continued)

RESEARCH & DEVELOPMENT - CURRENT STATUS					TECHNOLOGY FORECAST (Delphi survey - 50% median probability of market entry)			
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY	1985	1990	1995	2000
STANDARDS CONVERTERS FOR TRANSMISSION	Awaiting standards developments					J/NA	E	
o Tape and Disc Recorder								
VTRs		HDTV VTR: analogue available		Japan		J/E/NA		
	Digital: (Key to A/D studio conversion - research to increase data storage capacity from 120 minute max)			Japan				
Optical Disc	Optical tape: development for data storage			Canada				
	Optical Disc: research to increase storage capacity from 10 minuite max			Japan/US			J/E/NA	

LEGEND - ———— Status of Development
J - Japan
E - Europe
NA - North America

TV Technology Status and Forecast Highlights
(continued)

	RESEARCH & DEVELOPMENT - CURRENT STATUS				TECHNOLOGY FORECAST (Delphi survey - 50% median probability of market entry)			
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY	1985	1990	1995	2000
NETWORK BROADCAST/ TRANSMISSION								
o Digital Transmission/ Signal Processing	- Little work on codecs for A/D conversion - Some research on motion detection alogrithms - research required on optical switchers for fibre transmission			Japan, Germany				
Analogue Component		(C-MAC, B-MAC D2-MAC etc)	(1985 B-MAC installation Australia)	Canada, UK, Germany US		E	NA (B-MAC favoured)	
Enhanced Analogue Component	Research for evolution to wide aspect ratio			Canada, Germany		E (wide aspect ratio favoured)		NA
Bandwidth Reduced HDTV					J			E/NA (no consensus 1 ch vs 2 ch)
1 channel	(MUSE - Expo 86 trial)			Japan	(J)			
2 channel	CBS 2 channel component based-on-going research; lab demos			US, Germany				
	Philips NTSC 2 channel proposal at conceptual stage			US				

LEGEND – ——— Status of Development

J – Japan

E – Europe

NA – North America

TV Technology Status and Forecast Highlights (continued)

	RESEARCH & DEVELOPMENT - CURRENT STATUS				TECHNOLOGY FORECAST (Delphi survey - 50% median probability of market entry)			
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY	1985	1990	1995	2000
IMPROVED CONSUMER PRODUCTS								
o Receivers								
Line Store			(comb filters available now — 2 chip set with ghost cancellation & 3 lines of memory - 1985 introduction)	US, Japan, Germany	J	E/NA		
Field Storage	(Research on image processing awaiting reduction of cost of memory)			Japan, Germany Holland		J/E/NA		
Frame Storage	(MUSE preliminary prototype receiver generated - 1989 introduction ? cost of frame store $10 in 1989?)			Japan, Germany Holland		J/E/NA		
o Displays								
30"-40" CRT wide aspect ratio)	(Research to improve brightness available within 3 yrs?)			Japan, US			J/E/NA	

LEGEND - ——————→ Status of Development

J - Japan

E - Europe

NA - North America

TV Technology Status and Forecast Highlights (continued)

	RESEARCH & DEVELOPMENT - CURRENT STATUS				TECHNOLOGY FORECAST (Delphi survey - 50% median probability of market entry)			
	PRELIMINARY RESEARCH	INITIAL DESIGN/ PROTOTYPES	FIRST MODELS AVAILABLE IN MARKETPLACE	CURRENT RESEARCH ACTIVITY	1985	1990	1995	2000
HDTV Projection	(Research to improve lens and envelope effects - 1m high available within 3 yrs?)			Japan? Holland			J/E/NA	
Flat Panel	(LCD's lack brightness/resolution plasma - inefficient gas discharge - max size of prototype - 16")			Japan, US				J/E/NA
o Other Products								
VCRs	(No significant R&D - spinoffs expected from component VTRs)					J/E	NA	
Videodisc	(To follow studio video discs)							J/E/NA

LEGEND — ——————— Status of Development

J - Japan
E - Europe
NA - North America

manufactured to accommodate a variety of transmission standards. Thus, as the power of digital processing increases, the evolution towards higher definition television within the marketplace becomes more feasible.

While analysis of these technical considerations provides a basis from which the evolution of TV technologies can be examined, both technical and market forces must be considered when developing possible evolutionary scenarios for future TV products and services. The forecasted "take-off" dates of the various products and services, possible market forces, and influencing initiatives which could be taken by major players, are considered before the rate of consumer products/services adoption are examined.

5.0 MARKET FORECASTS AND FUTURE REQUIREMENTS

The purpose of this section is to develop scenarios as to how new TV technologies will be presented to the marketplace and what consumers' response will be to them. A discussion about the ways in which new TV technology developments are likely to occur precedes the actual forecasts of market penetration.

5.1 Methodology

The market forecast methodology is based first on research and analysis to establish reasonable development scenario assumptions. The logic of the discussion of assumptions is as follows:

- the basic question about whether there is a market, and how large it is, is raised with reference to other putative mass market consumer products;
- part of the response to the broad market question lies in the nature of the TV receiver product itself whose trends are analyzed;
- the major factors affecting the development of the improved NTSC, EDTV, and HDTV are reviewed, with particular reference to the investment plans and broadcasting structures of North America, Japan, and Western Europe.

The second component of the methodology is the quantification of forecasts from specific assumptions. Based on the service "take-offs" predictions of the Delphi survey, consumer receiver forecasts are made for the US and Canada, using three basic scenarios:

- no major improvements
- frame store smart receivers launched in the 1989-90 timeframe, but assuming no EDTV/HDTV services

- EDTV/HDTV launched in the mid 1990s, several years after digital receivers

with the key variables in these forecasts being as follows:

- replacement life cycle of receivers
- penetration rates of new technology receivers
- multi-set household maturation point
- terms of service availability: free or fee based

Conclusions are drawn as to the likely development path for Canada.

While projections of TV households acquiring TV products are developed to the year 2000, the emphasis is on the possible directions for development rather than on forecasts per se. No forecast over a 15 year period is highly reliable, especially in a field with so many unknowns and complex factors. However, the scenarios are explicit enough to determine the future requirements for Canadian broadcasters, programming suppliers and equipment suppliers, and government policy makers.

5.2 Consumer Behaviour Considerations

In terms of consumer reaction to 'hidef',* the fundamental question remaining is whether there is a sufficient market for improved image quality that will provide a satisfactory return to the major investments required. Introducing an upgraded television format will be very expensive and require a system-wide investment, ie. from studio to

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* 'Hidef' is a shorthand way of describing EDTV or HDTV or both.

home display. Even the investment in digital receivers with framestore capability can only be paid back if the consumer market for this product is in the millions of units. Therefore, it is a major gamble by manufacturers/broadcasters/governments to take without knowing the extent of consumer interest in higher image quality and other features.

This question can be addressed by reviewing (i) historical analysis and other consumer electronics products, (ii) the breadth of consumer interest in quality of product, and (iii) trends in receiver sales and the advent of component TV.

5.2.1 Historical Analogies

Although there are many imperfections in using past analogies, a brief examination of the introduction of colour TV, and on the audio side FM broadcasting, reminds us how major investments are hedged in unknown market situations. Colour television was introduced first by NBC whose parent company is a major receiver manufacturer (RCA) which had the financial capability to do it and had obvious stakes in generating new demand. At the same time, compromise colour standards were introduced to ensure that the new transmission format was compatible with existing black and white transmission. Thus, even for an obvious improvement area, ie. black and white to colour, it took a major investment by an integrated broadcaster-receiver-manufacturer, and a hedge against losing the black and white market to launch the age of colour television.

The introduction of FM broadcasting faced a similar chicken and egg situation, since at the outset consumer FM receivers were non-existent. It took a combination of the market interest demonstration by high sales of 33 RPM recordings in stereo, plus the relatively low, incremental investment in FM by AM broadcasters to get FM broadcasting started. Even then the first FM stations were trail-blazers.*

The question is whether changing from NTSC/PAL standards to new television signal formats can be accomplished within similar reasonable investment parameters. Clearly, the market in North America has judged that the near term introduction of HDTV via DBS is too big a gamble for such a massive investment. The actual go ahead for DBS projects in Europe suffers from the same major investment/large unknown equation.

Communications business history is littered with examples of new products or services that were targetted for the mass consumer audience, but whose market response was insufficient to justify the continuation of the product line. Or, they were too early. For example, the failed concept of whole consumer-based videotex casts a shadow over the communications sector. Videotex technology is superb and most observers believe that ultimately there will be an electronic information delivery to the home. However, except on a very limited basis, home based

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* Rogers CHFI in Toronto was one of the first, and the company practically gave away FM receivers,retailing them at a very low rate to get the market started.

videotex systems have not happened in spite of major investments to develop service concepts that would succeed.

There are other examples which suggest caution in making assertions about new TV technology:

- the failure (thus far) of the home market for the Nabu home computer software/information/games delivery service;or any of the teledistribution of software or games services;
- the failure of the CED videodisc product of RCA after an investment of several hundred million dollars in product development and marketing;
- the failure of most arts based programming discretionary services (C Channel in Canada, the CBS Arts Channel and the Entertainment Channel in the US).

Then, there are the success stories, beginning with TV or FM radio itself, right up to the current explosion in VCR sales and programming distribution systems like pay-TV and video retail. Unfortunately, no analysis of like products is ever very satisfactory, except to situate the nature of the product under examination. In the case of the digital receiver or hidef systems, one must go further in an analysis of its chances of becoming a mass market consumer electronics product.

5.2.2 Minority or Mass Markets

'Hidef' products could be limited to the upscale or "high fi" segment of the population (as in expensive audio equipment) instead of making their way into the mass market. If so, then broadcasters and equipment suppliers cannot afford to establish a complete infrastructure to deliver one or more programming channels in hidef format; they require a mass market to make the investments worthwhile.

A closer look at the actual features of new television technologies is warranted. First, the simple improvement in image quality (eg. removal of "flicker" and "ghosting") is readily recognized by experts as an improvement. However, the image quality of currently available video product is debased so much by conventional delivery technologies that it is not clear if consumers value image quality. It is programming content rather than image quality that is by far the most important factor in selling products and services. The image of the signal that leaves the studios is in good shape. However by the time it has been distributed by land line, VHF/UHF, cable, and as a result of impairments in the average receiver itself, the original 5-6 Mhz bandwidth could be as low as 2.5 Mhz. Similarly, VCRs deliver 2-3 Mhz and thus often provide an image of poorer quality than television. In this context, what does it matter to most viewers if TV image quality is improved?

Interest in Quality

One could argue that there is a general trend towards quality in consumer products, which would favour market interest in EDTV or HDTV. While it is believed that consumer expectations in television image quality have advanced somewhat over the last 10 to 15 years (in line with the product improvements themselves), it is the wide aspect ratio and larger size screen possibilities that are believed to be the main attractive features for North American consumers. In TV, manufacturers and broadcasters seem to share the opinion that a good (not necessarily high resolution) impairment free and bright display device of 30 inches will provide the quality increment that will attract the consumer.

There is some debate over whether the projection display device is sufficient or whether a flat screen technology will be required to enthuse the consumer. Once again, however, it is the programming which will sell the consumer. As in the case of colour TV, "hidef" will likely grow in popularity only as programming becomes widely available. Price is obviously a factor, but again as it was for colour TV (and VCRs vs discs), reasonable prices must be accompanied by good sources of programming.*

With increased digital memory, various features can be built into receivers that have potential market advantage besides image improvements. Such features include the "picture-in-picture" on the screen, whereby 2 or more channels are shown at the same time, a zoom effect to provide a close up of selected areas of the screen, a freeze frame to hold a television image, and teletext. These features may not ultimately benefit consumers a great deal but can be important in marketing terms.

Finally, the extent to which the television screen will be used as a monitor for information display from home computers or remote data base/videotex access is an unknown factor. There is no low cost, colour high resolution monitor for computers or information display; and a hidef television display device could become an important accessory to computer/videotex usage. While this feature would seem to address a small market now, in several years significant growth is possible, which gives a potentially relevant advantage to TV viewers.

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* For example, colour receiver wholesale priced in the US dropped from $1100 to $500 from 1954 to 1955 and declined steadily on an inflation adjusted basis after that. However, colour receiver sales only started to move in about 1962 when extensive programming became available.

Even though the features of new TV technologies can be identified and suppositions made about their appeal to consumers, it is still unclear as to how many consumers will want them, how much of a premium they will pay for hidef products, and whether TV viewers will acquire hidef sets (and subscribe to hidef services) if they offer limited programming compared to conventional television. In part, the resolution of this question lies in a close look at receiver sales trends and the potential for upgrading through modular TV.

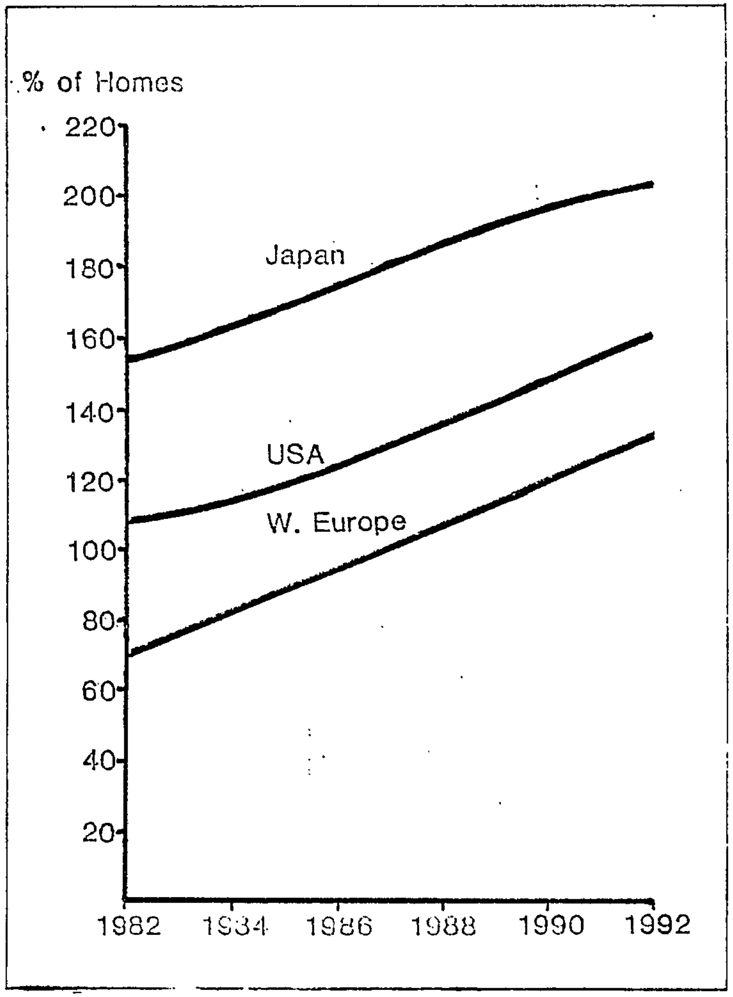
5.2.3 Receiver Sales Trends

Part of the reason a great deal of effort and expense has been generated by high definition television is that receiver sales represent some 50 million units annually worldwide. It is a big market. It is also a market whose saturation point has yet to be reached, contrary to the general view that "everyone" now has colour tv. For example, according to one industry analyst, there is still a great deal of growth in multiset ownership of television sets (see Exhibit 5-1).

The only trouble spot for receiver manufacturers is their dependence on the replacement market, increasingly so as initial and additional purchases decline as a proportion of total sales. For competitive reasons, and because of advances in production technology, TV receivers are now designed to last 12 to 15 years. This durability should lengthen the historical 10-11 year replacement cycle of colour TV sets. One indication of this pattern for Western Europe is illustrated in projections for the preparation of replacement versus initial and additional purchases for Western Europe (see Exhibit 5-2).

Exhibit 5-1

Colour Television Penetration Forecasts 1982-1992

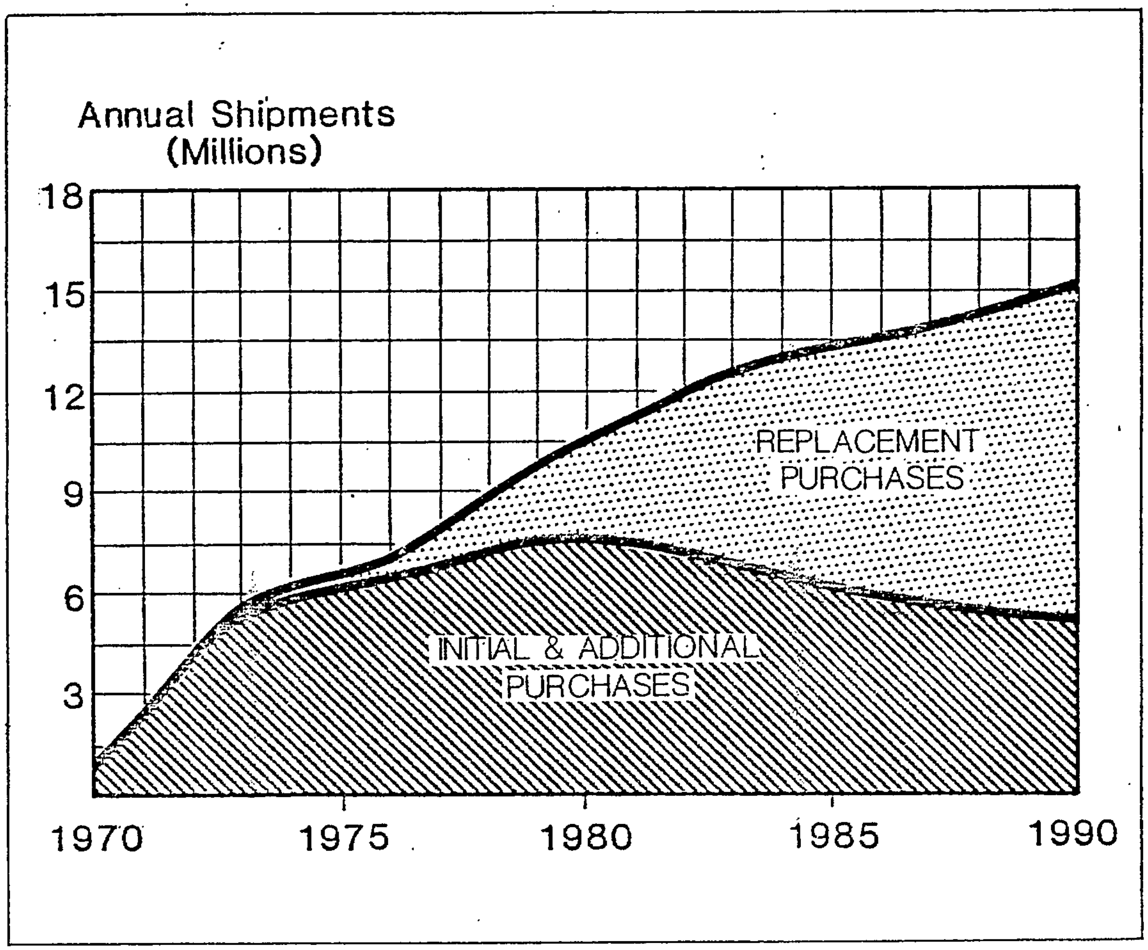


Note: (i) Penetration exceeds 100% due to multiple ownership.
(ii) This forecast is for <u>colour</u> TVs, not all TVs.

Source: Mackintosh International "Television Receivers: The Next Ten Years", February 1983.

Exhibit 5-2

West European Colour Television Replacement Market Forecast



Source: Mackintosh International "Television Receivers: The Next Ten Years", February 1983.

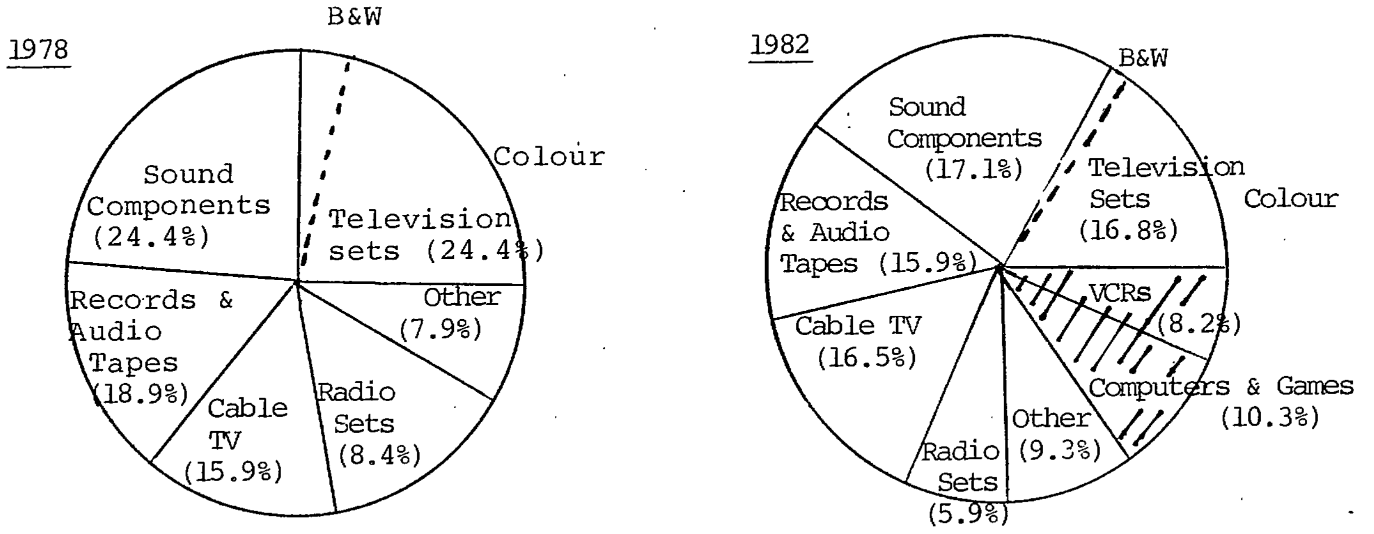
Thus, stakes are high in catering to the consumer electronics market; products in it are constantly changing as a proportion of market share, as illustrated by Canadian data comparing two time periods four years apart (1978 and 1982 - see Exhibit 5-3). Television sets dropped proportionately by nearly a third while VCRs and computers and games came out of nowhere to grab almost 20% of expenditures in that category. Evidently, finding a reason for technological rather than life cycle obsolescence becomes crucial to manufacturers. While receiver sales continue to climb in terms of units with no definitive maturity in sight, there is pressure on manufacturers to design and market "new" TV products.

The modular era is upon us in terms of product offerings in the luxury category of home entertainment, eg. integrated audio/video units featuring receiver/monitors, turntable/players, cassettes, and compact discs, and VCRs all under a master control centre. The Sony Profeel line and others frequent the advertising of publications geared to the upper middle income levels. It is perhaps this trend which will ease the successful entry of digital receivers and wide aspect ratio display systems.

The modular trend makes sense in economy and flexibility, just as it has done so in the audio field. One reason is the desire to have stereo sound with the advent of high-fi VCRs and stereo broadcasting. Another is to avoid the duplication of the tuner for the VCR and the conventional television set. Already the converter is often duplicated by the set top converter (with a decoder for discretionary services) and the "cable ready" television set with a built-in converter. Led by

Exhibit 5-3

Family Expenditures in Canada on Household Electronic Products



AVERAGE TOTAL EXPENDITURE PER FAMILY: $238

AVERAGE TOTAL EXPENDITURE PER FAMILY: $340

Source: Statistics Canada, "Family Expenditures", 1978 and 1982.

LEGEND:

▨ New Products

Europe, the "teletext ready" television set and the teletext/videotex decoder conflict should eventually be resolved through component products. Direct RGB inputs enable the receiver (or monitor) to be used for computer display as well as being accessible to a MAC decoder/tuner.

In terms of hidef, the acquisition of a wider aspect ratio display device could be made without having to purchase all the components in a conventional TV set. This makes the upgrading to EDTV or HDTV a relatively less costly step.

A reasonable conclusion, then, is that 'ultimately' higher image quality devices and systems will be adopted by most consumers. But when? In the next 5 to 15 years or well into the 21st Century? This timing question should be resolved in part by those with strong commercial or policy reasons to press ahead.

5.3 Factors Affecting TV Technology Development

While it is unclear as to exactly how future TV technology will be introduced into the consumer market, there are several factors which argue for the development of a mass market for new TV technology products in this Century. These factors are discussed in terms of the three basic entry scenarios - improved NTSC/PAL, "evolutionary" EDTV, and "revolutionary" HDTV.

5.3.1 Digital Processing - receivers and production studios

Whether or not analogue signals will be totally eliminated from television production/distribution/reception systems, the progression toward increased digital processing is quite evident. The predictable decline of costs of VLSI technology should lead to the production of receivers with advanced digital processing and memory capacity to perform the tasks required for image enhancement.

Two approaches are now being followed: first, the dynamic RAM technology borrows from the design of the computer chip; second, the charge coupled device (CCD) utilizes a specialized television serial based chip designed specifically for television receivers. The possibility of exploiting computer-driven development for television illustrates the importance of the cross-over between television and electronic processing and storage technology. In other words, future receiver sales may not have to cover the full R&D burden.

It is now up to major chip and set manufacturers to make the required market, business, and production assessments to determine when and at what scale investments should be made. As indicated earlier, this will be done in step function increases in memory and processing capacity to provide line, field and frame store and processing as well as adding new features. Each product improvement step will take advantage of the latest semiconductor productivity increases.

At present, the semiconductor divisions of receiver manufacturers, like Philips, and the semiconductor industry leaders, like IT&T, are investing significantly in product development. However, no major production commitment appears to have been made as yet to clearly indicate when receivers with frame and field store capacity will be available.

Digital technology is also required for processing the bandwidth compressed signals at the receiving end, from both an enhanced MAC and particularly in the MUSE HDTV television system. For that reason several Japanese television manufacturers like Panasonic/Matsushita are following the NHK lead to develop MUSE converters and HDTV receivers. This development activity should result in a corresponding boost to the smart receivers that will accept PAL/NTSC signals.

At the other end of the distribution chain, ie. broadcasting studio equipment, there is already a transfer from analogue to digital, particularly in video processing, and audio storage. In a forthcoming report on broadcasting equipment needs, it is projected that much of the studio equipment to be acquired by Canadian broadcasters over the next several years will be digital.* The first candidates for conversion to the digital environment are: camera sourcing, video recording, video routing and switching. While cameras are expected to use analogue tubes or Charged Coupled Devices (CCDs) for some time to come, the analogue signal will be converted to digital early in the processing chain (likely before the camera output). Digital video tape recorders (DVTRs) will be the key in development of the 'all digital studio'. Once storage of the video signal can remain digital, digital distribution systems, and digital routing and production switches will follow. In

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* See forthcoming publication of Canadian broadcaster industry survey.

fact, broadcasting studio technology is already beginning to converge with digital processing technology in other high speed and large volume storage applications (for example, high speed digital processing in remote sensing applications, large volume data bases using optical laser disc storage, and signal processing in computer graphics).

Part of the upgrading of the studio is to acquire the capacity to produce programming in higher definition format. As yet this is not a factor, but could become so over the next few years as producers seek to ensure that the productions are "banked" for possible subsequent transmission in a higher definition format. This would of course be particularly true for major productions for which a long life of syndication is anticipated. (Producing on film, of course, achieves the same purpose since film could be transferred to any of the major television formats now envisaged).

Thus, developments external to the decisions to broadcast in hidef format are moving inexorably to the point where the risk of major new investments is reduced. As described above, major receiver and chip manufacturers will contemplate bigger investments in receivers that depend heavily on digital signal processing. They can do this without requiring the total transformation of the television systems, since the smart receivers will upgrade picture quality within conventional PAL/NTSC standards.

In view of the expected interest in quality improvements, it is likely that the required investment commitments to production will be made. One estimate* for chip set costs is $200 (US) for about 1989, declining to just $10 by the year 2000. Thus, the first receivers would be available at a premium over today's receiver prices but drop thereafter.

Two-channel NTSC Approach

There is another possibility for improving television quality within the existing standards, based on the perception that the most desirable feature for TV viewers is a wider aspect ratio. Philips Labs in the US has explored the potential for a two channel service based on NTSC, where the first channel carries the traditional NTSC signal with the second supplementary channel providing the extra lines and "side panels". When combined at the receiving end, the resulting image has 657 lines and a 5:3 aspect ratio.

Such a 2 channel system could be distributed via cable (using 2 channels) to homes equipped with specialized decoders and receivers with field storage capabilities. Cable subscribers with conventional receivers would not be denied since they would continue to access the first channel and not the "wrap around" second channel.

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* Strategies for Higher Definition Television, Ovum Report Parts A&B, Tim Johnson 1983

This "hidef" proposal has not received much attention from the advocates of EDTV or HDTV, but represents a potentially very sensible compromise. The task of image quality and display enhancement would fall on the production and reception ends of the chain - not the transmission system itself. While it is premature to conclude that this approach is the best means of achieving quality ends without disrupting the installed delivery infrastructure, it demonstrates that there can be fairly practical, incremental ways of proceeding toward hidef.

5.3.2 Western Europe - DBS and MAC

There are two major investment forces which are driven by a mixture of public and private interests that are leading the television industry toward new television systems. They are the European analogue component video based satellite transmission system (MAC) and the Japanese HDTV system led by NHK.

With respect to the Western European analogue component initiatives, the stimulus emanates from the plans for DBS services.

UK

National governments view DBS primarily as a potentially important economic development stimulus, for export sales after adoption in the home market. It was the DBS interest that led the Independent Broadcasting Authority (IBA) in the UK to research and first propose the analogue component video system. To that time, the BBC's plans had been for a PAL-based system - Extended PAL. The IBA's version of MAC (C-MAC) has been adopted by the European Broadcasting Union (EBU), although the audio coding standards of MAC have not been adopted by the French and West German DBS projects.

The major question remains as to when (and indeed whether) the backers of the various DBS projects reckon that they would be viable enough propositions to launch. Though the UK DBS consortium received a further set back in May, 1985 when the backers concluded the project non-viable, it is a case worth examining.

The UK DBS consortium is comprised of the BBC (50%), the 15 IBA licensed broadcasting members (30%) and five private companies with equipment, programming, and TV rental interests. The IBA members have been enticed into the project by the government's decision to extend the life of their broadcasting licenses. However, the IBA involvement has added another channel obligation and thus raised the overall investment stakes. The BBC originally intended to sponsor the whole project as a 2 channel service but could not afford it. Even a reduced share is a burden for the BBC, which has been seeking increased TV license fees (the BBC's source of revenues) to support its ongoing operations for BBC-1 and BBC-2. BBC has also agreed <u>not</u> to use increased license fees to cross-subsidize DBS.

On top of these considerations is the current debate about the high cost of the chosen satellite supplier - Unisat, a British consortium of British Aerospace, Marconi, and British Telecom. The DBS consortium backers feel they can cut the cost in half through an international tender. This is still unresolved.

Ideally, the British would like to load DBS with a made-in-Britain satellite and receiver technology - without spending public funds (or increasing license fees). The resolution of the ongoing debate - if the project does proceed - may take some time, and some technological aspects may yet be jettisoned. At this time, the projected service start date of 1986-87 has clearly been abandoned.

Continent

The French and West Germans plan to proceed with PAL-based DBS services, although the intent is to design the system so there is an option to retrofit MAC at a later date. The audio standards under consideration (B-MAC or D-2 MAC) differ from those of the UK. However, the lack of a MAC standard (even though the EBU adopted C-MAC) is not a major compatibility problem because of the advent of a decoder system capable of receiving the differing digital data arrangements of the multiple standard MAC signals.

The Olympus TV DBS project, backed by several European countries and state broadcasters (like RAI in Italy and ARD in West Germany) is still heading for C-MAC. Their interest in C-MAC stems in large part from the 8 audio channel capacity of C-MAC, which is all important in the multi-lingual broadcasting environment planned for Olympus.

With the dependence on state sponsorship of DBS, there could well be further delay and consolidation of DBS projects. The overall viability of high powered DBS is still a major question in view of the huge capital costs and uncertain consumer market.

Cable terrestrial distribution systems are now under development in France, UK, and West Germany, although it could take a decade to wire as many homes as are presently cabled in the smaller European countries. The satellite to cable and SMATV options could reduce the programming suppliers' risk. This could further delay a 'true' DBS option, or at least reduce the distinction between DBS and communications satellites.*

The fate of MAC systems is not necessarily tied to the outcome of high power DBS, since it can fit in with the satellite-to-cable or SMATV delivery systems. New programming suppliers are becoming accustomed to communications satellites and are catering to the most obvious programming interests of potential subscribers. As this situation matures, it becomes more difficult for DBS projects to vault over established distribution arrangements. So, while the opportunity for high power DBS may be slipping away, there is a growing satellite distribution system which can reach people by direct-to-home services, SMATV, or cable. These developments may lead to an eventual transition to a MAC-based transmission format. At that point, the investment risk would be at least contained to the transmission system rather than to the viability of the service as a whole.

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* Technical advances in receiver design and beam shaping from the satellite have increased the possible trade-offs between number of channels and earth station size. The result will be more system efficiency and possibly integration of direct-to-home and multiple terrestrial distribution options, rather than a sharp distinction between DBS and communications satellites.

Whether Western Europe actually goes ahead with DBS, or chooses the transitional route at modified power levels, the introduction of MAC systems seems quite likely. This conclusion is corroborated by the Delphi survey results as reported earlier.

It should be noted that Australia has already incorporated the MAC approach (B-MAC) for its medium power DBS service to be launched in the fall of 1985. This service is primarily oriented to serve the rural and remote areas not reached by off-air broadcasting. B-MAC has been adopted largely for its substantial audio channel capacity and data and is not intended to displace the existing distribution infrastructure. The Australian initiative, while not aimed at mass markets will provide a very interesting test bed for the MAC technology.

North American Implications

In North America there have been serious proposals for using analogue component video systems. For example, CBS has a 2 channel system proposal that is adapted to the 525 line 60 field 4:3 aspect ratio based on a time multiplex component (a version of MAC) with a second channel carrying an additional 525 lines of video with a 5:3 aspect ratio. When the two channels are matrixed, a hidef picture is produced containing 1050 lines at a 5:3 aspect ratio.

The 2 channel 'analogue component type' scheme is not necessarily restricted to the CBS proposal. Scientific Atlanta, for example, intends to offer a family of systems, incorporating potential evolution to a 2 channel transmission scheme providing a 5.3:3 aspect ratio. It is Scientific Atlanta's initial 1 channel B-MAC technology (actually by the former Digital Video Systems of Toronto) that is being used in Australia.

In North America, the satellite-to-cable distribution option is a more likely route given the foundering of the principal DBS plans, including that of STC. The attractiveness of a MAC based delivery system for the cable industry lies in (i) its hard scrambling capability as a potential security system discretionary service; (ii) the elimination of NTSC impairments that MAC provides, and (iii) the potential evolution of an enhanced definition service while maintaining compatibility with existing NTSC receiver households. Essentially, the cable operator would have the following options if programming was offered via a MAC signal:

- convert the MAC signal to NTSC at the head-end for conventional distribution to its subscribers;
- pass on the MAC signal through the cable system to be decoded at the subscriber's premises.

If the cable operator passed the signal through to the subscriber, there would be some advantage to employing FM rather than AM transmission (although FM transmission would likely require more channel capacity - likely three contiguous high band channels). The result would be improvements in impairments such as "trailors" for households with conventional NTSC sets and a greater improvement in image for subscribers having a direct RGB input to their receivers. New generation monitors with RGB inputs and data grade (fine pitch) picture tubes would improve the image even more. If a subscriber had a smart receiver with field and frame store capabilities the results would be correspondingly better.

The bottom line for cable industry involvement is the following requirement:

- sufficient channel capacity (up to 3 channels required)
- a head-end expense of, say, $5-10,000 per channel
- a relatively high cost decoder replacement for current pay-TV decoders - say, around $140 range.

Cable operators in North America will take several years to sort out the pros and cons of going to the expense and technical changes required to offer MAC based services. Since they are essentially a fragmented industry, it is likely that one or more programming suppliers will make the decision as to which technology should be the next step and try to convince major cable operators to go along with it.

The logical candidate for initiating any major changes is HBO as the dominant pay-TV programming supplier. Its programming base as a movie channel is most suited to the enhanced viewing experience of hidef. As well, along with other discretionary service providers HBO has a direct relationship with the cable industry. This would suggest that the hidef service would be a discretionary, premium service for which subscribers would pay a monthly fee in excess of a typical pay-TV subscription. While HBO and other major programming suppliers are closely following TV technology developments, there is no public indication that they have decided on a particular course of action. For the present, HBO and Showtime have opted for a soft scrambling system as a first step to secure the signal from the growing number of home dish owners.

There are several well financed communications companies in the US who could finance the start-up and launch of a MAC based or any other high definition service. However, if they did not own programming rights or operate a programming service, the programming component would be a major barrier to overcome (as STC learned). The gamble would be large given the number of homes equipped with receivers that could take advantage of a new service would likely be small at the outset.

The only major potential exception to this difficult programming situation is one or more of the major Hollywood studios taking the initiative. While Hollywood studios have extensively benefitted from the pay-cable and video rental revenues (which amounted to 10% and 14% respectively of revenues in 1983), their percentage take on the "box office receipts" of pay-cable is only 18% as opposed to the 45% earned on cinema rentals. The studios have been trying to break the pay-cable distribution stranglehold of HBO, and indeed preventing the backward integration of HBO into the film production business. An interesting association has developed with Ted Turner's recent purchase of MGM.

It is anticipated by the studios that a pay-per-view window might generate a more "balanced" split of the gross revenue from teledistribution.

It is conceivable that studios could initiate a MAC (or HDTV) based delivery system for pay-per-view to increase their take in the revenues currently earned by the 'rent per film' charge. Again, this is at present conjecture since there is no known groundswell toward integrating pay-per-view and EDTV/HDTV or even a MAC based delivery system. Since lack of a sufficient quantity of addressable scramblers is considered a major stumbling block to pay-per-view, it is not likely that another barrier (ie. lack of MAC decoders) will be greeted with any enthusiasm.

5.3.3 The NHK Driven HDTV

The Japanese equivalent to the CBC, NHK, has been developing an HDTV system since 1968, and is the driving force behind an industry wide march toward HDTV in Japan. The NHK vision is to perpetrate a revolution of entertainment habits and consumer products covering display devices, high definition television systems, and complementary VCR and videodisc recording products. The premise is that the NTSC consumer equipment market is now saturated and that the new standard will give the Japanese electronic industries new mass markets.

The Japanese intend to institute the 1125 line 60 field standard initially transmitted via a MUSE bandwidth reduction coding scheme, until a wider bandwidth satellite capacity can be made available in the mid 1990s in the 22 GHz band. At that time the required 30 Mhz capacity (4 times the present) could be accommodated.

It is NHK's plan that the new service in HDTV would be launched in 1989-90 via the BS4 satellite. Selective hours on BS3 will be broadcast before that time and indeed are occasional at the present time. NHK expects that the new service would take some 5 years to popularize in Japan and first be concentrated in the mini-theatre, clubs, stores, and coffee shops markets prior to entry into the home. Ten to 15 years after its introduction, it is anticipated by NHK that the NTSC service will become like the "AM service" of today, versus its HDTV "FM service" equivalent.

The financing of the new NHK HDTV service would be by license fee from existing users as well as from the licensing of the HDTV patents developed by NHK. This means that the HDTV service can be made available through state imposed license fees and future revenue contributions from domestic and foreign manufacturers adopting the system. Since government authorization is still required to approve the arrangement, part of the equation is obviously the potential for export sales of HDTV components and receivers. This explains NHK's obvious interest in international standards.

The NHK initiative has the full support of the major Japanese consumer electronic manufacturers like Hitachi, Ikegami, Panasonic/Matsushita, and Sony. It is a total professional and consumer HDTV product line support, including MUSE bandwidth reduced HDTV converters, projection systems, optical and magnetic recording systems, and a readiness to design an appropriate VLSI circuitry for receivers once a standard is adopted. These developments are all geared to the 1989-90 launch of BS4.

Of particular interest is the complementary development of erasable and DRAW (direct read after write) optical disc systems for professional and consumer product lines as well as electronic office systems. Because of current applications in the information storage business, it is anticipated that there will be sufficient advances to make it transferable to current NTSC as well as future HDTV television applications. Thus, along with the development of optical video tape recorders, HDTV programming can be delivered to the home via tape or disc. The result is that there will be an independent means of delivering programming to homes in countries without HDTV broadcasting systems.

The consumer interest in Japan for electronic gadgetry is legendary. It is not too difficult to conceive of a responsive market for HDTV products in Japan. This impression is reinforced by some preliminary market results from a 1984 survey of 1,000 business people with an upscale average income of $40,000 US per annum (the 85th percentile in Japan).. The key results are:

- 9 out of 10 expressed interest in HDTV;
- there was a high degree of awareness of the concept (only 12% heard of HDTV for the first time; 30% knew the name, 49% understood the principle; 10% had actually seen HDTV pictures);
- while HDTV broadcasts would trigger purchase for 60% of respondents, another 40% would buy it for home video, computers, word processing, cable viewing, and videotex/teletext applications;
- the popular price was $1200 US, although 35% of interested respondents indicated they would purchase a set for more than $1200;

- the highest programming preferences were movies and travel/history; sports, educational, and music/variety were of secondary interest (this is likely due to the upscale market sector surveyed).

The planned exhibition of HDTV and accompanying cameras, monitors and video tape recorders at the Tsukuba exposition should stimulate interest even more. A focal point of Tsukuba is Sony's largest television screen in the world, but behind this drawing card lies the intent of NHK to show HDTV programming specially prepared for the exposition. While the Tsukuba will attract worldwide attention, it is expected that 90% of its visitors will be Japanese, thus providing a major showcase for the general public with respect to HDTV. It is interesting to speculate on the results of a new survey administered after the Tsukuba expo has done its PR work.

North American Implications

While an impressive case can be mounted projecting the advent of HDTV in Japan, it is more difficult to contemplate a scenario for its introduction into North America. In discussions with major television industry companies in the US (CBS, Philips, HBO, STC, Scientific Atlanta, RCA, etc.) the consensus seems to be a lack of enthusiasim for a non-compatible HDTV service. No major player speculated that the 1125 line NHK HDTV system would be adopted in the US.

While the informal consensus was against such a service in the US, the Delphi survey results showed a split between EDTV and HDTV (see section 4). It is useful, therefore, to explore a reasonable scenario in which an HDTV system could be introduced into the US and Canada. A series of events along the following lines could be contemplated:

- entry of consumer priced videodisc and VCR players shortly after they are made available in the Japanese market in 1989-90; with screens (front or rear projection) at reasonable prices and current release movies available, there could be a worthwhile luxury market in the US and Canada;

- the next five years should see growing hidef closed circuit television applications, first for price insensitive customers like the military and industry, and second for more price sensitive customers including medical and education applications; these standalone closed circuit systems could also be adopted by general public venues like hotels and bars;

- the Japanese receiver industry could bring into production a HDTV receiver that could accomodate both conventional NTSC and HDTV signals, particularly in a modular structure; with relatively high volume production in Japan, the price of such receivers could become within the range of premium receivers in North America; therefore, the digital receivers could be bought to upgrade regular TV, but then form a base for HDTV videodisc and eventually HDTV broadcast;

- with the existence of a receiver priced in the normal high end market, coupled with compatible disc and tape player systems, there could be a programming supplier that would seek to distribute programming via DBS and US satellite-to-cable; perhaps a critical mass is about 1 million units, about what it is now for TVROs, which has triggered the pre-satellite scrambling of pay-TV signals by the pay industry in the US.

While industry analysts in North America also seem to agree that the NHK system is not necessary in terms of image quality - the analogue component systems and enhanced proposals might do - it is quite possible that the analogue component video alternative will not emerge. In this case, would not the North Americans eventually adopt the Japanese standard? The key to this eventuality lies in the development of specialized transmission/ distribution systems.

5.3.4 Transmission of Specialized Services

A fashionable speculation about HDTV is in its use as a delivery mechanism for movie studios to movie theatres of movie product. Without altering the basic production industry, which is still a film oriented industry, the product could be distributed in HDTV format whereby it would be recorded or shown directly.

The primary motivation for establishing such a delivery system would be (a) cost reductions from projectionists salaries, and (b) greater distribution flexibility and potential cost reduction (for example, to save on the $1200 per film print charge, and the expense of print bicycling).

The trade-off might be a one time expense of a $200,000 high definition projector/VCR/dish system versus the operating costs of specialized projectionists salaries and film bicycling. While there is at present some satellite distribution to support worldwide release strategies (eg. a recent James Bond movie), there is no indication that the theatre owners are yet sufficiently interested in this concept.

The next step or a step that is an advancement of this concept, is to deliver live events and other HDTV programming (in addition to movies) for exhibition at public places - whether it is to sell liquor at bars/lounges, rooms at hotels, or popcorn at mini theatres - HDTV could play a role. While there are many economic questions about the launch of such services, it is clear that the cost of the individual display device is less sensitive in these applications than for individual households. Just as closed circuit broadcasting of major sporting events, particularly boxing, preceded their televised exhibition (whether pay-TV or broadcast), the mini theatre approach could precede widespread household use. This is also the evolution perceived by the Japanese, discussed earlier.

It is difficult to predict what kind of entrepreneurial effort or corporate combination is necessary and indeed viable to cause such services to be launched in North America. Could it be that under-utilized space on Anik C satellites, a US major hotel or bar chain, and a Japanese projection set manufacturer would provide the appropriate ingredients?

Specialized services along with HDTV disc/tape display/player systems seem more probable introductory scenarios for hidef services than major broadcasting commitments. While there is some evidence of positioning activity and service concept development at present, there are no obvious major plans. Likely, there will be several years of incremental steps, with false starts before viable business propositions come to pass. At that time broadcasters (or programming suppliers) will seek the best way to interpose themselves between the producer and the mass market, ushering in the hidef era.

5.3.5 Advent of Hidef Services

From the above analysis of development factors, certain preliminary conclusions are drawn:

1. Hidef services are not for the 1980s, and will only begin in the 1990s.

2. It is premature to predict an EDTV or HDTV approach; neither is completely compatible to NTSC, yet both are likely to be accommodated in the modular TV era.

3. The specialized transmission systems or tape/disk to hidef player/display are a necessary first phase.

4. Satellite to cable is the likely distribution option, with viewers without access to cable receiving hidef on a direct-to-home basis as a supplementary market for programming suppliers with primary distribution through cable.(This direct-to-home service would likely be offered as a 'low-power DBS' service as is currently being contemplated by Telesat Canada)

Taking the year 2000 perspective of how hidef services could unfold in the 1990s in North America, two principal scenarios seem likely:

(i) a multi service scenario where most mainstream programming services would be hidef; and,

(ii) a specialized service scenario where hidef services remain exceptional, discretionary options.

With hidef services virtually impossible to transmit over-the-air, given scarce frequency, hidef services will have to be distributed by satellite or via fibre optics. This means that the first services are likely to be specialized, pay-TV like services delivered to cable subscribers. At some point, however, most broadcasters will have to offer a hidef service in addition to their conventional over-the-air service. As in the case of start-up of FM, broadcasters could be distributing portions of their schedule slated for normal transmission on hidef. Gradually this would increase until the full second service was provided. The real question again is one of timing.

To reach homes a hidef service would have to be uplinked by satellite and follow the satellite to cable to home distribution paths. For off-air broadcasters to reach their local audience with hidef service, then, the transmission route will still be satellite-to-cable. This could substantially alter the current broadcasting structure. However, whether the whole scale transmission to hidef services by major networks and stations occurs in the 1990s or not until the next century, is not easy to resolve at this time. Specific quantification of the impact of these service "roll out" scenarios is now provided.

5.4 Forecast of Future Demand

Demand forecasts to the year 2000 are formulated for Canada and the US for TV households equipped with new TV technology products. The forecasts begin with a projection of conventional receiver sales to 2000 and adding successive waves of, first, smart receivers, and second, hidef receiver sales.

Specific assumptions are (i) the growth of the market (households, colour TV penetration, and sets per household), (ii) when the technology or service would appear on the scene, (iii) who would have access to the new hidef services, and most significantly, (iv) what the penetration rates would be. Many permutations of these assumptions were calculated; from them, six scenarios were derived as follows:

Conventional

1. No new TV technology introduced in the marketplace as the base case.

Digital

2. High penetration of smart sets with field/frame store capacity, based on very competitive consumer pricing of the new digital receivers.

3. Low penetration of smart sets, based on substantial price premiums being charged over conventional receivers.

Hidef

4. An early start (1992) of multiple hidef "broadcast" services.

5. A 1995 start of multiple hidef "broadcast" services.

6. A one or two hidef service (eg. CBC and CTV or First Choice) introduction in 1995 with the penetration rate assumptions based on market characterisitcs approximating pay-TV.

A summary of the specific assumptions for each of these scenarios appears on Exhibit 5-4 and detailed projections are presented in the following subsections.

5.4.1 Receiver Sales Projections

As a basis for determining the market for smart receivers, the conventional receiver market was projected to the year 2000 assuming no introduction of smart receivers, ie. scenario 1. Key assumptions in this calculation are:

SCENARIO 1: Base Case - No Major Technological Change in TV Sets

- median Statscan household growth projection scenario, as derived from the SERF* model;

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* Statscan Socio-Economic Resource Framework model - see Economic Impact section 8.

Exhibit 5-4

Consumer Scenarios for New TV Technologies - Canada

Assumption Factors	1 No new TV Technology	2 High pen. digital	3 Low pen. digital	4 Hidef early start	5 Hidef multi service	6 Hidef premium service
# of sets per households in the Year 2000*	1.7	1.75	1.75	1.75	1.75	1.75
Year of introduction	-	1989-90	1989-90	1992	1995	1995
Market universe	all TV households	all TV households	all TV households	all digital households	all digital households	all cabled digital households
Penetration	100% market share	10% 1991** 95% 2000	2% 1991** 50% 2000	high pen digital growth rate	high pen digital growth rate	10% 1995 25% 2000 of digital
Replacement cycle	11 years	7 years	10 years	9 for digital, then 6 for hidef	9 then 6	9 then 6

---

* Current number of sets per household in Canada is 1.4. The number of sets predicted in the year 2000 is based on historical growth curves for both Canada and the US and projections of these curves to the year 2000.

**Penetration is a consequence of pricing, whereby digital receivers carry a 0% or 50% premium over high end sets in 1990 and 0% or 20% over average sets by 2000.

- continuation of TV penetration curve (see Exhibit 5-5) to reach 1.7 sets per TV household by 2000, as opposed to 1.4 in 1984;
- continuation of historical 11 year replacement timeframe for receivers.

The key penetration assumption is derived from (a) the historical trend line and (b) broad parameters as set by the countries with the highest number of sets per household - Japan and US. The historical and projected penetration estimates for sets per household are shown on Exhibit 5-5.

The results of a projection of sales of TV receivers, which are based on the household growth, multi set households, and replacement assumptions are shown in Exhibit 5-6. They are graphed as an extension of the historical receiver sales since the beginning of TV broadcasting. A slightly more simplified approach was used to project receiver sales in the US with results and assumptions shown on Exhibit 5-7.

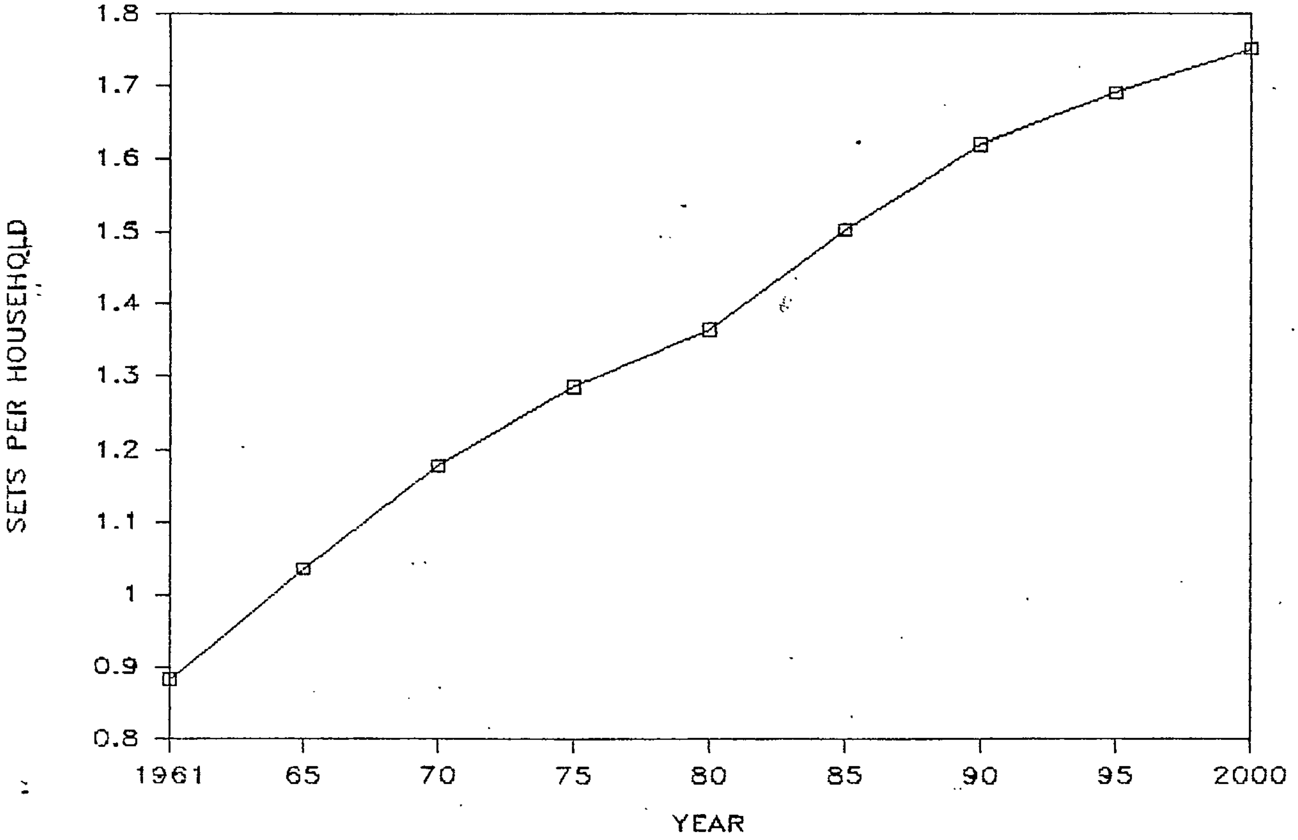
5.4.2 The Introduction of SMART Receivers

From interviews with manufacturers of both receivers and chip components required for the receivers, it appears that smart receivers with frame store memory capability would be introduced in the market within the next 5 years. The Delphi survey results concurred with the high probability of achieving this technological and production state in the 5 year timeframe (see section 4).

For projecting the impact of smart receivers on the marketplace, certain assumptions were made about the impact of the introduction of smart receivers in the "base case" marketplace in Canada. In fact, two scenarios were postulated - each one representing different price/penetration assumptions.

Exhibit 5-5

Historical and Projected Canadian Penetration of Sets per Household



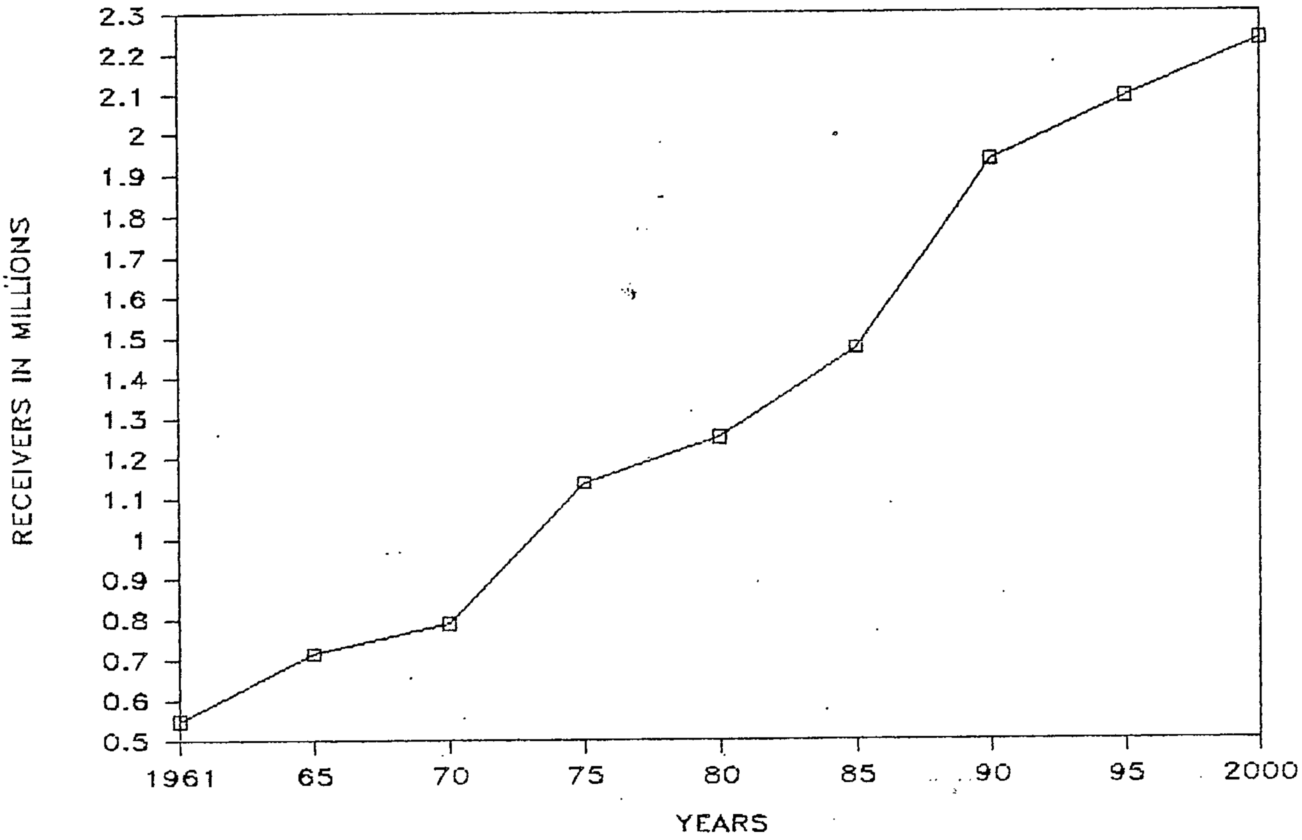
Assumptions

No major technological improvements in TV sets

Trend line increase in multiset households from .89 per household in 1961 to 1.7 sets per household by the year 2000.

Exhibit 5-6

Annual Sales of TV Receivers in Canada



Assumptions

No major technological improvements in TV sets

10 year replacement cycle (it is possible that receivers with digital components will have a slightly longer life expectancy).

Exhibit 5-7

Annual Sales of TV Receiver Sales in US (Millions)

YEAR	TV HHS	PENETRATION (sets/HH)	REPLACEMENT SALES	NEW RECEIVER SALES	TOTAL SALES
1984	85	1.53	8.4	7.6	16.0
1985	87	1.55	6.2	6.8	13.0
1986	89	1.57	8.2	6.9	15.1
1987	91	1.59	9.3	7.0	16.3
1988	93	1.61	10.7	7.0	17.7
1989	95	1.63	10.0	6.3	16.3
1990	96	1.65	10.7	6.4	17.1
1991	98	1.67	11.2	6.4	17.6
1992	99	1.69	11.4	6.5	17.9
1993	100	1.71	14.0	4.7	18.7
1994	101	1.73	16.0	4.7	20.7
1995	102	1.75	13.0	4.8	17.8
1996	103	1.77	15.1	4.8	19.9
1997	104	1.79	16.3	4.9	21.2
1998	105	1.80	17.7	3.8	21.5
1999	106	1.80	15.8	2.8	18.6
2000	107	1.80	16.6	2.8	19.4

Assumption:

- Assumes no major technological improvements in television sets (eg. NTSC based non-smart receivers); increase in multiset households from 1.53 sets/HH to 1.80 sets/HH by year 2000
- 10 year replacement cycle (it is possible that receivers with digital components will have a slightly longer life expectancy);
- Increase in TV households projections

SCENARIO 2:Smart Television Introduction - High Penetration Rate (Low Entry Price)

- new smart receivers with frame/field store would be introduced in 1989-90 (as indicated by the Delphi forecast results);
- by 1991 all the high-end colour sets (ie. about 10% of sales) would be digital field/frame store receivers offered at prices close to the equivalent of existing high-end analogue sets (ie. about $1000-1200 Canadian in 1984 dollars);
- by 1995 about 50% of the new sets sold would be digital - assuming that the price of SMART receivers would be about 20% above the price of traditional analogue sets ($600-700 in 1984 dollars). This price differential would eventually disappear, and by the year 2000 95% of receivers sold would be digital;
- the appeal of the quality and feature improvements would result in an increase in the number of sets per household to 1.75 by 2000 instead of 1.7 as projected in the base scenario;
- television replacement would tend towards 7 years* (beginning in 1990) instead of the current 11 year cycle.

SCENARIO 3:Smart Television Introduction - Low Penetration Rate (High Entry Price)

- new smart receivers with frame/field store would be introduced in 1989-90 (as in Scenario 2);
- by 1991 some of the high-end colour sets (ie. about 2% of sales) would be digital, with field/frame store receivers offered at prices 50% above high-end sets;
- by 1995 about 20% of the new sets sold would be smart - assuming that the price of smart receivers would be about 50% above the price of traditional analogue sets;
- by 2000 about 50% of the new sets sold would be smart - assuming that the price of smart receivers would be about 20% above the price of traditional analogue sets;
- the appeal of the quality and feature improvements would result in an increase in the number of sets per household to 1.75 by 2000 (is in scenario 2);
- television replacement would tend towards 10 years* (beginning in 1990) instead of the current 11 year cycle.

---

* While receivers with digital components may have a slightly longer life expectancy (eg. 12 years), these lower replacement cycles were utilized to capture consumer replacement of existing sets preceeding actual failure due to the attractiveness of new product features.

The key assumptions are penetration of receivers, their replacement cycle, and retail prices. The specific receiver retail price assumptions for conventional receivers and the two scenarios of smart receivers are shown on Exhibit 5-8.

The results of the calculations based on these assumptions (shown on Exhibit 5-9) indicate that smart receivers would boost the overall demand for receivers. From an initial 35 to 175 thousand in sales in 1989, the annual sales of smart receivers would grow to between 1.5 and 3 million by 2000.

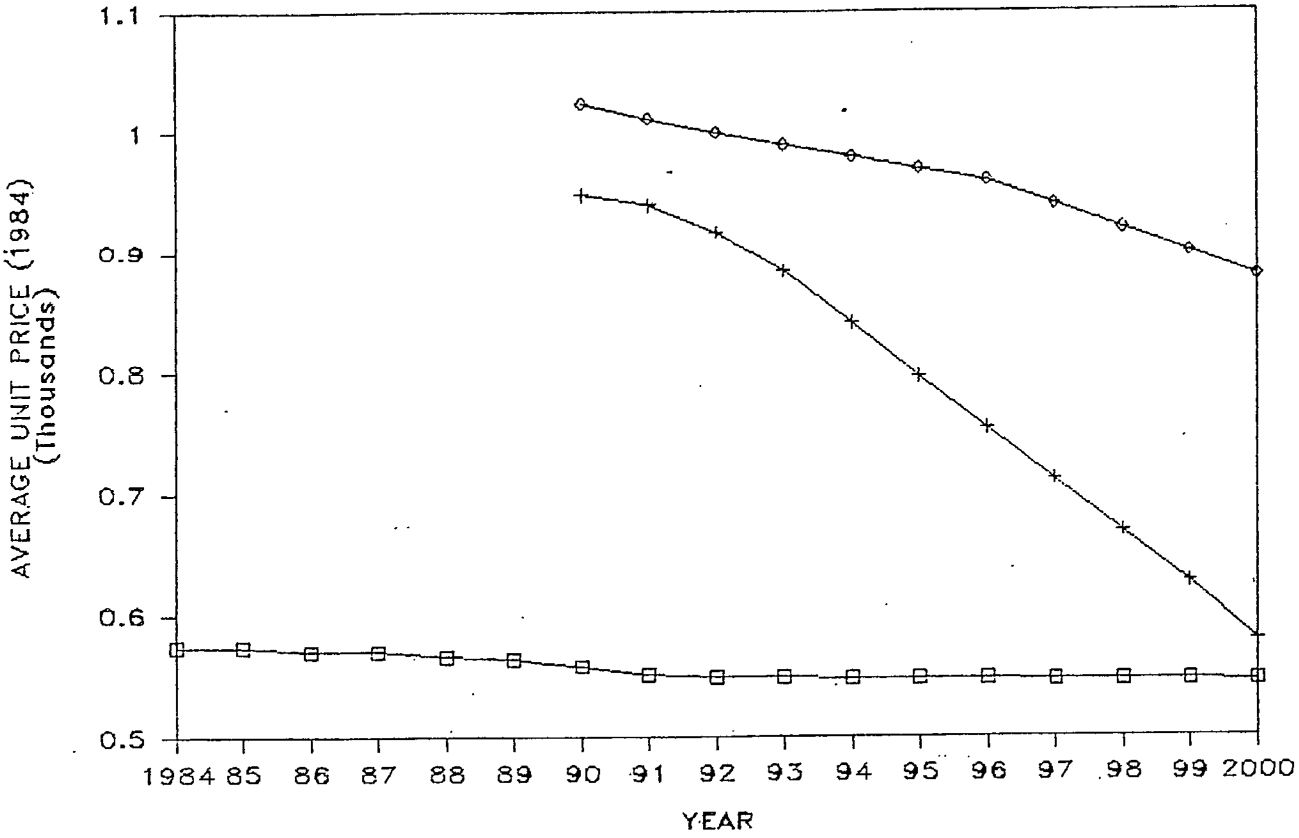
Obviously, the projected growth in TV receivers per household and the faster replacement cycle are judgemental. However, the assumptions used are quite conservative given historical trends and some additional perceived value by the consumer in digital receiver performance.

The smart receivers are providing an enhanced viewing experience (plus features) of programming that is already being broadcast, and do not depend on new, specialized programming. Again, using similar logic, smart receiver sales projections for the US were developed, shown in Exhibit 5-10. In the US sales would grow from .3 to 1.7 million units in 1989 to 10 to 20 million in 2000.

The relationship between receiver prices and market share are calculated for two scenarios to accommodate a range of sales. Since the programming viewed by conventional or smart receivers is the same, it is assumed that smart receivers are fairly price sensitive. While the

Exhibit 5-8

Average Unit Price Assumptions for Traditional Analogue and Smart TV Sets



□ Average unit price of present technology TV sets

\+ High penetration (low entry price), average unit price assumption for smart TV sets; scenario 2

◇ Low penetration (high entry price), average unit price assumption for smart TV sets; scenario 3.

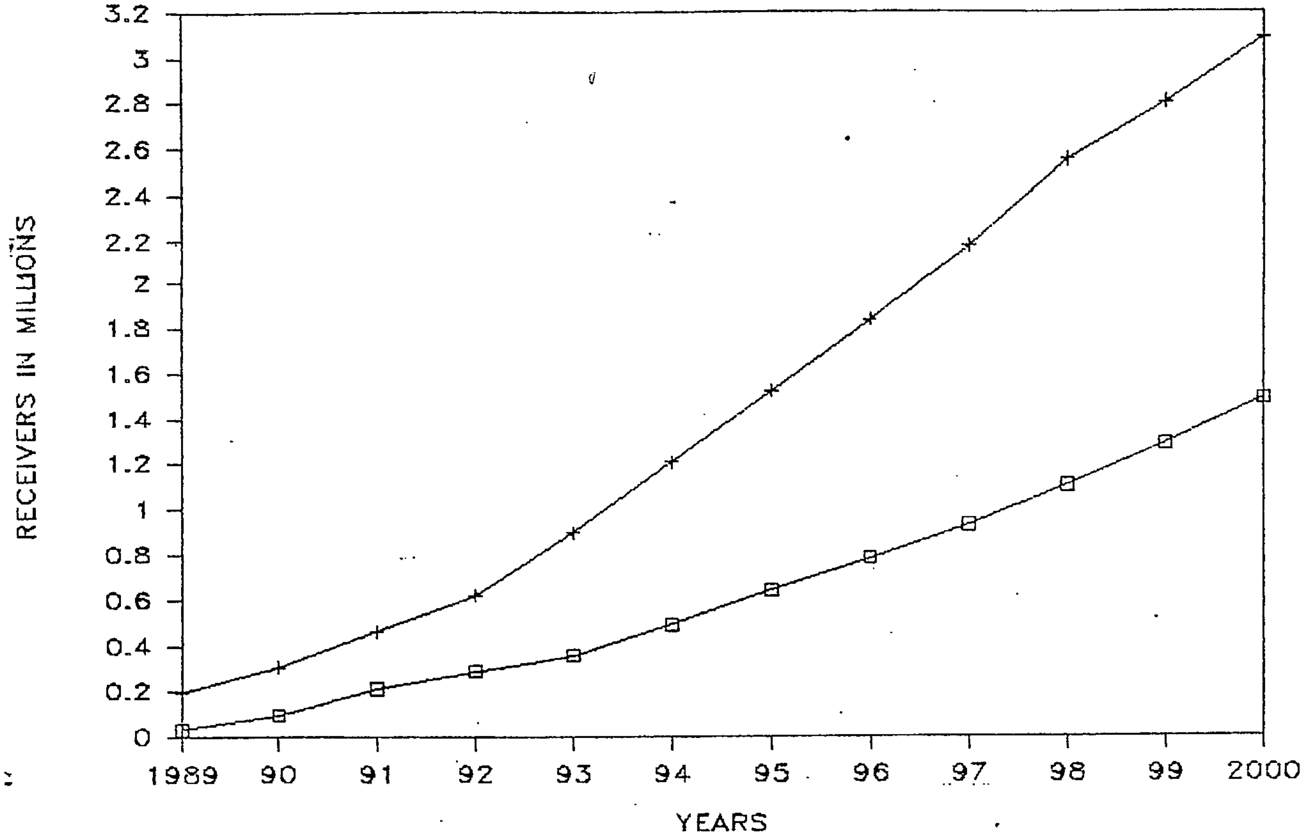
Assumptions

Low entry price - 1991 smart sets priced similar to high end analogue sets moving to 20% above traditional sets by 1995 and the price differential eliminated by the year 2000.

High entry price - smart sets initially offered at 50% above high end analogue sets moving to 20% above the price of traditional analogue sets by the year 2000.

Exhibit 5-9

Projected Growth in Smart TV receiver Sales in Canada



+ Sales of smart sets assuming low price entry scenario

□ Sales of smart sets assuming high price entry scenario

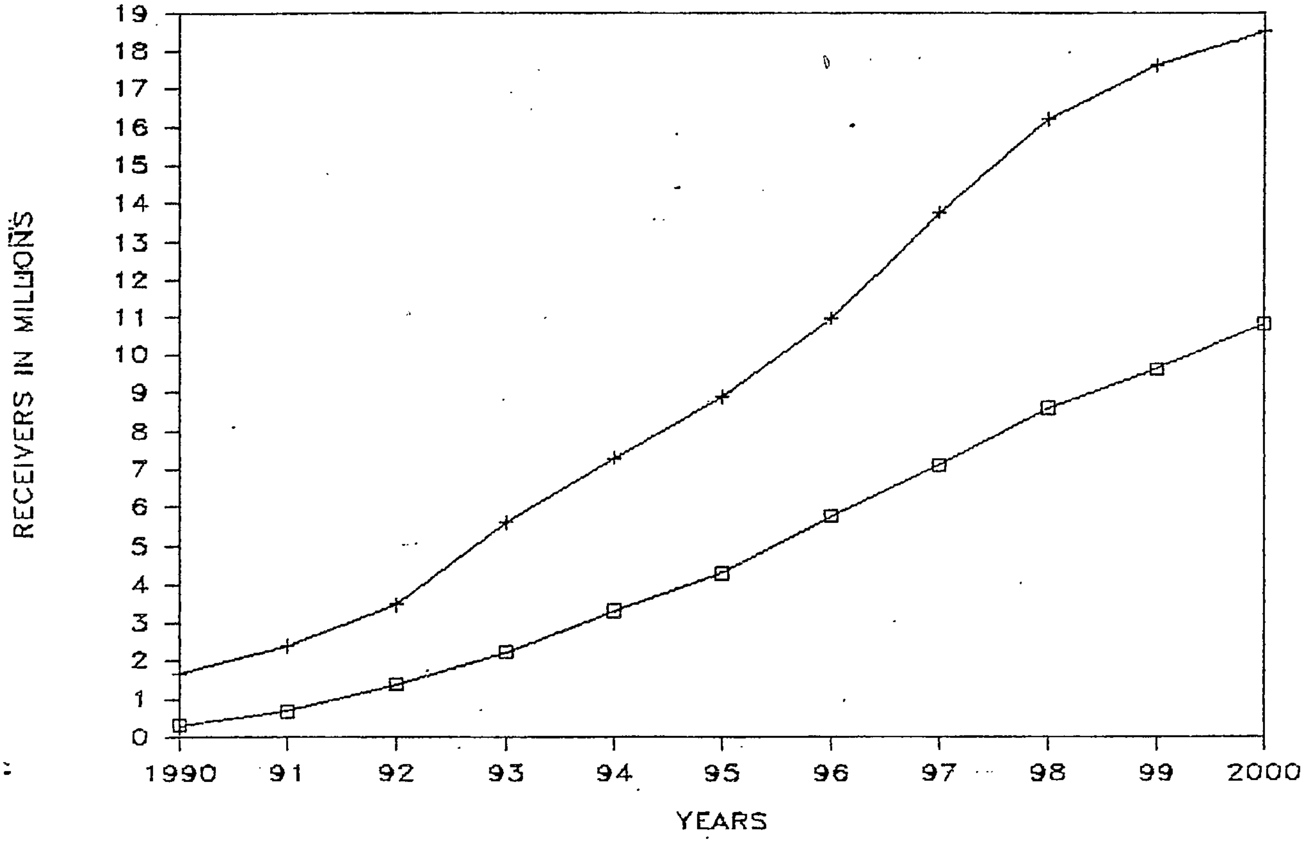
Assumptions

Low entry price - 1991 smart sets priced similar to high end analogue sets moving to 20% above traditional sets by 1995 and the price differential eliminated by the year 2000.

High entry price - smart sets initially offered at 50% above high end analogue sets moving to 20% above the price of traditional analogue sets by the year 2000.

Exhibit 5-10

Projected Growth in Smart TV Receivers - US



\+ US sales of smart sets assuming low price entry scenario

□ US sales of smart sets assuming high price entry scenario

Assumptions

Low entry price - 1-91 smart sets priced similar to high end analogue sets moving to 20% above traditional sets by 1995 and the price differential eliminated by the year 2000.

High entry price - smart sets initially offered at 50% above high end analogue sets moving to 20% above the price of traditional analogue sets by the year 2000.

quality of the colour image on smart receivers is superior and new features are available, the North American TV viewer is not likely to pay a large premium for it.

5.4.3 Introduction of Hidef Services

The results of the Delphi survey and an examination of the economic and institutional factors indicate that hidef services will not be available in Canada and the US until well into the 1990s. The three scenarios for which projections have been made are:

SCENARIO 4: An early start date of multiple hidef service "broadcast" (1992)

- the incremental effects over and above the smart set entry scenario 2 were considered
- the introduction of 2 or more hidef services would commence in Canada in 1992
- hidef receivers are assumed to replace 15% of smart receiver sales in 1992 growing to 65% by 2000
- (the price of hidef receivers will initially be approximately 45% above smart receivers declining to a 35% premium in 2000)
- penetration rate of televisions per household would achieve 1.77 by 2000
- replacement of existing televisions would tend towards 6 years commencing in 1990

SCENARIO 5: A slightly later start date of multiple hidef service broadcast (1995)

- same as Scenario 4 with 15% of smart receiver sales replaced by hidef receivers in 1995 and 40% by 2000

SCENARIO 6: Hidef 'premium' service broadcast in 1995

- same as Scenario 5, however hidef services would be offered as a premium service, with penetration assumed to be roughly analagous to pay-TV in Canada, ie. 10% of cable subscribers in first year of introduction and 25% by year 5 (thus 10% and 25% of smart receiver sales in 1995 and 2000 respectively).

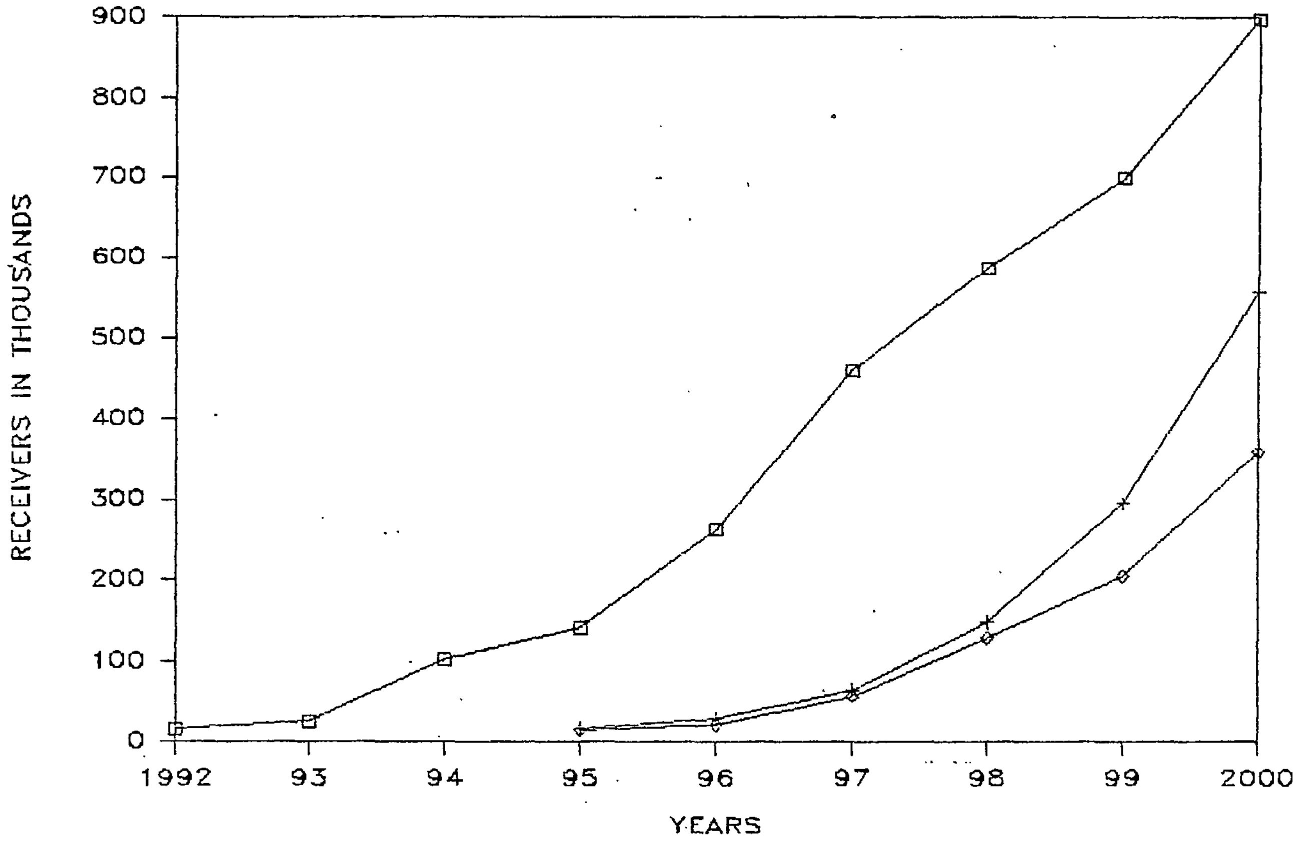
Based on the results of these calculations (shown on Exhibit 5-11) sales of hidef receivers in the year 2000 could range from 350,000 to 900,000.

As before, a set of US projections have been formulated to take account of differing penetration rates and earlier start dates. In particular, the historical growth curve of VCRs was used as one scenario. Assumptions and projections are shown on Exhibit 5-12. The results range from $5M to $13M in sales in the year 2000. To note in particular is the similarity of results in comparing the VCR penetration growth curve and hidef as a premium alternative to smart receivers.

Results of these projections indicate an expected penetration of hidef receivers (as a percentage of the total installed receiver base) ranging from 15%-30% by the year 2000 in Canada and 25%-65% in the US (see Exhibits 5-13 and 5-14). These US and Canadian scenarios for hidef receivers cover relatively conservative and optimistic assumptions about hidef service introduction. Obviously, there are many important factors to take into account which would vary these scenarios, eg. hours of hidef broadcast, nature of hidef services, whether most networks will operate dual transmissions, availability of display devices as separate components, distribution mode, and price of subscription fee. However, they provide an indication of the dimension of the requirements in North America for the programming, production, and distribution of hidef television services over the next 15 years.

Exhibit 5-11

Projected Growth in HDTV Receivers - Canada



□ 1992 start - Scenario 4

\+ 1995 start - Scenario 5

◇ 1995 start (premium hidef) - Scenario 6

Assumptions

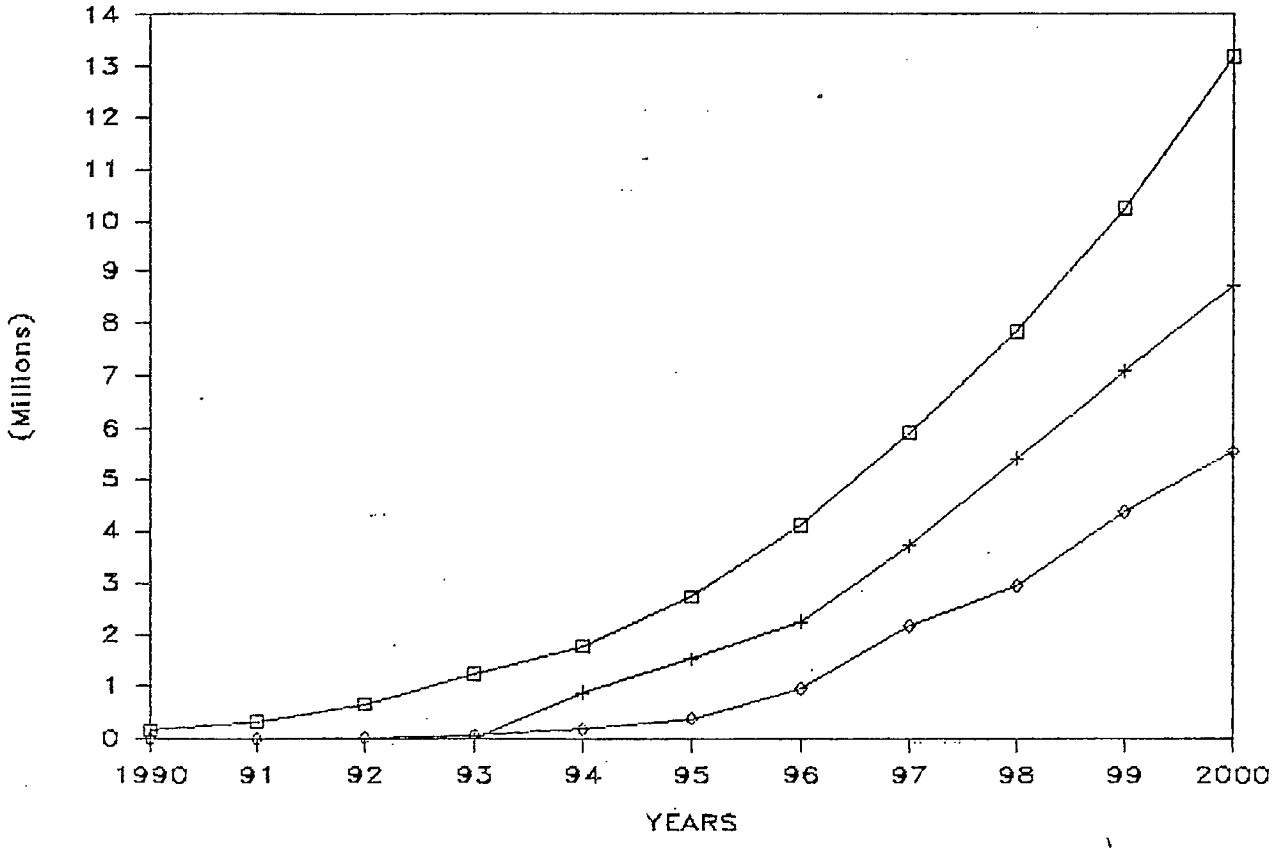
Scenario 4 - assumes introduction of HDTV receivers in 1992 priced at 45% above smart receivers in 1992, declining to a 35% premium in 2000.

Scenario 5 - assumes introduction of HDTV receivers in 1995 priced at 45% above smart receivers in 1995, declining to a 35% premium in 2000.

Scenario 6 - hidef receiver penetration roughly analogous to the pay-TV experience in Canada; ie, 10% of total cable subscribers in first year, reaching 25% by year five.

Exhibit 5-12

Projected Growth in HDTV Receiver Sales - US



□ 1990 start, high penetration

\+ 1993 start, high penetration

◇ 1993 start, penetration based on VCR growth.

Assumptions

High penetration scenarios assume HDTV receiver sales beginning at 10% of smart receiver sales, rising to 50% of smart receiver sales by the year 2000.

The VCR penetration scenario assumes HDTV receiver sales beginning in 1992 at 1% of digital sales, rising to 36% in the year 2000; ie, this approximates the VCR growth experience between 1978 and 1986.

Exhibit 5-13

Penetration of HDTV Receivers as a Percentage of Total Installed Receiver Base - Canada

	Scenarios		
	4 Multiple Hidef 1992 start	5 Multiple Hidef 1995 start	6 Premium 'Hidef' service 1995 start
1992	1%	-	-
1993	1%	-	-
1994	4%	-	-
1995	5%	1%	1%
1996	9%	2%	1%
1997	15%	4%	3%
1998	19%	5%	4%
1999	22%	9%	8%
2000	30%	17%	14%

Exhibit 5-14

Penetration of HDTV Receivers as a Percentage of Total Installed Receiver Base - US

	Scenarios		
	1990 high penetration	1993 high penetration	1993 based on VCR growth pattern
1990	2%	-	-
1991	3%	-	-
1992	5%	-	-
1993	7%	1%	1%
1994	10%	4%	1%
1995	15%	8%	2%
1996	23%	13%	4%
1997	33%	18%	8%
1998	43%	25%	14%
1999	54%	34%	18%
2000	65%	45%	25%

Exhibit 5-13

Penetration of HDTV Receivers as a Percentage of Total Installed Receiver Base - Canada

	Scenarios		
	4 Multiple Hidef 1992 start	5 Multiple Hidef 1995 start	6 Premium 'Hidef' service 1995 start
1992	1%	-	-
1993	1%	-	-
1994	4%	-	-
1995	5%	1%	1%
1996	9%	2%	1%
1997	15%	4%	3%
1998	19%	5%	4%
1999	22%	9%	8%
2000	30%	17%	14%

5.5 Summary - Technology and Market Forecasts

Over the next decade the television industry will undergo several significant changes both from technical and institutional perspectives.

From the technical and market forecasts several conclusions can be drawn:

- The first wave of change will be experienced with the replacement of analogue based products with digital products both in the studio and the consumer television market.
- Major broadcasters are expected to commence producing in high definition within the next 5 year period as equipment prices fall and further complementary HDTV studio products become available.
- The introduction of higher definition television specialty services will likely pave the way for revised transmission formats and for creating market awareness. While the exact entry date of these services is as yet unclear, technically these services could proceed almost immediately.
- Expansion of higher definition services to the general home consumer market will likely have occurred by the early 1990s. Based on market projections, these services are predicted to be well on their way by the year 2000 with market penetration in the US of hidef receivers expected to be 25%-65% and 14%-30% in Canada (based on conservative and optimistic scenarios).

There is an enormous amount of preparation which will be required in Canada (both technically and institutionally) to accomplish a smooth transition into these new technologies. The impacts to Canada of the entry of these new products and services are examined in the next sections of the report. Recommendations on action plans (both research programs and applications project initiatives) which would prepare Canada for these changes, follows the impact analyses.

6.0 CULTURAL/SOCIETAL/INSTITUTIONAL IMPACT

In this first impact section, the cultural, societal, and institutional impacts of the advent of new TV technologies is assessed. It represents the broadest view of the impact and provides an overall framework for later sections on industrial and economic impacts.

6.1 Methodology

The lack of fundamental, primary socio-economic research on television, let alone the impact of past enhancements such as colour, makes the task of assessing the potential impact of a new, but incremental, TV technology extremely difficult. From a sociological (or social psychological) point of view, we know little more than that television has joined the ranks (along with the family, the church and the law) as a major socializing factor in our society. Until some experience with actual use of digital and HDTV systems is available for observation, conclusions about impact will continue to have a speculative but reasoned character.

The methodology and approach to task 5 has three linked components that provide the framework and the content for the analysis discussed in this section: the analysis, research and York University participation.

6.1.1 Events, Implications, and Key Issues

From the development scenarios drawn in tasks 2 and 3 and summarized in section 1, an eleven stage progression path of smart digital and HDTV systems was developed to provide an analytical framework for the assessment of cultural/societal/institutional impacts. For each stage, first and second order implications have been suggested to provide a basis for overall conclusions. Implications were generated by a combination of expert opinion, a York University faculty workshop, available literature and findings from other project tasks. Finally, first and second order implications were distilled to form broadly based perspectives on key cultural/societal and institutional issues.

6.1.2 Expert Opinion and Historical Research

The purpose of conducting interviews with various experts in a range of disciplines was to provide insights and informed commentary on possible applications of digital and HDTV technologies as they might become available in North America. The intent was not to seek consensus on timing of introduction or on the likelihood of certain applications, but rather to raise issues or questions of impact within their areas of expertise and knowledge.

6.1.3 Colour Television

Introduction

The Canadian colour television policy was released by the federal government in June, 1965. The first overnight test of colour was conducted by the CBC on July 1, 1966 followed by the first colour broadcast of Canadian programming on September 1, 1966. The CBC started full colour service in 1967 with 30 hours per week of colour programming (10 of which was CBC produced). The US networks had started colour service earlier than Canada (1954) but introduced it incrementally over a period of ten years until colour began to gain prominence over monochrome service in the mid-1960s. This transition from monochrome to colour television had little social or cultural impact but had a transformative impact on broadcasting institutions. Broadcasting can be divided into three primary sectors: production, distribution and reception.

Production

New program formats and production techniques evolved from the introduction of colour television. The enhanced visual impact and realism of colour television led to new programs designed to accentuate visual rather than linguistic content (ie. wildlife, sports programs). Colour television also permitted utilization of new production techniques (ie. chromakey), which enabled images to be overlayed, reducing costs and increasing production flexibility.

HDTV is likely to follow this pattern, combining improved resolution, a wider aspect ratio and digital production and post production techniques to further transform the nature of television production into a more visually focussed medium.

Distribution

As with colour television, HDTV will require that distribution systems be upgraded to accomodate new types of signal emissions. The added cost of this may centralize production until the technology matures, drawing funds from program production. This tendency contributed to the slow development of colour systems in the US and will likely have a similar impact on HDTV development in both the US and Canada.

Reception

The transformation from monochrome to colour television required the purchase of a new set to receive colour signals, but those signals were compatible with black and white receivers. A similar scenario is under study for HDTV whereby the HDTV signal would be receivable on either existing NTSC or HDTV sets. The question of compatibility of receivers is fundamental to the introduction and future development of HDTV, as it was with the transformation from black and white to colour television.

6.2 Background - Basic Premise

By all accounts, the impact of television on Canadian society and culture has been massive and pervasive, affecting social/political/economic relationships among people and between society and individuals. Although the introduction of colour TV, stereo radio, new delivery systems (cable and satellite) and VCRs have been very important commercially, their impact on society has been incremental only when compared with television itself. This leads to the basic premise to be examined in the societal, cultural, and institutional impact assessment: that the new TV technologies are expected to continue the enhancement of the communications use and capability of the television set rather than produce transformative change.

6.3 Impact Assessment

6.3.1 Impact Framework

In order to provide a framework for organizing and containing information pertinent to the implications of digital and HDTV systems, a ten stage progression of possible development has been distilled from the scenarios articulated more fully in section 1.

Development time frames are less relevant in the socio-cultural assessment than in the projections leading to conclusions on industrial and commercial market potential for the technologies. This analysis assumes a development progression and seeks to identify impacts without particular regard for the accuracy of the "start date". What is more important to the socio-cultural analysis than the year in which a certain level of market activity is reached, is the qualitative relationship, or set of linkages, in the development progression. In other words, the framework is essentially time frame insensitive. And finally, the framework calls for first and second order impacts that are possible, with probability being governed by judgement.

Exhibit 6-1 lists the elements of an eleven stage development progression for digital and HDTV systems socio-cultural impact identification.

6.4 Impact Identification

The socio-cultural-institutional impacts for each stage in the eleven step development process outined in the previous section are itemized sequentially in Exhibits 6-2 to 6-11. A read through of the

Exhibit 6-1

Eleven Stage Progression of Smart and HDTV Systems Cultural/Societal/Institutional Impact

Stage	Progression Element
1	Non-standardized digital and HDTV set development
2	Agreement reached on HDTV studio standards
3	Use of digital and HDTV prototypes by producers
4	Smart sets introduced in marketplace
5	Advanced digital sets introduced in marketplace
6	Movement from conventional to modular television systems
7	Initial marketing push to producers and broadcasters to ensure HDTV format software availability
8	Initial HDTV service by satellite to theatres and bars
9	Marketplace adoption of specific HDTV transmission system
10	Initial penetration of HDTV sets, VCR's videodisc player/recorders and software
11	Full HDTV service to the home, theatre, institutions, etc

Exhibit 6-2

Stage One: Non-standardized digital and high definition television development

Primary Impact

- new high tech product development permits expansion of potential market for all television equipment through indirect improvement of analogue and digital components;
- spinoff peripheral technologies for digital and HDTV (eg. wave generators, test pattern equipment, etc) may create new businesses;
- lack of standards may create risk barrier to entry for small manufacturers;
- no specific cultural or societal impact at this point.

Secondary Effects

- potential new market and product development opportunities for Canadian manufacturers;
- may establish a need to assist digital and HDTV development to support fledgling industries and preserve employment; otherwise HDTV introduction could threaten existing industrial capability.

Exhibit 6-3

Stage Two: Agreement Reached on HDTV Studio Standards

Primary Impact

- Focus of research activities on selected standard
- Standardization of studio product lines for manufacturers
- Earlier implementation of HDTV suites by majority of broadcasters

Secondary Effects

- Possible increased interest in early specialty service development
- Growth in export markets for HDTV software

Exhibit 6-4

Stage Three: Use of prototypes by film and TV producers

Primary Impact

- use of prototypes will begin to establish HDTV as a competitive system for feature length production;
- high cost of use of prototypes could give advantage to companies with most resources, reinforcing centralization of production in existing large production companies and production centres geographically.

Secondary Effects

- familiarity with new medium will permit smoother transition to HDTV production standards;
- prototype use will help signal need for software in future stages of HDTV market penetration.

Exhibit 6-5

Stage Four: Basic smart sets introduced (no picture in picture or improved resolution)

Primary Impact

- improved sales of TV receivers;
- videophiles (innovators) will be first target market.

Secondary Effects

- greater reliability of sets and ease of repair;
- digitization will require retraining or hiring of computer literate technicians;
- may permit self-diagnosis of technical problems by consumer.

Exhibit 6-6

Stage Five: Advanced smart sets introduced (picture in picture, higher resolution, computer compatible, etc.)

Primary Impact

- some change in programming needed to take advantage of smart features (eg. interactive content);
- multiple use receiver could reduce viewing of network television programming;
- better resolution, improved flexibility and interactivity will stimulate use of digital sets as the centre of the homes information retrieval and entertainment activity (centralization of information/ entertainment activity);
- large initial increase in viewership expected - novelty;
- picture in picture, freeze frame and storage, hard copy printout will increase the scope of interactive uses for the digital set;
- investment in digital sets (even conventional 4:3 aspect ratio) may displace spending on film, theatre and other cultural activities in the short term;
- initially videophiles, high income purchasers and institutions will be target market ("innovators and early adopters");
- film: there could be a drop in film distribution in the short term;
- video: digitization may improve demand for video software (smart or MUSE coded VCRs and software will further accelerate this trend);
- conversion to digital production systems is more likely to occur first in major centres.

Secondary Effects

- improved resolution will show up existing detail, and thus will require more visually attractive content, more detail;
- improved resolution will speed use of digital set for non-broadcast uses (eg. videotex, computer uses, games);
- integration and centralization of home entertainment/information activity could produce greater family conflict as each vies for his own viewing preference;
- more activity in the home and with family could reduce community contact and may have an impact on volunteer based organizations;
- improved quality may draw higher income groups to more television viewing overall;
- centralization of digital production in the short term;
- vulnerability of Canadian broadcasters to higher quality foreign services prior to delivery of competitive Canadian programming;
- increased need for interactive programming as an incentive to buy sets.

Exhibit 6-7

Stage Six: Movement from conventional to modular television systems

Primary Impacts

- modular systems will erode the concept of TV use for the reception of broadcast programs only;
- the movement to modular television will permit the upgrading of part of the system without the financial cost of upgrading the entire system. This is expected to be pivotal to the introduction of HDTV, requiring only the replacement of the monitor;
- the move to modular television may permit market entry for new high tech companies in the manufacturing of individual components.

Secondary Effects

- could erode dominance of foreign multinationals and provide opportunity for Canadian firms in specialized areas;
- increase in use of stereo speakers for enhanced audio experience.

Exhibit 6-8

Stage Seven: Marketing push to producers and broadcasters ensure HDTV format software availability

Primary Impacts

- fundamental change in production techniques, film vs. traditional TV;
- boost to film producers who have readily convertible content (aspect ratio 5 x 3);
- high initial cost will centralize production (subsidized decentralization may be necessary);
- US content is likely to be the first available; strong incentives must be present for Canadian production industry;
- performing arts - boom or bust? (Will money be funnelled from production to HDTV hardware?);
- combination of film and HDTV will integrate film and television production techniques - best aspects, most cost efficient features of each will be used;
- major business opportunity in short term to transfer existing 35mm film to HDTV format.

Secondary Effects

- push to integrate film and HDTV production to ensure large software supply to support hardware market sales;
- incentives will be required for Canadian HDTV production industry.

Exhibit 6-9

Stage Eight: Initial HDTV service to theatres, bars

Primary Impact

- an increase in integrated film - HDTV production;
- boost for special events production due to possible changing role of theatres from first run, to combined first run and special event outlets;
- sporting and special events are expected to be the real drawing card for HDTV service to theatres and bars;
- not expected to have a major impact on performing arts attendance;
- the use of regulated delivery mechanisms will permit government regulation of content;
- offers similar appeal that current film does compared to home videocassette viewing;
- increase in community viewing;
- centralization of production will be lessened by need for production crews to travel to where special events are occurring;
- major impetus to completion of the integration of film and HDTV;
- linkage and integration of film and video distribution systems should occur;
- service to theatres will not transform the traditional theatre but will give it a new wider market;
- hard copies would be circulated, limiting the opportunity for duplication.

Secondary Effects

- potential increase in bar business revenues;
- mobile HDTV production units will become common;
- centralization of in-studio production will continue;
- less piracy due to control of master in central uplink facility.

Exhibit 6-10

Stage Nine: Marketplace Adoption of Specific HDTV Transmission Systems

Primary Impact

- full scale gear-up to produce HDTV sets and associated hardware;
- standardization will permit long term consumer choices - reduce worry about compatibility and obsolescence;
- standards agreement will determine the transmission and reception specifications and regulations for the Canadian market.

Secondary Effects

- production of HDTV and smart VCRs, videodisc player/recorders, videotex and computer terminals adjusted to conform to new standard;
- new purchases may interrupt traditional product replacement cycles.

Exhibit 6-11

Stage Ten: Initial penetration of HDTV sets, VCRs and videodisc players/recorders and software

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Primary Impact

- increase in home viewing of films;
- boost for "high culture" production - due to initial market penetration in high income homes;
- high production costs for new production of Canadian content difficult to sustain if market too small to recoup costs;
- if tape and disc are the main initial software sources for inhome viewers, there will be no regulated control guarantee of Canadian content;
- high cost of equipment transfer to HDTV may further retard input of capital for production in Canada;
- value of NTSC 4x3 television productions will decline;
- increased screen size: the wiser (5 x 3) aspect ratio is the only visible change for the audience (smart enhanced resolution will have already had an impact on the audience);
- home environment: the novelty of HDTV may generate more communal viewing and home entertainment;
- number of viewers could increase dramatically due to obvious superiority of system (eg. high income innovators and early adaptors);
- a wider aspect radio matches most performing arts stage configurations (at 5 x 3) thereby improving the forum for performing arts content;
- incramental nature of HDTV (only some modules needed to upgrade to HDTV) means consumer hardware cost will be lower than for non-modular system transition;
- HDTV could be cost effective replacement for a trip to movies (an incremental incentive added to current VCR usage);
- there should be a large positive impact on HDTV VCR's and videodisc hardware;
- impact on broadcasters - conversion to HDTV first in major centres;
- negative impact on film distributors due to more stay at home viewers;
- theatre audiences could decline due to novelty of HDTV and quality of visual strength in home viewing;

Secondary Effects

- in absence of domestic product, foreign HDTV content could be even more attractive;
- possible capture of market by foreign suppliers;
- negative impact on syndication of NTSC programs;
- home environment: greater space required for larger set;
- range of uses increased by professional institutional use;
- high resolution and freeze frame hard copy availability may encourage greater interest in visual art or visually based programming;
- capital may be diverted from film theatres to HDTV conversion and production;
- centralization of production of both programs and commercials.

Exhibit 6-12

Stage Eleven: Full HDTV service to the home, theatres, institutions, etc.

Primary Impact

- increase in home viewing of films;
- HDTV production: uncertainty lifted, large production boom to provide content for new service despite cost of equipment;
- performing arts: impact will depend on institutional structure of delivery system;
- labour: large, short term increase in number of employees needed (incremental progression to HDTV provided for less radical upheaval of labour force);
- since the system can be regulated, Canadian content will be protected to some extent, however production economies are expected to favour foreign material;
- increased need for interactive content;
- new wider aspect ratio will require change in production techniques to take advantage of HDTV's film-like characteristica;
- the overall audience for television could grow as more high income level viewers are drawn by high quality product and enhanced viewing experience;
- there may be a slight drop in movie theatre attendence initially (greater competitive measures will be taken by theatres);
- viewer choice expanded - off air, disc, tape, or go out to the theatre for HDTV service leading to integration and competition in software;
- more time may be spent inside at the HDTV information - entertainment centre in the home due to convenience and lower cost;
- more disposable household income will be spent on hardware and software for HDTV and other communication services;
- production will remain centralized until costs fall to a point where diffusion will occur.

Secondary Effects

- choice between interactive and regular programming;
- pressure for multiple reception sets to handle priority setting and multiple home users;
- high cost of HDTV production equipment may have severe negative effect on affiliate and independent stations operating on a low budget;
- advertising production will also remain centralized due to cost of production - perhaps the mobile units used for special event coverage will be the model for lower cost, portable HDTV production systems;
- only largest advertisers will be able to afford HDTV ads, initially providing a big boost in market place for large corporations;
- film and video distribution impact will depend on regulatory and institutional structure for delivery of HDTV.

primary and secondary impacts illustrates the breadth of the consequences of new TV technologies in economic and industrial as well as cultural/societal/institutional dimensions. The criteria for the separation of primary and secondary impacts is necessarily arbitrary. Primary impacts are selected based on their linkage to the relevant stage in the progression. Secondary effects are subsections of the primary impacts. The synthesis of these potential impacts forms part of the section's conclusions discussed below.

For example, the timing of the HDTV adoption of all system standards is speculative, and will have direct impact on numerous societal, cultural and institutional development factors.

Wanting to standardize the HDTV technology will recreate the AM stereo chaos that the radio industry has just suffered through. If we learned anything from that situation it was that waiting for the "marketplace" to make the system level decisions is a very naive approach. A clear definition of the major system parameters eliminates false starts, duplications of effort and avoids confusion in the marketplace. Too much regulation, on the other hand, can have an equally detrimental effect. Attempts to specify detailed performance characteristics before gaining experience with real systems can seriously limit the flexibility required to build a realiable system that fulfills the consumers needs. Regulation is therefore a delicate matter that, if applied with foresight and intelligence, can help, rather than hinder the development of new services and reduce the negative societal, cultural and instutitional impacts in the Canadian HDTV market.

6.5 Perspectives on Key Issues

Based on a combination of findings, conclusions and opinions gathered from the impact assessment, interviews, the York workshop, other study tasks and the study team itself, perspectives on key cultural, societal and institutional importance are addressed in this section. The comments offered are more directional than conclusive and often serve to raise additional questions or suggest answers of more narrowly focused investigation.

6.5.1 Cultural (Industries) Issues

- How will HDTV affect performing arts industries?

The question of whether HDTV will enhance or be detrimental to Canadian performing arts may turn out to have an answer of not much impact at all. On one hand the demonstrated Canadian appetite for serious performance program viewing in the home is small. The failure of C-Channel and the Entertainment Channel, and the Arts Channel in the US suggest that the target market segment was a fragment, just too small to support a viable commercial service. It is inarguable that HDTV would provide an enhanced viewing experience, but it is not at all clear that picture resolution improvement would provide enough viewer motivation to create a home consumer niche to the detriment of theatre or concert box office revenues.

Enhanced audio capabilities, already popular and expected to increase as more stereo television services evolve, will have an effect on programming areas including music and performing arts. The popularity of Hifi VCRs and existing stereo music channels (ie. MuchMusic) is evidence of this trend.

Multichannel sound capability will allow bilingual soundtracks to be encoded on the television signal. This is especially useful in bilingual or multilingual countries such as Canada.

On the other hand, the availability of much improved performing arts programming delivered to the home may create, over time, more broadly based awareness and thus increased audiences not only for in home viewing but also for live attendance.

- How will investment be split between hardware and programming?

Whether equipping the Canadian broadcasting system with the new TV technologies will divert investments in programming is close to being a fact for many industry observers. The negative impact on the health of program production (perhaps short term only) is less than the risk to the whole industry if the Canadian system is not upgraded, leaving Canadian viewers with inferior domestic service competing with foreign enhanced product. There is little choice but to make the technological and hardware investment to ensure that Canadian broadcasters remain competitive in the North American marketplace. However, the investment can be phased and remains relatively small compared to the annual operating expenses of broadcasters.

- Will a US head start further divert Canadian audiences?

Given that the US has repeatedly developed new broadcasting services (ie. television, colour television, pay television) faster than their Canadian counterparts, the answer has to be an emphatic yes. Historically, Canadian audiences have been exposed to increasing amounts of American programming, even after Canadian broadcasters provided comparable services. Syphoning of audiences to available American programming would have a primary direct audience impact in Canada and a secondary program production industry impact, for both advertising and subscription-based services.

Viewer pressure for cable companies to carry the attractive US programming would eventually lead to their authority to do so. This would have the effect of encouraging a more rapid build-up of receivers in Canada and an audience siphoned from Canadian discretionary service subscribers and Canadian broadcasting service viewers.

Audience declines have translated into lower ratings for conventional television but this has not led to lost revenues. One main reason is the simultaneous substitution practice of cable operators which would no longer be possible if systems were not compatible.*

- Would the size in programming costs preclude the Canadian production industry from competing with Hollywood?

Any significant increase in programming costs would effectively reinforce the US, Hollywood-based concentration in movie production. Even with the current cost structure of "blockbusters" or generally high end productions, Canadian producers cannot compete. The risk to the Canadian production industry is in the lower budget area wherein Canadian producers compete more successfully.

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* Simultaneous substitution permits Canadian cable operators to substitute Canadian advertisements on US programming shown simultaneously on a US and Canadian station.

6.6 Societal Issues

- Will consumers' viewing habits change?

With the enhanced viewing attributes of the new TV technologies, there is little doubt that viewing habits will be altered in some way. Those program formats and subject matters that especially lend themselves to the new technologies may be selected more frequently (eg. more home movie viewing). However, this observation does not lead necessarily to the conclusion that viewers (or society) will spend more time watching television generally. There are no predictions, for example, that children will watch more than the current 24 hours per week average because of a better picture. Furthermore, there is no evidence that enhanced viewing will keep people in homes versus going out. What does seem reasonable to conclude is that viewers will have an enhanced viewing experience when they choose to watch. In other words, HDTV is not expected to provide sufficient motivation to cause people to substitute more "home" behaviour for "going out" behaviour per se.

It is assumed that new TV technologies will reinforce the trend toward greater choice in television products and services (although it may even lead to a decrease in actual programming offerings). The TV viewer is expected to pay more for this choice, as has been the trend over the last two decades. New TV technologies should provide further options for the viewer for additional costs, but not necessarily lead to an increase in TV viewership in terms of hours per week.

- How will consumer expenditures and leisure time be affected?

Decades ago when most homes were equipped with a telephone, a phonograph, a radio and a black and white television, who thought we needed anything more? In fact, there has been nothing but a continuous stream, accelerated more recently, of new or upgraded home electronic devices competing for the household disposable dollar. With many households now being run like small businesses (with two income streams) purchase decisions increasingly are based on factors such as: demonstrated needs; cost/performance criteria; budgeted replacement cycles; etc. The impact of any new, incremental home entertainment enhancement is expected to face tighter scrutiny and competition from other home electronic products.

The impact of enhanced and HDTV services on leisure time is harder to judge. With some similarity to pressure on consumer expenditures, the number of choices available to consumers of leisure time is enormous - television is but one.

Recent history suggests that we have more leisure time than our parents and much more than our grandparents. When the nature of work was much more physically demanding, leisure was often defined more passively in terms of resting, than actively in the pursuit of challenge or stimulation. For much of today's society, leisure time means doing something or at least a combination of active/passive pursuits. If the current underlying trends towards activity, coupled with the attention to personal health and fitness care persist, it is reasonable to expect no major increase in the uptake of passive leisure time would occur because of an incremental TV enhancement.

What could in fact occur is more pronounced use of the TV/display system for interactive purposes - games, personal productivity, polling, alternative TV serials and the like. Again, this trend would fit the use of leisure time, not the amount.

- How will TV technologies affect users in applications such as training and videoconferencing?

Aside from the cost/benefit assessment of these types of applications, an improvement in screen resolution is indeed a positive factor for the user/viewer. However, teleconferencing has associated with it such a number of complex, and perceived to be negative, user factors, that screen resolution alone is unlikely to cause any surge in peoples willingness to use it. The main barrier to increased teleconferencing is cost, which is pushing development of "slow scan" and other bandwidth economies, ie. the opposite direction of higher definition.

The high resolution benefit in training systems is equally hard to make a case for dramatic increase in use. There will be benefits from applications such as "video lectures" in which the viewer can readily see and relate to the speaker as compared to a "speck at the podium". Interactive training applications with high definition and optical disc storage and retrieval technology provide another illustration of benefits that new TV technologies will contribute to but not in a fundamental way.

- <u>How will professions such as teaching, legal, and medical be affected?</u>

The training implications, generally, have been referred to above. Benefits will be associated with highly specialized medical procedures eg. microscopic surgical techniques that would be better communicated with HDTV. Overall, however, the professions are not expected to be major forefront users of the new TV technologies. The professional users will certainly not constitute a large enough market to influence the development of HDTV.

6.7 Institutional Issues

- <u>Will broadcasting systems become more centralized?</u>

Because of the high cost of installing enhanced or HDTV systems, independent stations may decline in number if their economic base (marketplace) is too small to justify the cost or even amortize the high capital investment over the longer term. This is particularly so if HDTV/EDTV delivery systems will require satellite-to-cable or direct-to-home technology rather than over the air.

Somewhat like the development of dual format radio transmission with AM and FM, some broadcasters in either mode have been more successful than others in exploiting the higher quality FM technology. Unlike a decision to invest in FM, however, the stakes are much higher for an HDTV entrant. This factor should lead to increased centralization.

- Will HDTV produce pressure to separate CBC's programming from distribution functions?

It is unlikely that HDTV would prove the argument to separate CBC programming and distribution functions or conversely to keep them together. If HDTV had any influence on the question, the outcome would more likely be based on the nature of predominant CBC programs content and format (eg. entertainment event vs talk show).

- What will be the impact on integration of movie and television product business?

The expanded use of digital video production techniques will continue the integration of movie and television product business that is already well underway without the spur of the new technologies. The trend toward integration will naturally and inevitably continue.

- How will the advertiser/broadcaster relationship change?

While it is expected that advertisers will continue to follow the programming, there will be some advantage for large, well resourced national and international advertisers over smaller, local firms who may not have the resources for higher budget productions or the access to centralized (or at least concentrated) HDTV production studios.

- How will theatrical and video cassettes change as cinemas obtain product direct from distributors?

The major impact of cinemas obtaining their product directly from producers will be that studios will be able to negotiate an even bigger slice of box office revenues - a typical outcome anytime a distribution chain is shortened. However, the main market will be the home. Distribution to the home via cassette or cable should continue to be as competitive as these delivery systems are today.

6.8 Impact Conclusions

From a distillation of primary and secondary impacts along the ten stage progression described earlier in this chapter and from the examination of key issues, there are, however, major implications that can be summarized as important consequences of or conclusions on HDTV impact.

6.8.1 No Transformative Change

In terms of broad cultural/societal/institutional impact, the original premise still stands - new TV technologies do not represent a transformative change to society. While new TV technologies will indeed cause substantial change to the broadcasting industry, this will not be the case on a more general level.

The new TV technologies are part of the much larger field of information technology that has the potential to change many aspects of social and cultural endeavour. Progress in finding useful technology applications has the effect of improving the communications infrastructure. The contribution of digital and HDTV system applications can be discerned readily in industrial and economic terms, and strategies articulated to provide for a Canadian stake in the spoils.

The contribution of digital and HDTV systems to the socio-cultural aspects of life are far more elusive. The old question "Is bigger better?" puts forward the difficulty of resolving the "evaluation of benefits" issue in other than economic terms. There is no available yardstick to determine whether enhanced digital video training, for example, is better or any more socially desirable, than face-to-face classrooms, unless economic parameters such as cost or resource allocation benefits are brought to bear in the analysis. Moreover, the burden of proof on the relative importance of a perceived socio-cultural impact (or benefit) has to be weighed against economic cost parameters and the importance of societal interest being served as defined by commonly held objectives and values.

The intensity of the socio-cultural impact of digital and HDTV systems is further diluted because they are expected to be used in ways that will improve the communications and information infrastructure only incrementally. In other words, the potential for these technologies to have a very large socio-cultural impact is by definition much smaller, than if their use could be expected to create fundamentally new ways of doing new things.

Moreover, because Canada will be a recipient, rather than a pioneering marketplace for the new technologies, the real impact will occur only after the transition to HDTV is well underway in the marketplace.

6.8.2 Broadcasting Industry

While from a socio-cultural point of view digital and HDTV technologies are expected to have an evolutionary impact, the institutional impact on the broadcasting (and film production) industry is likely to be more pronounced and the timing of change more compressed. The broadcasting industry will make the new format transition not because of their fascination with the new technologies but because their need to produce and distribute programming.

The implementation of the new technologies will affect the whole industry eventually and not just components in isolation. The infrastructure of the television industry required to put product into households is huge. The investment in the industry in programming, production and distribution is valued at some $3 billion annually and it is this base that will have to adapt to the technology change.

While perhaps not "transformative", the shift to digital and HDTV systems can be expected to cause a strengthening of the industry's annual capitalization rate, currently in excess of $150 million. Because of the potential temporary or short-term upset in traditional capital to labour ratios for the industry when the transition to new standards occur, there is a real need for longer term capital budgeting in the industry as a whole, but especially for the CBC.

Institutionally, the impact will have to be absorbed comparatively quickly and simultaneously in programming, production and distribution areas of activity. The need for parallel progress on these three fronts will present a significant internal organizational challenge to broadcasters large and small alike. Perhaps the most useful role the federal government can play is that of a catalyst to industry awareness of the development and timing of these new TV technologies, as well as the implications as to delivery (including the role of cable and carriers). No opportunities should be lost to help facilitate this evolution through greater awareness of the changes taking place. While the technical side of an organization may be comparatively well informed, the management and planning groups may be a more important audience.

6.8.3 Consumer Spending

Consumer spending on home information and entertainment products has reached a point where the aggregate market is 'big business'. Although the impact of how the disposable household income is spent is more a point of economic analysis than socio-cultural impact, there is a broad societal consequence to any domestic marketplace supplied with products and services that are essentially imported. Because the prospects for hardware development, and to some extent hardware manufacturing, are not large for Canada, the domestic production of content becomes all the more important from a socio-economic perspective. The impact on direct employment and capital investment alone is worthy of note when billions of dollars are spent on foreign product and services - some of which could be provided domestically if the consumer spent his disposable income differently. This is evident in the increasing presence of foreign, particularly Japanese automobiles and consumer electronic equipment, as well as in Canada's growing tourism deficit.

6.8.4 Program Content

The cultural consequence of an American head start over Canada in the transition to HDTV format for television programming is a further exacerbation of the pervasiveness of American culture as portrayed in program content, in Canada. As market acceptance and hardware penetration grow, Canadian program demand will be met, as it was in the first days of colour television, by American product alone. Because there is less of an economic rationale for Canada to pioneer digital and HDTV systems, it could well be a follower in the development of (Canadian) content software.

At some point in the early evolution of widespread introduction of HDTV, the area of most significant cultural risk would be to have no developed capability to convert existing 35mm Canadian content to the new HDTV format. Based on expert views, this lack of capability is potentially more serious than starting the transition in program production methods late. The skills and training required to move from film to HDTV process production, including equipment familiarity, has a technical learning curve not unlike that for Electronic News Gathering (ENG) technology--a matter of weeks not years.

6.8.5 Equity of Access

Canadian communications and transportation public policy has long had, as a base objective, the provision of services to all parts of the country. Indeed, the expansion of coverage for publicly owned broadcasting systems has often taken precedence over program development and production in budget and capital allocation decisions.

While federal policy may not be the appropriate instrument to balance spending between hardware and software investment decisions, it will have an important role to play in the design of the distribution system to ensure that, within a reasonable time frame, the service is available to "all Canadians" and not solely those in densely populated, lucrative markets.

The design of the distribution system must also be reflective of the more specialized needs of Canadian socio-cultural geography. It may well be that specialized applications (eg. rural/remote training needs, special communication support for long term offshore operations, production and exchange of visual and performing arts among communities) will require more capacity in the system, or perhaps a different configuration of the network. The potential role, in industrial terms, for a public instrument or vehicle is more fully explored in section 12, under applications programs.

6.9 Conclusion

While the social/cultural impact of the introduction of new television technologies is expected to be incremental, the impact on television institutions is expected to be pronounced and transformative. Consequently, television institutions including broadcasters, production houses and distribution facilities must begin to prepare for the impending transformation to digital and high definition systems to enable them to meet the challenge from foreign television institutions.

Program Production

Financially successful Canadian program production is considered essential to the social and cultural development of the Canadian public. The program production sector is also a vital component in Canada's industrial growth, particularly in high technology areas. With the introduction of digital and high definition production systems, Canadian producers will be faced with increasing competition from foreign programming sources, especially if foreign and particularly American producers get a substantial headstart in high definition program production.

To understand the institutional implications of an American headstart in HDTV program production, it is instructive to look at current import, export and domestic production figures to determine the scope of the potential problem.

Import

The total value of imported programming in Canada in the 1983-84 season, was close to $435 million. Exhibit 6-13 shows the breakdown by program category.

Exhibit 6-13

Total Value of Imported Programming

($ millions, 1983-84)

Television	190
Feature Film	125
Home Video	75
Pay-TV	20
Syndication	25
Total	435

Source: Nordicity Group Home Video Survey
Statistics Canada
CBC Annual Report 1982-83, 1983-84

Export

Combined Canadian film and video exports totalled $18.9 million in 1982-83*, with $18.7 million accruing to production companies and $180 thousand paid to distributors. The breakdown per program area is as follows:

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* Figures for 1983-84 not available

Exhibit 6-14

Total Value of Exported Programming

($ millions 1982-83)

Television Programs	8.29 million = 44%
Television Commercials	3.91 million = 21%
Feature Film	2.84 million = 15%
Short Film	.18 million = 1%
Industrial/Educational	3.52 million = 19%
Total	18.7 million = 100%

Source: CPER Analysis of Capabilities and Needs of Canada's Cultural Industries in Foreign Marketing

The CBC accounted for over $5 million of the total exports of television programs with independent and private broadcasters providing the remainder.

Domestic

In 1983, the total expenditure on Canadian programming was over one billion dollars. Exhibit 6-15 illustrates the breakdown per production sector.

Exhibit 6-15

Total Value of Domestic Programs

($ 1983)

Television	906,683,000
Film	98,589,000
Pay Television	20,000,000
Total	$1,025,272,000

Source: Statistics Canada

When comparing the import export and domestic program production figures, it is clear that a massive trade deficit has emerged. With close to $435 million flowing out of Canada for foreign programming and only $18.9 million flowing back to producers and distributors the negative trade balance for the 1983 season was approximately $416 million. This negative trade balance will likely grow with the introduction of HDTV service in Canada, unless measures are taken to ensure a substantial body of Canadian HDTV programs are developed for export.

The figures for domestic production are an encouraging sign that this will occur. With over one billion dollars invested in Canadian programming in 1983, the problem is not that sufficient funding for production is unavailable. One problem is that the expenditures are spread among too many productions, reducing the expenditure per program to a point where they are no longer qualitatively competitive in international markets. Additionally, the bulk of production expenditures are allotted to programs of specific Canadian interest (ie. news, information, sports), excluding them from prospective international sales.

Insufficient funding in high export demand program areas such as drama, variety and children's programming contributes to the magnitude of the trade deficit as these programs are imported for a fraction of the comparable Canadian production cost.

The fundamental policy question is whether the cross-subsidization of Canadian programming from the profits earned through the exhibition of foreign content, produces more tangible social cultural and institutional benefits for Canadians than if the situation were altered to prevent such massive importation of foreign programming. It may be argued that a reduction in foreign program imports would reduce the funds available for Canadian productions, thus lowering the overall standard of Canadian programming at a time when a higher quality transmission technology (HDTV) will be introduced. Consequently, the thrust must be to improve the quality of the Canadian programs of potential export value as the transformation to HDTV production standards progresses. This will improve the trade balance and potentially improve the viewership of Canadian programming both in Canada and in international markets.

Telefilm Canada

Telefilm Canada plays a central role in program production for independent Canadian producers and a growing role in network productions. However, the current mandate of Telefilm prevents it from participating in HDTV production of any kind. The mandate enables Telefilm to contribute funding only to productions intended for off-air broadcast. If HDTV is initially distributed via tape or optical disc, Telefilm would have no mandate to contribute to productions for these formats. More importantly, HDTV will never be an off-air system, eventually expected to be distributed via satellite (DBS) or satellite to cable. To continue as a viable entity and to fulfill the spirit of its mandate, Telefilm must have its mandate expanded to encompass these delivery mechanisms.

Telefilm anticipates a direct relationship between HDTV production costs and the advent of a Canadian HDTV production industry. Costs must be competitive or lower than existing formats to stimulate HDTV production. Additionally, an HDTV broadcasting service must exist and a strong commitment to HDTV productions must be displayed by that service prior to any commitment of funds by Telefilm. These factors indicate the need for a cooperative effort among producers, network broadcasters, Telefilm and the federal government to ensure HDTV production is established in Canada. According to Telefilm, effective training programs for producers and technicians are central to any such cooperative exercise.

Future Scenarios - Economic Impacts

Scenario One - HDTV to Mini Theatres, Bars

This scenario is important because it clearly illustrates the economic problems associated with the launch of HDTV services. Initially, program sources are likely to be special entertainment events, sports, and to a lesser extent feature films. While Canadian sports could supply an adequate amount of content, it is unlikely that Canadian entertainment and feature films could be quantitatively sufficient to meet anticipated demand. Since this type of service would be regulated as a common carrier, no control of Canadian content would be possible. This could add to the already considerable negative trade balance in program production currently experienced in Canada. Despite considerable domestic production, the primary types of programs for this type of service, other than sports, are dominated by foreign program sources. This trend is expected to continue in the time frame projected for the introduction of this service.

Scenario Two - HDTV to Home Subscribers

The economic impact of this scenario will depend on the institutional structure chosen by broadcasters for the HDTV network. Currently, various networks exist in Canada. Whether these networks combine forces to create one HDTV channel, or convert to HDTV on a network by network basis, will have a significant impact on broadcasters. The cost of restructuring the production and transmission infrastructure will be high, at a time when audiences for network programs are being segmented through competition from other entertainment sources. Special attention must be paid to the impact of this scenario on employment, especially if networks combine to create only one HDTV channel initially.

7.0 INDUSTRIAL IMPACT

This section examines the industrial impact of the development of TV technology on Canadian industry. It identifies the areas of opportunity for Canadian companies and research resources. It assesses the impact on broadcasters and cable operators as users of the new TV technologies and devises a focussed industrial policy program approach, taking advantage of these opportunities.

7.1 Scope and Methodology

The purpose of the industrial impact assessment is to examine the existing Canadian capabilities in terms of potential opportunities arising from the digital era and EDTV/HDTV transmission formats, as well as the potential downside impact on Canadian industry.

The scope of the assessment includes the following:

- the companies whose main business is to supply broadcasting equipment needs in studio and transmission systems;
- companies which are peripheral to industry but whose expertise could be applied to HDTV technology, as well as those companies whose product lines embrace non-broadcasting applications of television;
- program production companies supplying film and television programming for theatrical, broadcasting and video retail distribution;
- broadcasters, cable companies and carriers as the users of new television technology.

An activist approach was taken with respect to the impact assessment, primarily through the convening of an Industrial Opportunities Workshop and follow-up survey of Canadian resources - companies, government labs, and universities. Participants at the one-day workshop numbered about 60 including appropriate government program officials, the principal users (broadcasters, cable operators and carriers), and venture capitalists. The purpose of convening this mix of people was:

- to brief the supplier and user industry as to current trends in technology development around the world;
- to suggest opportunity areas for Canadian companies for discussion and feedback by the user and supplier communities;
- to brief the industry on the timing and magnitude of the advent of EDTV/HDTV systems;
- to stimulate and assess the interest of Canadian companies and research resources in new TV technologies;
- to discuss possible joint government/industry efforts at stimulating Canadian industrial development in this sector.

At the workshop, the participants separated into three panel discussions on the key opportunity areas: studio, distribution and display systems. The notes from these discussions are attached as Appendix C. An active follow-up program was undertaken to obtain a profile of the companies interested in this sector in order to extend beyond the range of companies that are immediately identifiable as suppliers to the industry. The Canadian Advanced Technology Association (CATA) was enlisted to spread the interest. A follow-up workshop is planned with a specific focus on Canadian product development and R&D priorities.

From publicly available documentation, a requirement survey undertaken by the Canadian broadcasters (to be released publicly shortly) and the follow-up industry/university/government lab survey an impact assessment was conducted. Opportunities were identified and matched against the industry suppliers. As the advent of EDTV/HDTV has major implications for Canadian broadcasters, cable operators, and to a lesser extent, carriers, the impact of these users as well as for the Canadian program production industry was assessed. Finally, strategic options and policy recommendations that emerged from the industry workshop was addressed.

7.2 Framework Statement on TV Industry

In terms of industrial impact, new TV technology is by itself difficult to measure, particularly in terms of Canadian companies. This is so because there are no major Canadian receiver manufacturers, so that the effects tend to be indirect. The second reason underlying the difficulty is that it is not easy to determine as yet whether HDTV or EDTV will "arrive" incrementally or in the form of a quantum change. The outcome of regulatory and standards development is also unknown, both in time and specification. Finally, HDTV is not, in and of itself a "transformative" technology as discussed in section 1, so that its effects are hard to determine.

A different perspective, which yields a clearer assessment of impact needs to be recognized.

7.2.1 Nature of the Opportunity

HDTV is a product of the marriage of broadcasting, computer and even communications technologies. As in so many other fields, with the arrival of digital technology and the chip comes a family of related technological advances which provide for a substantial range of opportunities. In this context, HDTV becomes one of the application areas which provides pressure for technological response and associated additional market opportunities for these new technologies. A typical example of this would be computer graphics, where advances will find large markets in the broadcasting industry, which in turn will be powered by the emergence of HDTV as the next generation of institutional and consumer demands. It is evident then that the issue of industrial "opportunity" in respect of HDTV needs to be addressed in two ways:

- those areas in which HDTV advances directly cause unique demand for new product;
- those areas in which enhanced television provides additional opportunities for technologies and products which are required for other applications, and which can be effectively utilized by HDTV.

7.2.2 Nature of the Impact

In terms of industrial impact, as a wider issue than opportunity, several considerations apply. The first and most obvious one, endemic in the Canadian industrial environment, deals with those products and services where demand will fall or disappear with the advent of "the better mousetrap". In this connection, largely under the aegis of the CBC, several new products, and new product enterprises, were launched in Canada (Central Dynamics, Leitch Video, McCurdy, etc) and were successful. The renewal of their technology and product base, under the impact of rapid technological change, must be a prime concern.

In particular, it has been noted that the dozen or so Canadian companies who developed product lines dedicated to this industry, and whose early growth was greatly supported by the encouragement of the CBC and by the stimulus of its orders - are largely 'analogue' in terms of technical discipline. For such companies, the challenge is not merely to develop new products for survival and growth; it is more formidable than that, and lies in the transformation of technical disciplines to the digital world, involving a new generation of engineering talent. Besides the challenge of developing digital hardware, these companies will typically deploy computer-aided design (CAD) technology in their internal developmental processes for productivity and competitive reasons (As will have to be done for manufacturing in general).

For the medium sized and small innovative companies, the transformation to the digital world should not be underestimated. Management, management information systems, organization, skills from emerging management to the shop floor and capital equipment expenditures, are all subject to substantial change, employing significant investment over several years.

The second concern relative to industrial impact also bears upon the special nature of the Canadian industrial base. With regard to branch plant operations such as Scientific Atlanta, for instance, the world product mandate assigned to the Canadian division needs to be reaffirmed in respect of new technologies, in order to sustain the momentum of Canadian activities. Clearly, in a period when product development and production is easily transferrable worldwide and where the central technological thrust of HDTV lies elsewhere, these resources are at some risk.

Third, there is an important institutional factor bearing on industrial impact in respect of HDTV. As noted, the CBC, as the second largest broadcast network in the world, has been in the past a powerful instrument of technological and industrial stimulation in the broadcasting manufacturing industry. Several Canadian companies owe their technical and industrial success to the role played by CBC in defining new specifications, ordering advanced product, specifying standards, and in effect assisting in the process of satisfying their own operation needs, in the launching of new products to world markets and in the absorption of front end non-recoverable costs.

Such a form of stimulation (through the actual placement of first orders for new equipment) had positive secondary and lasting effects of providing market leadership and of thereby attracting venture capital support based on that leadership.

At this time, the CBC remains as a strong and viable institution in the broadcast business. It is not at all clear however whether, in the light of the new severely curtailed budgeting regime, the CBC can sustain either its own strong technological thrust, or its role as a stimulator of industrial innovation. As implied, this is particularly a problem when the challenge lies now, not only to evoke new products and services, but also to help "push through" a new generation of technology and skill level.

Since there is no other potential Canadian actor in sight to carry out that vital role, it becomes questionable even from an institutional standpoint as to whether such new technical and market opportunities can be translated into realisable industrial opportunities, with all that implies in terms of an entrepreneurial support structure for innovation. It is interesting to note in this respect that at the "Industry Opportunities Workshop" conducted under the aegis of this future TV technologies study, this issue of the CBC's dynamic role as an industrial stimulator was emphasized very heavily by the participants from industry. Great stress was placed upon the critical need for a continuance of the role through the next generation of technological advance.

The new, currently planned CBC Toronto Broadcast Centre could be envisaged as an extremely powerful opportunity for Canadian suppliers of advanced equipment. Indeed it is not only an opportunity but a fully operational showcase for such products and services.

However, for this to be the case in Canada, the acceptance and implementation of an 'industrial development' priority in the Broadcast Centre planning would need to be a conscious decision with known budgetary implications and provisions. That conscious decision has not yet taken place. It would be a mistake to assume that industrial advantages will accrue unless definitive plans and expenditures are developed.

There are therefore a variety of substantive and institutional factors which are embraced in the assessment of industrial impact--other than the mere detection of "opportunity" or identification of risk.

7.3 Impact on Industry Suppliers

As indicated in the earlier discussion, the industrial emphasis is on the suppliers of studio equipment, given that Canada has virtually no capacity in the consumer electronics receiver markets. Suppliers to the transmission and distribution systems are also considered as well as the program production industry.

In the studio equipment sector, Canadian companies participation in meeting the demands of broadcasters has fluctuated over the years and typically is thirty to fifty percent. The danger is that this percentage may fall drastically as production facilities equip themselves for digital processing. Correspondingly, the major opportunity is to engineer a leap forward in view of the expected new national demand for digital products. The implications of industry being severely affected are quantitatively addressed in the next section on economic impact.

The progression from digital to higher definition television receivers in the home will have a significant impact on the traditional suppliers of broadcast equipment in Canada. Major steps in the evolution toward full digitization in the broadcast studio will likely occur in the short to medium term (next 2 to 5 years) and continue into the 1990s. Therefore, the ability of Canada's dedicated broadcast equipment suppliers to respond to broadcasters' requirements for digitally-based studio, transmission and reception/display equipment will be paramount to their survival.

The transition to digitization also presents opportunities for suppliers who are not peripheral to the broadcast industry but serving markets with needs related to those of the broadcast industry (eg, institutional/industrial closed-circuit television applications), and suppliers not serving the industry but engaged in digital processing applications that may be common to both their markets and broadcasting.

Preparing for digitization over the short term hinges on successful research and development activities. This depends on the availability of talent schooled from the beginning in digital approaches to video technology. Therefore research links with universities R&D capabilities are important, and they in turn can provide some of the required resources. Government laboratories also provide an important resource, particularly as a link to the standards setting and potential government sponsorship of trials and demonstration programs.

7.3.1 Current Status of R&D Activities - Industry Survey

To provide a detailed information base of current Canadian research and development activities, a survey of manufacturers (both dedicated and peripheral broadcasting suppliers) was conducted.

The primary objectives of the sample survey were to determine the type of television research and development activities currently underway in Canada and the expected target market for these products and services, and to determine the financial characteristics of these research and development activities (eg. R&D expenditures, impact on employment and relative reliance on domestic and export markets).

The survey included high technology manufacturers across Canada currently involved in television technologies (based on a list of prominent television equipment manufacturers supplied by the CBC) and high technology manufacturers not currently involved in television related manufacturing but positioned to move into that area as television technology evolves into digital and high definition formats.

These companies were identified through a survey of members of the Canadian Advanced Technology Association (CATA).

7.3.1.1 Overview of Survey Findings

There is currently a substantial core of small to medium sized companies manufacturing components required for the production, transmission, reception and display of television programming. The vast majority of these companies provide highly specialized products occupying narrow market niches, enabling the capture of domestic and export markets through concentration on developing products in areas of low or no competition from major foreign multinational corporations. Complementing the small companies are a few large manufacturers, also relying on specialized product lines and strong export sales for their success. This strategy of specialization rather than diversification is the result of limited Canadian markets and the strong presence of foreign multinationals in export markets. This has left Canadian manufacturers little choice but to channel their resources into specialized product lines not occupied by major companies. It must be noted that the vast majority of firms surveyed are producing analogue components and systems. A universal concern expressed by the respondents was related to their market vulnerability in the transition period from analogue to digital systems manufacturing. They seek to minimize the risk associated with this transition, aiming to remain competitive in the international and domestic marketplace.

These organizations agree that the timing of their move into the manufacturing of digital or high definition products will be pivotal to their success. Entry into the market too early will prevent sufficient sales to justify or sustain high R&D costs. Conversely, an overly cautious approach could allow foreign companies to capture formerly secure Canadian markets, with negative implications for the viability of Canadian manufacturers.

The twenty-one respondents* to the survey include manufacturers of products for:

- studios (eg. switching systems, audio systems, test equipment, record/playback equipment);
- post-production (eg. graphic systems, special effects generators);
- transmission (eg. fibre optic systems, signal processors, control equipment, transmitters);
- reception (eg. TVRO's, SMATV and cable head-ends, etc.);
- displays (eg. high resolution displays, monitors, videotex displays, etc.);
- software (eg. studio and post-production activities).

The primary markets for these Canadian products and services include:

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* These companies are located in and around the major centres of Toronto, Montreal, Ottawa and Vancouver. Of the 21 respondents, ten are based in Ontario, six in Quebec and five in British Columbia.

- video and film producers, post-producers;
- television stations and networks;
- military, utilities, air traffic control;
- graphic artists;
- CATV operators;
- SMATV distributors;
- videotex marketers;
- advertising companies;
- consumers;
- universities; large institutions and corporations.

Without exception, each manufacturer intends to stay within its existing product line in research and development activities, with only slight diversification expected in those companies experiencing increased competition from foreign manufacturers.

Expenditures on television related reseach and development by the respondents ranged from one half to six million dollars in 1984. The vast majority (90 percent) spent between one half and three million dollars, with 72 percent spending less than one million dollars. Further, the average research and development expenditure as a percentage of total sales was 19 percent, ranging from a high of 50 percent, to a low of 4 percent. Illustrating the gap between large and small manufacturers in the Canadian market, the company with the highest expenditure on TV related research and development ($6 million) in 1934, had the lowest average R&D expenditure as a percentage of total sales (4 percent). Conversely, the company with the highest average R&D

expenditure as a percentage of sales (50 percent) had one million dollars in sales. This is indicative of the discrepency between mature and new organizations in their spending for research and development. In this survey, the newer companies generally spent a higher proportion of their sales on research and development than mature organizations.

The number of employees undertaking research and development in television technologies is expected to average 44 per company in 1985.* The total research and development expenditure of the twelve respondents who provided 1985 projections was $18.2 million. There was no apparent correlation between the number of R&D employees and the R&D expenditure by any of the companies, indicating a wide variance in employee costs and/or supporting equipment requirements per organization. The most obvious similarity among all survey respondents is the recent and anticipated future rapid growth in research and development employment. No company is expected to reduce R&D employment and many anticipate employment growth of nearly 50 percent in the R&D departments of their organization over the next five years.

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* Twelve of the twenty-one respondents provided projections or R&D expenditures for 1985. Eleven of twenty-one respondents provided the number of employess projected for research and development activities in 1985.

Of the respondents to the survey an average of 69 percent of all sales came from export markets. The highest average was 92 percent and the lowest 10 percent. Each respondent cited the small domestic market and specialized nature of their product or service, as the rationale for aggressive export marketing.

As indicated in the "survey approach", there are two separate groups of companies expected to participate in digital and HDTV related research and development. First, companies currently manufacturing analogue television systems and components are expected to continue some research and development aimed at upgrading their analogue systems to digital and HDTV compatibility. Second, companies manufacturing equipment which is not currently used in television but whose products will be applicable for television usage once digital and high definition television systems develop, are expected to pursue more television related research and development to expand markets and potential sales. As a prime example, manufacturers of high resolution monitors for videotex, computer graphics, or flight simulators may be positioned to adapt their products to television usage through smart digital or HDTV monitor development, particularly for professional studio applications.

The two groups currently have measurably different characteristics regarding the role of research and development within their organizations. Exhibit 7-1 illustrates the difference between the two groups.

Exhibit 7-1

	Average R&D Expenditure ($ millions)	Average R&D Expenditure as % of Sales	Average # of R&D Employees	Exports as % of Sales
Aggregate	1.5	19.25%	19	69%
Companies conducting TV related R&D	1.62	12.0%	16	75%
Companies conducting R&D unrelated to TV	1.35	36.0%	25	56%

Source: Nordicity Group Ltd.

Based in part on survey feedback, the remainder of this sub-section provides an assessment of the major dedicated and peripheral broadcasting Canadian manufacturing/distributor groups with reference to:

- product areas covered;
- capabilities in marketing, particularly export, managerial, manufacturing, technical, R&D, and financial backing;
- commitment to playing a role in the development of future TV technologies;
- short and medium term research and development thrusts and directions.

7.3.1.2 Dedicated Broadcasting Industry Suppliers - Studio

The dedicated broadcasting industry suppliers are companies that develop and manufacture products primarily for the television broadcast studio. In 1984, according to a recent estimate, these companies accounted for approximately 80% of total sales of Canadian-manufactured equipment. In that same year, these companies reported total sales of roughly $50 million, approximately 70% of which was accounted for by exports, employed some 690 people and spent almost $6 million in research and development. These companies, which have an obvious stake in future TV technologies include:

- Central Dynamics(television switching systems);
- Scientific Atlanta (which has absorbed the former Digital Video System) (satellite systems, test equipment, B-MAC);
- Electrohome Systems (industrial, consumer and broadcasting electronics);
- Evert Micro Systems (production studio electronics eg. timing devices);

- Gigatek, a subsidiary of Electro-Optical Systems (high resolution colour graphic display monitors, projectors);
- Image Video (broadcast switching systems);
- Leitch Video and its subsidiary Digi-Tel (sync generators, timing devices);
- McCurdy Radio Industries (integrated production consoles, audio/video);
- Ross Video (television, broadcast switching equipment);
- Skotel (time code readers and generators);
- Ward-Beck (audio production consoles).

The dedicated suppliers to the broadcast industry generally have strong technical and R&D capabilities. However, at this time only three of these firms are at the leading edge of developing digital equipment for the studio. As well, only one Canadian company manufactures high resolution displays in Canada. That company is currently developing a high resolution monitor for military applications and a multi-standard high resolution decoder for broadcast applications. Another company manufactures a high resolution display device off shore through agreement with a major foreign manufacturer.

Other firms are still investigating the implications of producing digitally-based studio equipment but are not yet positioned. One company is considering the development of a completely digital production switcher but not until the medium term, ie, the next two to five years, preferably based on a "second market" strategy. Another is committing short and medium R&D resources to developing a 1000 line 19 inch and 25 inch video display monitor.

In general, then, these companies have managed to advance technically in the past, but face major product development challenges in switching from analogue to digital. In present circumstances, it does not appear likely that all will be able to make that transition.

7.3.1.3 Canadian Subsidiaries of Large Multinational Suppliers

Canadian distributors of large multinational broadcast equipment suppliers are well positioned to reap new opportunities in the broadcast equipment sector. These companies already have a relatively large share of the domestic broadcast equipment market, particularly in studio cameras and audio and video recorders.

Some of the companies in this category are:

- Ampex: magnetic tape, closed circuit TV equipment;
- Hitachi Denshi: cameras, VTRs, oscilloscopes and waveform monitors;
- JVC: cameras, 3/4 inch VCRs, monitors and editing systems;
- Matsushita Electric (Panasonic): cameras, video switchers, VTRs, VHS recorders and editors, optical disc recorders;
- Philips: a range of studio and consumer products;
- Sony: Betacam cameras, monitors, VTRs, audio systems, editing systems;
- Mitsubishi: cameras, monitors, VTRs
- Studer Revox: professional audio and recording equipment;
- Tektronix: electronic test equipment, TV instruments and monitors;
- Thomson-CSF: cameras, character generators, transmitters and video processing equipment;
- 3M: magnetic audio/video tape.

None of the companies appear to conduct development work in Canada. Their activities are limited to sales and service, warehousing and, in some cases, assembling products manufactured by their corporate parents. With respect to consumer products (TV sets, VCRs, videodiscs) there is only one case of Canadian assembly (Mitsubishi - VCRs). The components in Electrohome TV sets are manufactured by Mitsubishi in Japan and assembled in a Mitsubishi plant in Canada. Electrohome was the only Canadian company manufacturing TV sets in Canada until it divested itself of its consumer electronics product line in 1982.

7.3.1.4 Distribution System Suppliers

The evolution toward digitization in the broadcast studio will have a large impact on the traditional suppliers manufacturing components, sub-components and systems for the distribution of television signals. These companies include suppliers of:

- satellite earth stations and uplinks - eg, Spar Aerospace, SED Systems, AEL Microtel, General Instrument, Scientific Atlanta;
- fibre optics, coaxial cable and CATV equipment - eg, Northern Telecom/BNR, Foundation Instruments, Canstar Communications, Triple Crown Electronics, Lindsay, Delta Benco Cascade;
- decoders, terminals and converters - eg, Vidacom, Viewstar, Norpak, Jerrold, Electrohome;
- terrestrial broadcast transmitters - eg. Larcan.

These companies could play an important role in capturing manufacturing opportunities for Canada. They are currently developing and manufacturing products related to some aspect of the distribution and reception of television signals. General Instrument, for example, has received the world product mandate to develop 12 GHz satellite receiving equipment for the consumer direct-to-home market. Other examples include:

- Vidacom, a joint venture between Le Groupe Videotron and G-Tech Computers to develop and manufacture an integrated cable, pay-TV and videotex/teletext decoder;
- Viewstar which manufactures the Philips cable-TV converter could play a role in developing digitally-based encryption devices for HDTV applications;
- Norpak, through a joint venture with Rockwell International, has developed a VLSI chip for decoding teletext signals. Through an agreement with Samsung of Korea, the teletext decoding chip will be built into the next generation of Samsung television receivers.

Companies like Northern Telecom/BNR with strong managerial, financial, technical and R&D capabilities in digital transmission technology also have a stake in future TV technologies and can be expected to lead developments in digital transmission.

Satellite receiver manufacturers, GI, Spar, SED Systems, all of whom have strong financial, managerial and R&D capabilities, must play a key role in developing digitally-based satellite receiving equipment if they expect to continue playing any role in this market.

Other companies in the fibre optics area, for example, which are not currently significant broadcast suppliers could potentially play a key role in fibre optics-based distribution systems. Examples include: Northern Telecom/BNR, Canstar Communications and Foundation Instruments which is developing fibre optic communications systems, fusion splicers and high speed digital fibre optic links for military and telecommunications applications.

7.3.1.5 Suppliers Peripheral to the Broadcasting Industry

There are two groups of suppliers peripheral to the broadcasting industry who either have or are developing capabilities in digital processing, transmission, graphics, encryption and display:

- the first group includes those companies serving markets related to the broadcast television industry, eg. interactive video, closed circuit television, projection systems;
- the second group includes companies from the digital processing (fields, eg. encryption, graphics, computer manufacturing and software development.

Related Markets

The first group of peripheral suppliers include companies generally in one of the following areas:

- institutional and business projection display applications (typically for presentations) - Electrohome, Immax, CAE Electronics;
- interactive applications (typically using optical disc technology) - Interactive Image Technologies, Meridian Technologies.

Electrohome, for example, manufactures a series of business and institutional projection systems capable of projecting computer data and graphics on video tapes to a large screen.

Digital Processing Markets

The second group of perhipheral companies includes companies such as GEAC Computer Corporation, McDonald Dettwiler & Associates, Meridian Technologies, Helix Circuits, CREO Electronics and Videtics. There are many other companies developing software, firmware and hardware for a variety of computer-based applications. These companies are generally in one of the following areas:

- signal conversion - Videtics;
- computer displays - Matrox Electronics, Microstar Software;
- data storage and archiving - CREO Electronics, GEAC Computer Corporation, Macdonald-Dettweiler;
- integrated circuits - Helix Circuits, Siltronics.

In the data storage and archiving area, CREO Electronics is developing an optical tape recorder which will allow the storage of at least one terabit of digital information to be stored on a single reel of metalized polyester tape. CREO is looking at applications that have bulk data storage and archiving requirements. There may develop an opportunity in the motion picture and program production industry, where producers may be interested in optical tape recorder technology for archiving film and television programming.

In the signal conversion area, Videtics among others has developed an image acquisition and display package for the IBM PC-XT microcomputer "which converts a standard analogue video signal from a camera (or other video source) to digital data at 60 fields per second and stores the resulting 64 grey level picture data in a 1024 x 512 frame memory."*

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* Videtics VPC 170 brochure

7.4 Impact on Industry Users

The possible evolution towards higher definition in television will have technical implications on the broadcasting industry both from the production studio and delivery perspectives.

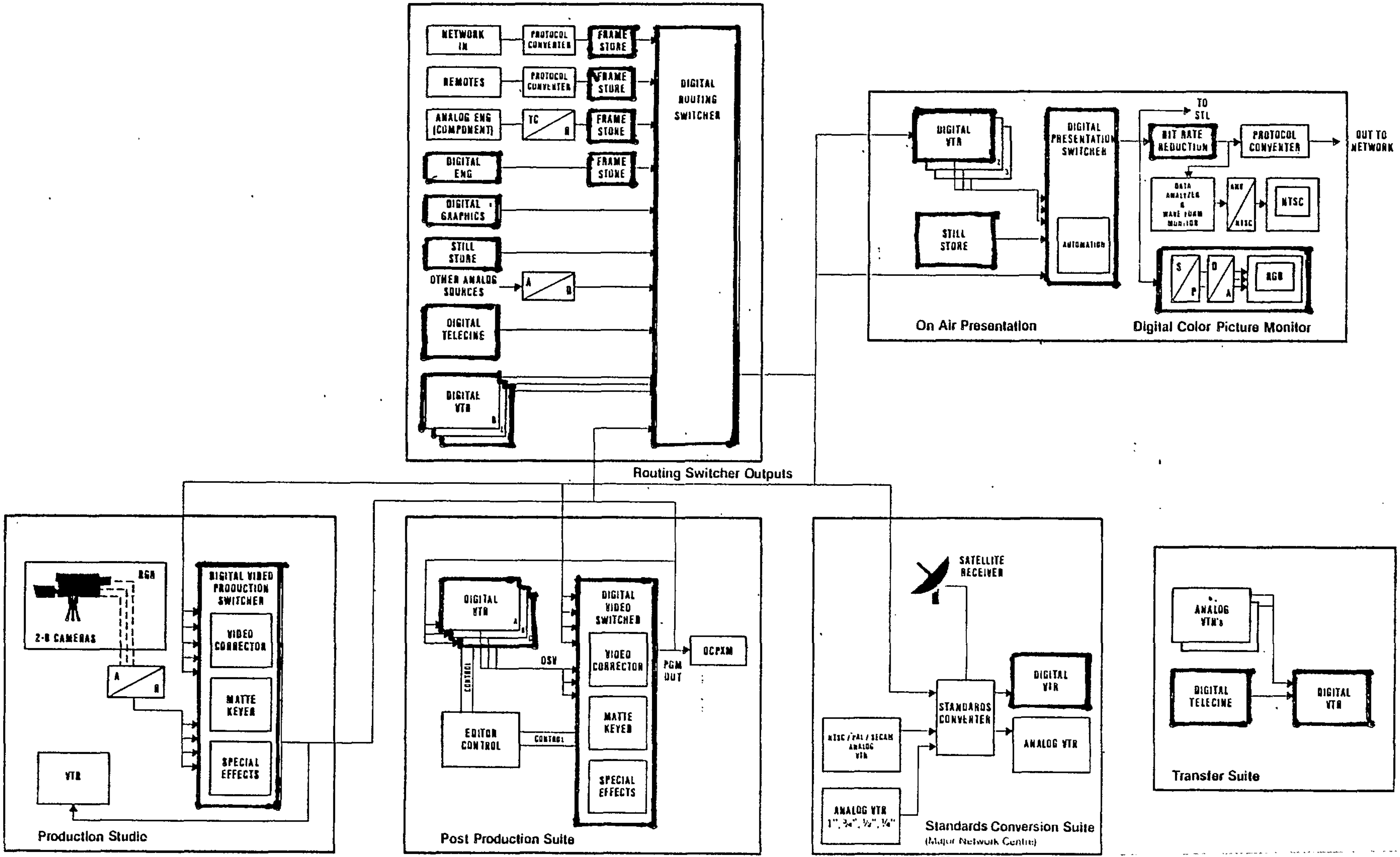
7.4.1 Production Studio

Competitive pressures may not only require an improvement in production quality as a result of digital processing techniques, but also image resolution improvement as a result of a desire for higher definition software.

The recent convergence of computer and video technologies is enabling digital studio equipment to perform tasks which cannot be accomplished at all by analogue techniques or that can be done better by digital means. This evolution of sophisticated digital products will result in replacement of more and more analogue equipment items. While the costs, for some digital components remain prohibitively high for most users, prices are expected to fall with a cross-over between analogue and digital occurring within the next five to seven years. Exhibit 7-2 provides a layout of the typical '1987' television studio, with the digital equipment items which are expected to be in use. Use of analogue to digital converters will be an integral part of the studio system during this conversion period. Ultimately digital highways (possibly fibre optics - by the 1990-1995 period - as indicated in the Delphi Survey - task 3), will provide for video transfer between the various studio production suites.

EXHIBIT 7-2

A TYPICAL TELEVISION STUDIO IN 1987



SOURCE: CBC SEPTEMBER 1982 FIVE YEAR TECHNOLOGY IMPACT FORECAST

☐ Digital Equipment

From the Delphi forecast, opinion is that in most regions the majority of major broadcasters will follow a trend towards production quality improvement - with high definition production utilized for major broadcasters for specialized needs as early as 1990. If this is in fact the case, competitive pressures will most likely require major broadcasting centres to contain at least one HDTV suite.*

The technical challenge facing major broadcasters planning for their production plants of the future, is to ensure that discrete implementation steps taken over the next few years will result in successful broadcasting centres where competitive quality is produced.

The Toronto Broadcast Centre is being planned with the full appreciation of the rapidly evolving digital technology. The program manager was cited in <u>Broadcast Technology</u> stating that "by 1988 to 1990 (digital technology) could be far enough advanced to be seriously considered for major portions of the overall system design."** At the outset, digital

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* The question remains as to whether a Japanese 1125 line 2:1 interlaced, 60 cycle standard (as produced by Sony) will be adopted worldwide or whether the Europeans will adopt a separate standard.

** <u>Broadcast Technology</u>, November 1984, CBC Toronto Broadcast Centre, by Fred Fox, p12.

equipment costs are much higher than analogue - for example audio consoles and tape recorders currently cost three to four times more than their analogue equivalents - but there will be a cross-over point in cost terms with analogue, expected to be in the early 1990s.

Some CBC representatives have expressed strong interest in playing a role in the development of digital studio products.*

Production of major feature films utilizing high definition techniques will likely be led by a few innovative production studios outside of the traditional Hollywood film industry. It is expected that the traditional producers will gradually follow these leaders due to competitive pressures.

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* In the same Canadian broadcasting article Fred Fox was quoted as anticipating the following areas that will be digital in the next production plant:

- some key production studios - Radio/TV,
- key post- production areas - Radio/TV,
- main routing/distribution - Radio/TV,
- all major production and release VTRs.

To support these key digital areas, the CBC would require all-digital technology to be available for the following main items:

- audio consoles and tape recorders,
- VTRs,
- video switchers,
- audio/video routing,
- audio/video distribution.

7.4.2 Delivery

In future (if introduction of higher definition television services occurs in the early 1990s in North America) to compete with services offering image quality improvements, broadcasters will face a delivery dilemma. Current bandwidth constraints available in both the VHF and UHF frequencies will not permit off-air transmission of many wider bandwidth signals (as required by any of the proposed higher definition transmission formats).

Unless the need for wide channels spurs development of super-high frequency transmission, the options available for transmission of enhanced signals will be via satellite delivery (either directly to consumers or through cable distribution) fibre optics or utilizing frequencies on Multi Channel Distribution Systems (MMDS). The question arises as to whether duplication of off-air programming would be required to compete with other higher definition services.

Some experts believe that if improved definition television is offered by some, all broadcasters will have to 'jump on the bandwagon' (drawing from the AM versus FM experience) if they are to remain viable. This could lead to off-air delivery being essentially obsolete 25 years from now, with terrestrial distribution only being appropriate for some purposes.

7.4.3 Cable Operators

Where channel 'quantity' is currently a critical issue for cable operators in Canada, improving 'quality' has in the past not been of primary importance. Both the introduction of smart receivers of increasing sophistication (offering image quality improvements and picture manipulation features) and the possible introduction of hidef services (offering further image quality improvement) raise issues which should be of concern to cable operators in Canada.

Exhibit 7-3 extends in some detail the possible options available and implications to cable operators, of new TV technology products and hidef services which could be introduced. Consideration has been given to implications on the cable head-end, cable transmission, and equipment located at the subscriber premises. Active participation of the cable industry will be required to ensure that cable operators are not caught in a situation similar to the 'stereo unready' dilemma that some are caught in today.

Key questions requiring consideration include:

- will the introduction of digital television of increasing sophistication (which will remove 'expected' impairments inherent in NTSC transmission) expose the disparity between off-air signals and the poor quality transmission (and resulting 'unexpected' impairment) on some cable systems?
- could an NTSC two channel systems provide a suitable transmission compromise or perhaps an interim measure for cable operators towards higher definition services (with conversion from a hidef satellite delivered service occuring at the cable head end)?

EXHIBIT 7-3

HIGHER DEFINITION TELEVISION - IMPLICATIONS ON CABLE

DELIVERY OPTIONS			IMPLICATIONS		
SYSTEM/PRODUCT INTRODUCTION	SERVICE	CABLE	ON HEAD-END	ON CABLE TRANSMISSION	AT SUBSCRIBER PREMISES
SMART RECEIVERS WITH FEATURES AND CAPABILITIES OF INCREASING COMPLEXITY	- DO NOTHING	- DO NOTHING		- AS 'EXPECTED' TRANSMISSION IMPAIRMENTS ARE CORRECTED WITH RECEIVER POST-PROCESSING, 'UNEXPECTED' IMPAIRMENTS DUE TO POOR CABLE TRANSMISSION MAY BE EXPOSED - INCREASED ATTENTION ON MAINTENANCE PROGRAMS REQUIRED?	- CURRENTLY USED SYNC SUPPRESSING ONLY DECODERS MAY BE BYPASSED WITH SMART RECEIVERS THUS MORE SOPHISTICATED SECURITY SYSTEMS FOR SOME OPERATORS WILL BE REQUIRED
	- OFFER COMPLEMENTARY SERVICES SUCH AS: O SELECT END OF STORY OPTIONS O COLOUR SELECT OPTIONS O ETC.	- DELIVERY ADDITIONAL CHANNELS FOR SPECIAL SERVICE OPTIONS	- INCREMENTAL EQUIPMENT FOR CHANNELS		- ENSURE THAT NEW GENERATION OF DECODERS ENABLE SPECIAL SERVICE OPTIONS
	- COMPLEMENT WITH REVISED TRANSMISSION FORMAT (SEE SYSTEM OPTIONS BELOW)				

HIGH DEFINITION TELEVISION - IMPLICATIONS ON CABLE OPERATORS (CONTINUED)

DELIVERY OPTIONS			IMPLICATIONS		
SYSTEM/PRODUCT INTRODUCTION	SERVICE	CABLE	ON HEAD-END	ON CABLE TRANSMISSION	AT SUBSCRIBER PREMISES
SATELLITE DISTRIBUTION OF MULTIPLEX ANALOGUE COMPONENT (MAC) SIGNALS	- MAC (VARIOUS VARIETIES; C MAC, D2-MAC, B MAC)	- CONVERT AND DELIVER TO SUBSCRIBER AS NTSC SIGNAL	- CONVERTOR MAC/NTSC		
		- DISTRIBUTE MAC USING AM (NOT LIKELY - MAC DESIGNED FOR FM)	- INCREMENTAL CHANNEL EQUIPMENT	- 2-3 CHANNELS REQUIRED	- ADVANTAGES OF MAC DELIVERY ESSENTIALLY LOST
		- DISTRIBUTE MAC USING FM	- FM MODULATION, FILTERING AND INCREMENTAL CHANNEL EQUIPMENT	- APPROX 3 CONTIGUOUS HIGH-BAND CHANNELS REQUIRED	- DECODER (OR MAC ADAPTER) REQUIRED WITH MAC/NTSC COMPATIBILITY (RECEIVERS WITH RGB INPUT ACHIEVE IMPROVED IMAGE)

(NOTE: 2 LINE STORES REQUIRED FOR MAC RECEPTION)

Higher Definition Television - Implications on Cable Operators (continued)

Delivery Options			Implications		
System/Product Introduction	Service	Cable	On Head-end	On Cable Transmission	At Subscriber Premises
SATELLITE DISTRIBUTION OF EXTENDED ANALOGUE COMPONENT SIGNALS	- E-MAC VARIOUS OPTIONS WITH SAME NUMBER OF SCANNING LINES AS BASIC MAC, MORE BANDWIDTH REQUIRED, PRE AND POST TRANSMISSION FILTERING, (POSSIBLY WIDER ASPECT RATIO)	- CONVERT TO 2 CHANNEL NTSC SIGNAL (IF WIDER ASPECT RATIO IS PROVIDED)	- CONVERTER E-MAC/ 2 CH NTSC REQUIRED	- 2 CHANNELS REQUIRED	- REPLACEMENT OF DECODERS <u>ONLY</u> FOR SUBSCRIBERS WHO HAVE WIDE ASPECT RECEIVER-WHO DESIRE FULL 2-CHANNEL SERVICE - OTHERS RECEIVE 1 CHANNEL ADDITIONAL IMPROVEMENTS ACHIEVED WITH FINE PITCH PICTURE TUBES
		- CONVERT TO NTSC, DISTRIBUTE ONE CHANNEL		- POSSIBLE IMPLICATIONS ON CURRENT POWER LEVELS	
		- DISTRIBUTE E-MAC SIGNAL USING AM (NOT LIKELY)	- CONVERTER MAC/NTSC		- REQUIRE MAC DECODER WITH 'ENHANCED' CAPABILITY
		- DISTRIBUTE E-MAC SIGNAL USING FM	- FM MODULATION, FILTERING AND INCREMENTAL CHANNEL EQUIPMENT	- 4 CONTIGUOUS HIGH-BAND CHANNELS REQUIRED - POSSIBLE IMPLICATIONS ON CURRENT POWER LEVELS	- IF DISTRIBUTED AS WIDER BAND SIGNAL - ONLY RECEIVERS WITH WIDE-BAND CAPABILITY COULD VIEW

HIGHER DEFINITION TELEVISION - IMPLICATIONS ON CABLE OPERATORS (CONTINUED)

DELIVERY OPTIONS			IMPLICATIONS		
SYSTEM/PRODUCT INTRODUCTION	SERVICE	CABLE	ON HEAD-END	ON CABLE TRANSMISSION	AT SUBSCRIBER PREMISES
SATELLITE DISTRIBUTION OF BANDWIDTH REDUCED HDTV	- PROPOSALS HAVE INCREASED NUMBER SCANNING LINES AND WIDER ASPECT RATIO				
	1) - 2 CHANNEL OPTIONS (EG. CBS 2 CHANNEL)	- CONVERT TO NTSC DISTRIBUTE 1 CHANNEL ONLY			
		- CONVERT TO 2 CHANNEL NTSC SIGNAL	- CONVERTER REQUIRED	- 2 CABLE CHANNELS REQUIRED	- REPLACEMENT OF DECODERS ONLY FOR SUBSCRIBERS WHO WHO HAVE WIDE ASPECT RATIO RECEIVERS WHO DESIRE FULL 2 CHANNEL SERVICE - OTHER SUBSCRIBERS CAN RECEIVE 1 CHANNEL SERVICE
		- DISTRIBUTE CHANNELS USING AM (NOT LIKELY)			
		- DISTRIBUTE CHANNELS USING FM	- MODULATION, FILTERING, INCREMENTAL CHANNEL EQUIP REQUIRED	- APPROX 4 HIGH-BAND CHANNELS REQUIRED - POSSIBLE IMPLICATION ON CURRENT POWER LEVELS (CURRENT SYSTEMS NOT OPTIMIZED FOR SIGNAL TO NOISE RATIO)	- DECODER REPLACEMENT AS IN 'MAC' WITH 2 CHANNEL OPTION CAPABILITY - DECODER SHOULD ENABLE CONVERSION OF BASIC CBS CHANNEL TO NTSC FOR CUSTOMERS WITHOUT RGB INPUT RECEIVERS

HIGHER DEFINITION TELEVISION - IMPLICATIONS ON CABLE OPERATORS (CONTINUED)

DELIVERY OPTIONS			IMPLICATIONS		
SYSTEM/PRODUCT INTRODUCTION	SERVICE	CABLE	ON HEAD-END	ON CABLE TRANSMISSION	AT SUBSCRIBER PREMISES
	2) - MUSE	- CONVERT TO NTSC 2 CHANNEL SIGNAL	- CONVERTER MUSE/ NTSC 2 CHANNEL	- 2 CABLE CHANNELS REQUIRED	- 'REPLACE' DECODERS ONLY FOR SUBSCRIBERS WHO HAVE WIDE ASPECT RATIO RECEIVERS (OTHER SUBS COULD RECEIVE 1 CHANNEL SERVICE) ('QUALITY' ADVANTAGES OF MUSE WILL BE LOST - POSSIBLY ADDITIONAL IMPAIRMENTS INTRODUCED IE. BLURRED MOVEMENTS)
		- DISTRIBUTE AS MUSE SIGNAL	- MODULATION, FILTERING, INCREMENTAL EQUIPMENT	- LIKELY FM - 4 CONTIGUIOUS HIGH BAND CHANNELS? - POSSIBLE IMPLICATIONS ON POWER LEVELS?	- 'MUSE' DECODER REQUIRED TO REPLACE DECODERS FOR THOSE WHO WANT SERVICE ONLY. RECEIVER MUST HAVE STORAGE CAPABILITIES AND WIDE ASPECT RATIO - OTHER SUBSCRIBERS WOULD NOT RECEIVE SERVICE UNLESS SPECIAL DECODER/CONVERTER FOR RGB INPUT TO BASIC SET WAS UTILIZED

- with decoders due for periodic replacement anyway, should their replacement coincide with or be prepared for the introduction of some MAC or enhanced MAC discretionary service which might be implemented?
- would enhanced transmission provide an attractive perk for one or two premium services? (Particularly after 1990 when ample channel capacity should be available in most cable systems in Canada*)?
- with a possible market for specialized services to bars, mini theatres, etc. should cable operators take a pro-active role in obtaining these services for delivery?
- should cable operators position themselves for an evolutionary approach to enhanced service offerings or await possible introduction of a Japanese type HDTV service?
- could possible carrier placement of fibre optics to subscribers provision for full-fledged HDTV?

7.4.4 Transmission by Carriers

The evolution of TV technologies towards higher definition television will impact on network transmission systems for both program production preparation, as well as distribution transmission systems for direct delivery to home consumers or to cable head-ends.

It is expected that the trend towards digital production in studios will result in the need for improved transmission quality for inter-studio program preparation. On the terrestrial carriers networks, over the next five to ten years the trend will be towards more and more digital transmission (eliminating the need to convert to NTSC), thus a need for improved picture processing codecs. Currently 45 Mb/s codecs are

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* Reference: Survey of cable operators in Canada conducted in conjunction with 'Project 90' - Strategic plan prepared by the Canadian Cable Television Association with assistance of Nordicity Group Ltd. in association with Moss, Roberts Associates, February 1985

utilized on a limited basis, but as more emphasis is placed on increased image definition (45 Mb/s not sufficient for studio to studio HDTV transmission) and as digital processing costs fall, it is anticipated that 140 Mb/s codecs will be utilized for high speed digital transmission on microwave radio and terrestrial cable facilities. This high speed transmission will likely prompt some modification to current carrier microwave channelization schemes. While the availability of fibre optics links throughout Canada will reduce much of the current microwave video traffic over the next 10 years, the need for transmission modes for studio to studio use will not disappear completely.

For improved satellite transmission quality for program preparation needs, the tendency will most likely be towards adaptation of a form of Multiplexed Analogue Component (MAC) transmission. The impact on Telesat Canada for this conversion should not be terribly significant.

A significant impact on Telesat could result however, if in future full fledged movement to higher definition services requiring double the channel capacity occurs. If a small number of special higher definition services are implemented, the incremental satellite transponder requirement would not likely have a significant impact on satellite provisioning requirements. However, if eventually the majority of broadcasters (most of which currently provide service terrestrially) also tend towards higher definition service provision, the need for satellite capacity could increase as much as 4 or 5 times, thus causing a need for additional satellites.

7.5 Industrial Opportunities

The industrial workshop conducted in conjunction with the industrial impact analysis focussed on identifying new product/system/component development directions for Canadian industry. Three discussion workshops were held covering television production, transmission and display. Notes from these workshops are provided in Appendix A as indicated earlier. General findings of these sessions confirm Canadian industrial opportunities as discussed with individual broadcasters and manufacturers. Highlights of these findings are included below.

Canada's strength in the Canadian television and broadcasting manufacturing industry has in recent years been in the provision of specialized components. When determining particular opportunities for Canadian television and broadcasting manufacturers, two important criteria must be considered; the potential for the next evolutionary 'step change' to meet future equipment requirements, and the potential for product export. Equipment items selected for development should be generally commercially viable (ie, not unique to one particular user), however should not demand mass production. Through the international survey on the present status of television technology and research, several opportunities have been identified. Further analysis of the capabilities of Canadian TV and broadcasting equipment manufacturers through both the industrial workshop and industrial survey, has led to the selection of several key opportunity areas for Canadian industry as highlighted below.

7.5.1 Production Studio

Discussions with broadcasters indicated expenditures in the next few years in Canada on studio equipment could be in the order of $100 plus million annually. This anticipated expenditure includes requirements for the new Toronto CBC production centre. In the past few years, Canadian manufacturers have provided for almost half of Canadian studio equipment requirements. The potential for this participation in future years exists if steps are taken towards development of key digital products. As approximately 70% of total sales ($50 million) in 1984 for 13 of the major broadcast studio equipment manufacturers were exported, it is critical to maintain a competitive position in the domestic market.

In the next few years, it is anticipated that the main areas which will require the development of digital products for conventional 525 line television include:

- some key areas in production studios
- key post-production areas
- main routing/distribution
- all major production and release VTRs.

Discussions in the studio workshop session (confirmed through discussions with broadcasters) indicate the following digital video products are particularly well suited to Canadian development:

- video switchers
- digital coders/decoders

- digital serializers/deserializers
- special effect equipment for production and post production
- special effects for ENG
- character generators
- key and chroma equipment
- slide storage equipment
- video monitors
- standards converters
- video tape recorders (if an international joint venture was arranged with Canada providing the electronic processing components)

Although Canadian manufacturers do not currently have the capacity for the development of a complete studio system, the possibility exists for the manufacturing of individual components leading to development of a complete system package through joint effort of two or more manufacturers. For example, through a joint venture, development of several compatible components for a digital post-production suite could eventually be produced by Canadian manufacturers. In fact, unless Canadian manufacturers band together for more systems related product developments, Canadian companies will have to rely on fitting into foreign studio systems.

7.5.2 Toronto Broadcast Centre Opportunity

Since time is of the essence, and competition is strong, it is important that some innovative entrepreneurial thinking be done in respect of collaborative action centred upon the opportunities as they are discussed and developed. Certainly, the fact of the Toronto Broadcast Centre as a potential catalyst for an attack on new product development should be examined in greater detail. It would be unfortunate to lose such a 'show-case' opportunity without at least exploring its potential.

With only a very small amount of pre-designed procurement contracts that can be issued, CBC faces the reality of current CBC financial straits. This may give rise to a fairly perverse scenario. If there is a definite consolidation go-ahead budget allocation, the CBC's new facilities budget is likely to be stripped to bare bones. This will mean that little flexibility can be designed into it, and that the lowest cost off-the-shelf equipment will have to be ordered. This is in fact roughly what happened a decade ago in the new Montreal studio facilities.

In that scenario, CBC will not have the lead time nor funds to encourage Canadian companies to develop products in advance of the order. The lead time is critical and points to the need of Canadian suppliers to invest heavily in the digital applications of their products.

The Toronto Broadcast Centre needs, and the perceived lack of across-the-board preparedness on the part of the suppliers, has led to the initiative of the Canadian Association of Broadcasters, the Canadian Broadcasting Corporation and CTV to put together a detailed requirements list for the next five to six years based on a survey of all major Canadian broadcasters. These requirements have been published in the 1985 Survey Report of the Task Force on New Technology in Broadcasting.

In this survey of the broadcasters in Canada, the information that was requested included the following:

- potential percentage of equipment that could be be acquired from Canadian manufacturers;
- number of units to be ordered over a year time-frame;
- expectations as to whether the order preference would be digital or analogue;
- expression of potential premiums to be paid for digital as opposed to analogue.

While the gauntlet has been thrown at the feet of Canadian manufacturers, this will not alleviate them from pressure to concentrate on daily operational challenges. However, individually and collectively they must be able to focus on the two to five year product development needs.

It would be worthwhile considering the consortium mechanism as a means of developing systems approaches and coordinating the financing and conduct of R&D activities. The consortium as a mechanism is enjoying a new wave of experimentation in Canada as a means of combatting the strong challenges from off-shore competition. There is already evidence of a strong responsiveness on the part of industry in this particular case; the consortium could be an appropriate response. What is needed is a catalyst. Implementation options are discussed further under section 11 - R&D Requirements.

7.5.3 Transmission

The transmission workshop conducted highlighted a few manufacturing possibilities for Canadian industry.

With inter-studio transmission for program preparation expected to tend towards digital transmission, demand for picture processing codecs will increase. Currently, a limited number of 45 Mb/s codecs are available. However, for improved high speed transmission the need for 140 Mb/s codecs will develop. As a significant knowledge base in this area is available within Canadian industry, these items could be a good market niche for a small manufacturer.

As program preparation via satellite could utilize some form of Multiplexed Analoque Component (MAC) transmission, potential for a limited number of related products exists. For future possible hidef delivery via cable, to either mini-theatres or subscribers, a new generation of decoders would be required. Although Canadian manufacturers may not anticipate mass production of decoding devices, equipment for cable head-ends might represent a possibility.

Within Canada, introduction of fibre optics to the home faces several regulatory and economic hurdles. However, it is expected that other countries will move into fibre optics before Canada, offering product export opportunities. As Canada has considerable expertise in the field of fibre optics technology, in addition to current production of fibre optics cable, an opportunity to develop specialized products might be pursued. Presently the Communications Research Centre (CRC) holds two patents on opto-electronic switching products which are available to interested manufcturers. Potential market niches identified requiring development include; 243 Mb/s fibre optic transmission system components (NTSC Digital Studio Standards), fibre optic routing jacks and switchers.

Along with the exploitation of fibre optic transmission for television delivery in Western Europe, there is the potential for switched star rather than tree and branch cable design, thus opportunity for Canadian export of optical switching equipment. For example the rights holders of the Omnitel switch technology (the product of the Elie field trial) have been marketing their product in the UK. This technology which was initially planned for use in the Louiseville switched star, fibre optic field trial, is not directly related to new TV technologies under examination but forms part of the overall opportunity universe.

7.5.4 Display

In the display area, two areas of opportunity for Canadian industry were selected: projectors and CRT displays.

Currently, projectors are expensive, lack the quality needed to produce an acceptable 'small theatre' image, and represent a small enough market to avoid long-run production-type competition. A theatre market package might be desirable, including the projector and delivery system, with signals being delivered by satellite, cable or in recorded form. Laser light sources for projectors show some promise, and such laser capabilities exist in Canada. It was also pointed out at the workshop that there is a university market for a projector that can be used for displaying computer information to groups of 30 to 50 students. Such a projector should have sufficient resolution and color, and about twice the light output of current projectors. They should also accept the output from the various personal computers that would be used to drive them.

CRTs are currently the most costly component of a complete display. There is felt to be a market for a very high resolution graphic display for computer generated data. The developments achieved in this area could be applied to broadcast monitors, in order to improve their performance. Such broadcast monitors would need to handle multiple scanning standards and accept several composite and component signal coding shares. They would need to be available within five years and be flexible enough to promise a product life-span of 15 to 20 years. It is felt that the market potential would be in the order of 4,000 units per year for ten years - which would be an ideal base for a Canadian company.

The display workshop pointed also to interactive displays as the 'seed device' for the emerging interactive entertainment industry, as well as for the computer-aided instruction industry.

7.6 Opportunities Conclusion

There are therefore several promising market niches which Canadian companies could possibly fill, provided that some outside stimulus is provided to support their own initiative in the field. Given the small population of the industry and the presence of the CBC as an accepted technical authority and sponsor, this outside stimulus could probably be organized with relative ease through a highly focussed collaborative exercise over a very short period.

When considering industrial opportunities for Canada, it should be borne in mind that the pure, R&D cycle, and the standard setting process are subject in the case of HDTV to an enormous over-burden of "political economics". There is a presence of .6 billion TV sets in the world, indicating the tremendous size and importance of the global market. West German industry, for one, is looking to the HDTV market to regain the 60,000 jobs lost in the TV receiver field over the last decade. Japan is pressing its advantage in consumer electronics by attempting the early creation of a Japanese domestic market, thereby assisting in the enforcement of standards favourable to its industry on a world-wide basis.

Thus, because of market scale and industrial impact, national economic interests are involved, of a magnitude such as to colour the choice of technology, dictate the approach to standards and generally pace the arrival of new television products to the consumer. This virtually overriding factor of national economic rivalry poses particular difficulties for the Canadian supplier, particularly those who will concentrate on specific product niches (such as smart monitors) where eventual commercial success depends on access to large well defined world markets and the volumes attendant on them. Further, the presence of this factor emphasises the need for appropriate Canadian technical authorities to participate fully in standard-setting activities at the institutional level, with Canadian product aspirations and capabilities in mind. The protection of our R&D investments through influence on emerging standards is a key in the area of HDTV systems.

This general factor of 'political economics' is of considerable importance in respect of the form of response that needs to be developed from Canada. It is a real question, when orchestrated government-industry support strategies are being pursued in other countries, whether we can expect our own fledgling enterprises to survive without similar assistance. In this general context, the role of the CBC or some similar Canadian institution, in the 'first order' mode, has added significance.

8.0 ECONOMIC IMPACT ANALYSIS

This section examines the economic implications on Canada of various TV technology evolutionary scenarios, considering the effects on the balance of trade, on the GNP and on employment within the television and broadcasting industry.

8.1 Methodology

As no single evolutionary scenario for the development of TV technologies in Canada is clearly evident, a multi scenario approach has been taken to the economic impact analysis. The scenarios for this analysis were drawn from both the market forecasts as developed in tasks 2 and 3 of the Future TV Technologies Impact Assessment study, and the industrial analysis in task 7 which identified the potential capabilities and limitations of the Canadian television and broadcasting industry.

The Statscan Socio-Economic Resource Framework (SERF) model, specifically designed to facilitate scenario synthesis of possible technology evolution paths, was selected for this analysis. With the assistance of Statistics Canada, the SERF model was augmented with an entertainment products module, enabling rigourous impact analysis on television set penetration to be conducted.

This examination enabled the impacts on labour, balance of trade and GNP to be analyzed in light of several possible evolutionary and industrial scenarios.

8.1.1 SERF Model Overview

Statistics Canada's newly developed Socio-Economic Resource Framework (SERF) is structured in a macro economic framework that is concerned with the broad interrelationships of Canadian markets. The hallmark of SERF is its ability to disaggregate markets (allowing the simultaneously change of a number of micro inputs); thus the behaviour of the Canadian economy can be readily examined in a number of different scenarios.*

For the analysis of the impact of future TV technologies, various television receiver projections and studio equipment demand scenarios could be examined, under different Canadian content alternatives. The choice of SERF as the economic analysis tool arises from three striking characteristics that set it apart from other macro economic models. First, as discussed briefly above, there has been an effort to rigorously ground micro relationships within macro economic theory. This approach has the advantage of a model that can explicitly examine increasingly disaggregated information. For example, SERF allows the analysis of changes in macro variables (such as employment or GNP), by enabling as many iterations of a micro variable (such as number of TV sets per household), as are desired.

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* In more detail, the identities used in SERF are based on the premise that the production process involves strong interconnections of many industries. For example, demand for television sets generates demand in industries supplying the television set industry, which in turn generates demand for the suppliers to the suppliers. Each industry sector affected requires imports, labour and other factors. Unlike the input-output models however, the interrelationships between these components (such as the percentage Canadian content or the life cycle of TV sets) can easily be changed to enable analysis of various trade options and Canadian industry incentives.

Second, an allowance for dynamic interaction within the model is a vast improvement over the timeless and static input-output models previously used for macro analysis. In this study's context, this capability enables forecasts to be developed and sensitized over the whole planning horizon. That is, the implications of alternative timeframes for the introduction of new TV technologies can be examined.

The third striking characteristic of SERF is in the area of data base compilation. SERF is an information base which contains both information indicating past states of variables, and information describing and quantifying relationships among components of the system. The historical data series are rigourously defined and are subject to several intermediate checks for self consistancy within the context of the Canadian economic structure.

The SERF model framework is made up of four main blocks which can be sensitized independently to determine effects of a particular condition, such as industrial policy changes, research and development activities, changes in commodity penetration rates, or imports/exports on a component within the total system. The four blocks can be generally described in the following manner:

- Demography Block: serves to calculate population, labour force and number of family units;
- Consumer Demand Block: calculates goods required to meet the needs of the population directly and the goods required to maintain and augment the stocks of goods which yield services required by the population;

- Industrial/Primary Production Block: includes international trade in goods and the formation of the capital stocks required to support the transformation of resources into the finished goods calculated in the Consumer Demand Block;
- Exploration Management and Development Block: serves to calculate the values of the 'tension' variables that indicate the viability of the entire scenario from the point of view of self-consistency.

Exhibits 8-1 and 8-2 illustrate in graphical form the interrelationships within the SERF framework of the various inputs and outputs associated with the economic impact analysis of television receiver demand. Exhibit 8-1 outlines the interrelationships within the consumer demand block while Exhibit 8-2 provides an outline of the industrial/primary production block. Each box in the exhibits indicate either a required input, an intermediary output or a historical base.

8.1.2 Scenarios for Economic Impact Analysis

Based on both the market projections (from task 2) and an understanding of the capabilities of the Canadian television and broadcasting manufacturing industry (from task 7), the economic impact of two main sets of scenarios have been analyzed. The first set of scenarios deals with the various possible market projections for entry of digital and "hidef" (ie, EDTV/HDTV) consumer television products. The second set of scenarios involves analysis of various options for the participation of the Canadian manufacturing industry in broadcasting studio equipment.

The first set of scenarios analyzing the impact of consumer television products include:

- The basic scenario - no evolution in TV technologies
- The introduction of digital receivers (under two different price/penetration scenarios)

Exhibit 8 - 1

SERF VIEW OF THE TV CONSUMER MARKET

(Consumer demand block)

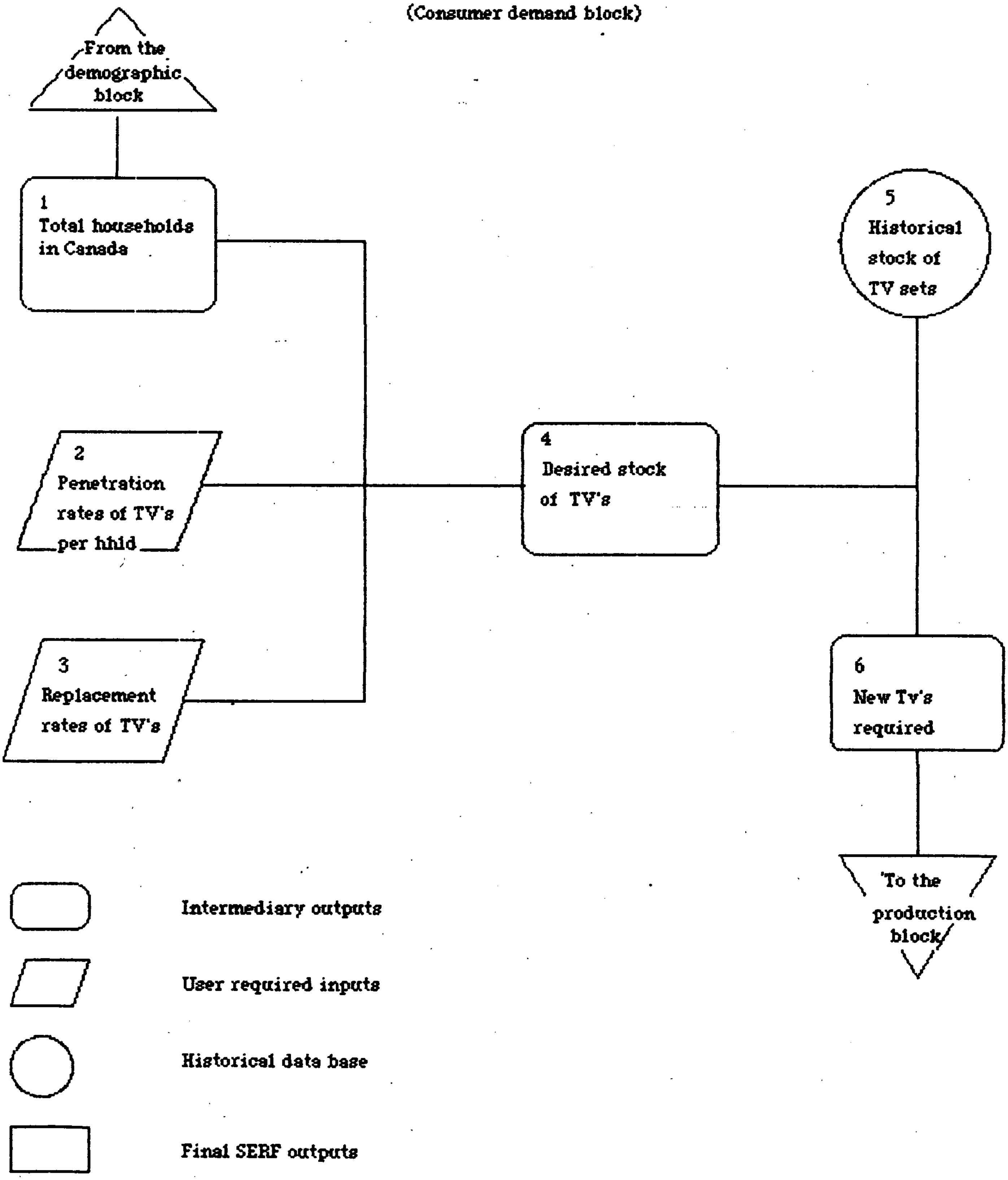
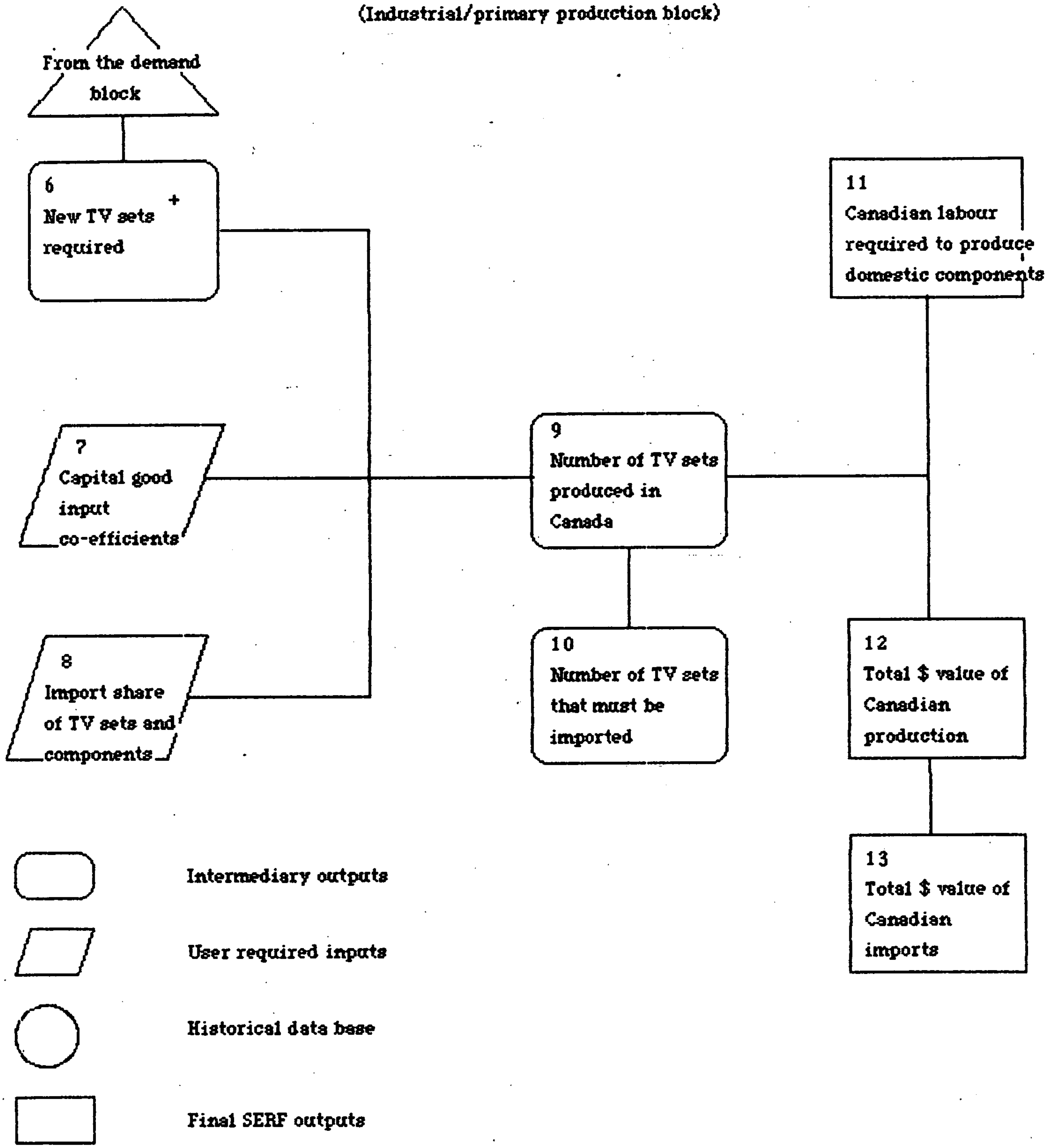


Exhibit 8-2

SERF VIEW OF THE TV PRODUCTION SECTOR

(Industrial/primary production block)



\+ TV sets for this presentation include TV set and related tv component production

- The introduction of digital receivers and hidef "broadcast" (under three different start-up dates and service penetration rates)

The second set of scenarios involves:

- Hidef service introduction with different Canadian content options for Canadian industry participation.

8.2 The Economic Infrastructure of the Television/broadcasting Industry

The thrust of major international players within the television industry, could very well make the evolution towards higher definition television in Canada and elsewhere inevitable. Should Canada be unprepared for this possible outcome, opportunities for both the Canadian cultural and industrial television communities could be lost.

As discussed in section 1 of this report, several possible entry scenarios for high definition television into Canada exists. In the following discussion, the economic influences of these possible entry scenarios are discussed in light of the industrial infrastructure of the Canadian television and broadcasting sectors.

8.2.1 Broadcasting Sector

The television broadcasting industry in Canada is currently supported through approximately $1.1 billion of advertizing revenue annually, $950 million of government support and $650 million through subscription revenues to cable, pay television and specialty services.* Thus revenues (including government appropriations) in the television sector are about $2.7 billion, currently employing about 20,000 people (cable and TV). Another 2000 are employed in independent film and TV program production, and nearly 1000 in the broadcasting

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* 1984 preliminary estimates

equipment sector. The receiver market of some $350 million in annual sales ('84) makes up the remaining component of the TV industry.

The important elements of the broadcasting industry that are variable are (a) programming, and (b) studio, distribution, and consumer equipment. The Canadian content and export sales performance of the program production and manufacturing industries comprise the key economic impacts from future TV technologies.

8.2.2 Program Production

The programming trade deficit is estimated to be in excess of $140 million for 1982,* likely close to $200 million this year. In addition, about $250 million in feature film theatrical and video license fees is estimated to be imported for the year.** Thus, the possible entry of higher definition television production outside of Canada should be of major concern to the Canadian production industry.

Should major players in the United States (HBO or CBS for example) launch higher definition services, a resulting trend towards high definition television production will result. If Canada is not prepared, the potential for foreign co-production and export will be severely diminished. In addition, should the introduction of a service of this nature (either for mini theatre or home subscriber use) in Canada follow, and Canadian producers are not versed in high definition production, much of the programming would be imported, thus increasing the current trade deficit.

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* Calculated from 1982 Statscan data, based on commercial broadcaster average of 30% of total programming costs being procured from foreign suppliers, less estimated Canadian programming export sales.

**Derived from 1982 data for feature films from DOC's "The National Film and Video Policy", May 1984; added to it is the projected foreign receipts from the sale of home videos derived from 1984 estimates (2 million units sold in 1984).

8.2.3 Manufacturing - TV Products

The manufacturing of television products in Canada has in recent years focussed on studio production equipment. Currently, Canada does not have the capacity to compete with the mass production of electronic component products for consumer use. In 1984, 91% of television receivers were imported. Without special incentives to attract foreign manufacturers to locate in Canada, this trade deficit in receiver products will not be improved. In fact, if penetration of new digital or higher definition television consumer products grows rapidly, the current trade deficit of $350 million (1982) for television sets and related components will escalate.

In 1984 with an estimated 800,000 units sold, the trade deficit due to video cassette recorders (VCRs) alone had reached about $320 million. Over the next two to three years, when VCR unit sales will reach their peak, a trade deficit approaching $500 million could very well result. VCRs are part of the video product component of an even larger basket of home electronics products (eg. compact discs, home games consoles, feature telephones). This suggests a worsening trade deficit in this sector.

8.2.4 Manufacturing - Studio Products

Canadian manufacturers have been more successful in supplying equipment for broadcasting and production use. In past years, over half of Canadian broadcast studio equipment requirements have been met by Canadian manufacturers. However, as discussed in section 3, Canadian manufacturers' ability even to maintain that share has been slipping.

Further adverse consequences will result if (as predicted in the Delphi forecast) television studio use of high definition television grows internationally, and Canadian manufacturers are not positioned in this market.

8.3 Economic Analysis Scenarios - Input Assumptions

The first series of inputs (scenarios 1 to 6) project the sales of consumer TV products as a basis for calculating the economic impact. The projections themselves are based on market forecast scenarios discussed in the "HDTV Forecast Report". The second set (scenarios 7 and 8) specifically relates to an analysis of the economic impact on studio products.

8.3.1 SCENARIO 1:The Basic Scenario - No Evolution in TV Technologies

The base scenario for the economic impact analysis, should be considered the "continue as is" technology path, as described in the task 2 analysis. This scenario examines the Canadian economy in a macro view and the TV production and consumption sectors on a micro scale: if no new TV technology is introduced into Canada during the study period 1985-2000. A base scenario is required so that a comparative analysis can be carried out on the incremental effects of introducing differing technologies as well as introducing these technologies over different time frames.

Examination of a base scenario also allows the specification of all macro variables in the SERF model, that are necessary inputs (ie; demographic requirements, labour statistics, fiscal policy), but are unaffected by the in-depth alterations of TV consumption statistics. This allows the initial variable requirements, although open for interpretation themselves, to be held constant through all the scenario computations and therefore have no altering effects on the macroeconomic outputs on a scenario versus scenario basis.

The base scenario for the economic analysis was constructed with the following assumptions:

- all recent historical demographic, household growth, etc trends would continue to 2000;
- the rate of television penetration would follow the historical trend growing from 1.4 sets per TV household in 1984, to 1.7 by the year 2000 (see Exhibit 8-3)*;
- the average life estimate of television receivers would continue to be 11 years;
- the import share of television sets and components would continue to follow the trend of recent years and rise from 91% in 1984 to 95% by the year 2000.

8.3.2 SCENARIOS 2 and 3: The Introduction of Smart Receivers

As reported on in the task 2 results based on the interviews with manufacturers of receivers and chip components (required for the receivers), and the Delphi forecasts conducted, smart receivers will be making their way into the international marketplace over the next 5 years. Features and image improvements will be offered with increasingly complex picture manipulation capabilities over this period.

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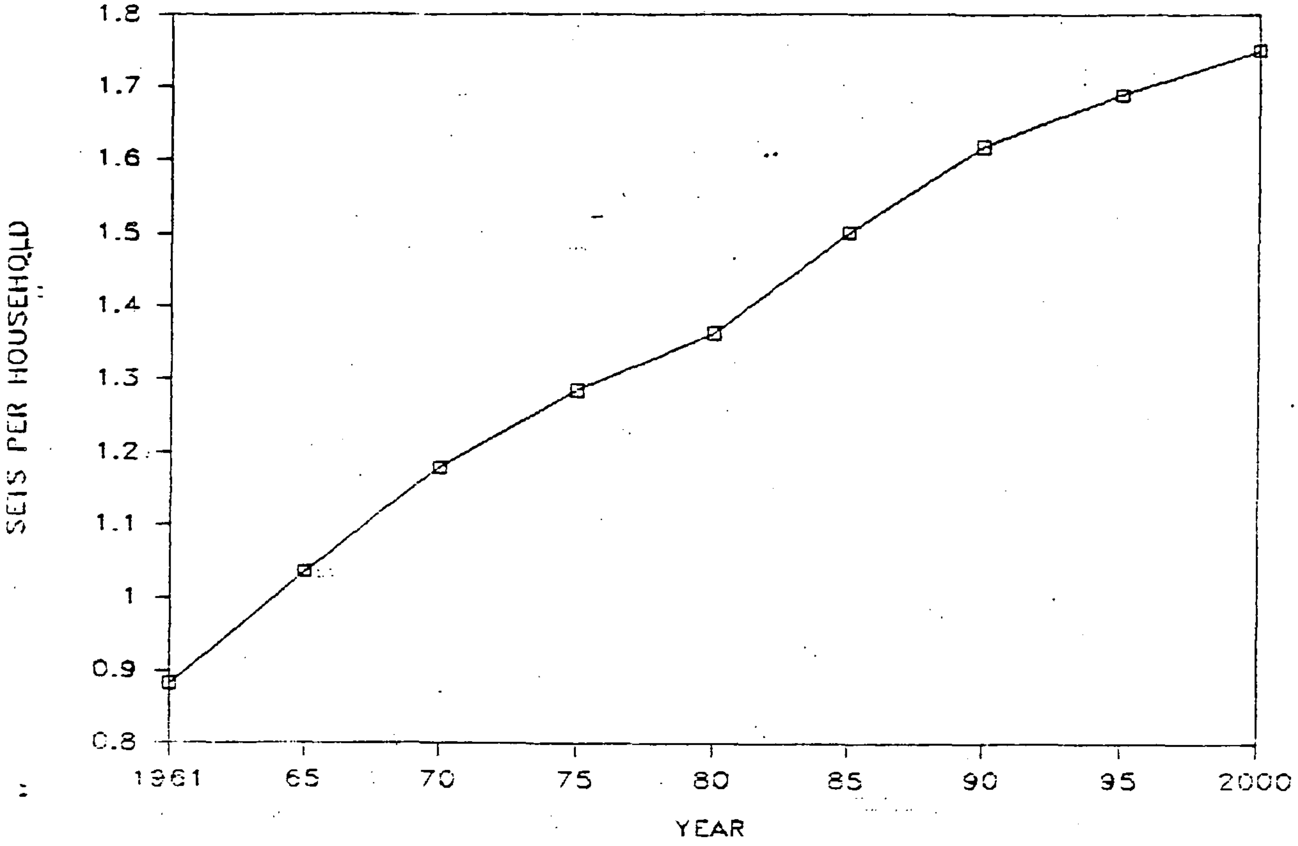
* The TV per household penetration rate is comprised of 3 further statistics pertaining to; the number of zero set households, one set households and multi-set households. The base scenario view of these three statistics is to continue as per their recent historical trends.

Exhibit 8-3

Historical and Projected Canadian Penetration of Sets per Household



Assumptions

No major technological improvements in TV sets

Trend line increase in multiset households from .89 per household in 1961 to 1.75 sets per household by the year 2000.

In Scenarios 2 and 3 it was assumed smart receivers with frame/field store capabilities would be introduced in the 1989 to 1990 period. No additional "hidef" products or services were considered for introduction for these 2 scenarios. While their basic framework scenarios was identical, each contains different smart television price/penetration assumptions as outlined below:

SCENARIO 2:Smart Television Introduction - High Penetration Rate (Low Entry Price)

- new smart receivers with frame/field store would be introduced in 1989-90 (as indicated by the Delphi forecast results);
- by 1991 all the high-end colour sets (ie. about 10% of sales) would be digital field/frame store receivers offered at prices close to the equivalent of existing high-end analogue sets (ie. about $1000-1200 Canadian in 1985 dollars);
- by 1995 about 50% of the new sets sold would be digital - assuming that the price of smart receivers would be about 20% above the price of traditional analogue sets ($600-700 in 1985 dollars). This price differential would eventually disappear, and by the year 2000 95% of receivers sold would be digital;
- the appeal of the quality and feature improvements would result in an increase in the number of sets per household to 1.75 by 2000 instead of 1.7 as projected in the base scenario;
- television replacement would tend towards 7 years (beginning in 1990) instead of the current 11 year cycle.

SCENARIO 3:Smart Television Introduction - Low Penetration Rate (High Entry Price)

- new smart receivers with frame/field store would be introduced in 1989-90 (as in Scenario 2);

- by 1991 some of the high-end colour sets (ie. about 2% of sales) would be smart, with field/frame store receivers offered at prices 50% above high-end sets;

- by 1995 about 20% of the new sets sold would be smart - assuming that the price of smart receivers would be about 50% above the price of traditional analogue sets;

- by 2000 about 50% of the new sets sold would be smart - assuming that the price of smart receivers would be about 20% above the price of traditional analogue sets;

- the appeal of the quality and feature improvements would result in an increase in the number of sets per household to 1.75 by 2000 (is in scenario 2);

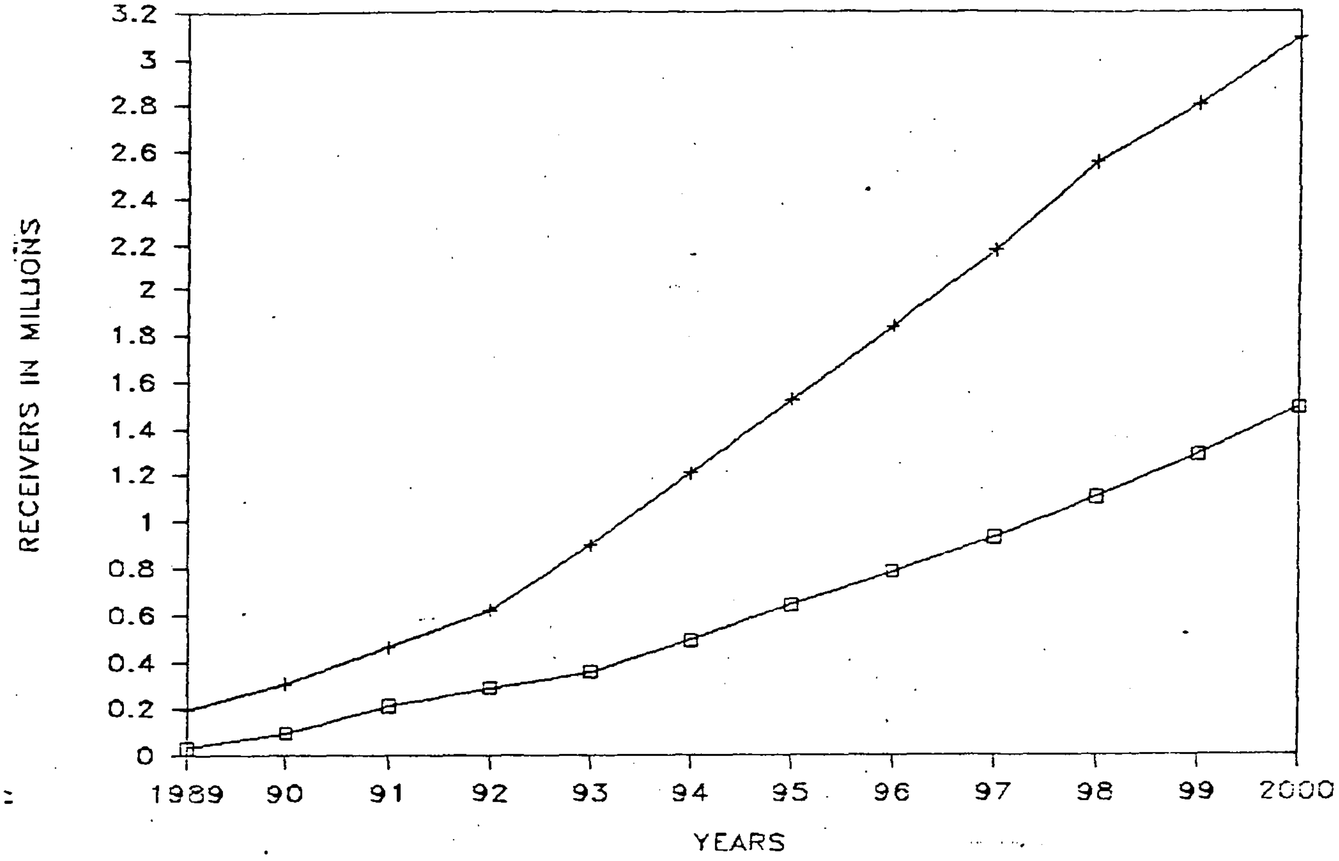
- television replacement would tend towards 10 years (beginning in 1990) instead of the current 11 year cycle.

As shown in Exhibit 8-4, the penetration rate for consumer television receivers for total TV sets utilized for scenarios 2 and 3 increases above the base scenario in year 1989 through to year 2000 to 1.75 TV sets per household. This is caused by the introduction of the new smart television product, which increases the number of multi-set television households marginally. A drastic change in the number of multi-set households is not realistic to expect (based on historical evidence of colour television introduction).

The main difference in the inputs for these two scenarios (#2 and 3) is the unit price at which the digital receiver is initially priced and the price movement over the 15 year study period.

Exhibit 8-4

Projected Growth in Smart TV receiver Sales in Canada



\+ Sales of smart sets assuming low price entry scenario

□ Sales of smart sets assuming high price entry scenario

Assumptions

Low entry price - 1991 smart sets priced similar to high end analogue sets moving to 20% above traditional sets by 1995 and the price differential eliminated by the year 2000.

High entry price - smart sets initially offered at 50% above high end analogue sets moving to 20% above the price of traditional analogue sets by the year 2000.

The "low price smart set" scenario (#2) leads obviously to a higher growth rate than the "high price smart set". Exhibit 8-5 compares the projected market share of smart receivers relative to total TV set sales for these two scenarios.

This difference in penetration pattern is compounded by the larger impact on the demand for smart TV sets caused by the consumer's replacement cycle. Depending upon the price at which receivers are introduced, consumers will replace existing sets, not through historical attrition rates, but simply through a desire to have a better quality receiver (note that a good many of these consumers are already multi-set households). Exhibit 8-6 provides the resulting demand projected for television sets under these two scenarios, one assuming a 7 year replacement cycle ("low price smart set") and the other a 10 year replacement cycle ("high price smart set").

8.3.3 SCENARIOS 4, 5, and 6: The Advent of Hidef Services

The final three scenarios for consumer television products consider the introduction of hidef television services in addition to smart television sets. The differences between these three scenarios arise from alternative introduction dates (hidef services for scenarios 4 and 5) and alternative service entry possibilities (scenario 5 and 6). Assumptions for these scenarios include:

Exhibit 8-5

Smart TV set Penetration as a Function of Total TVs Purchased

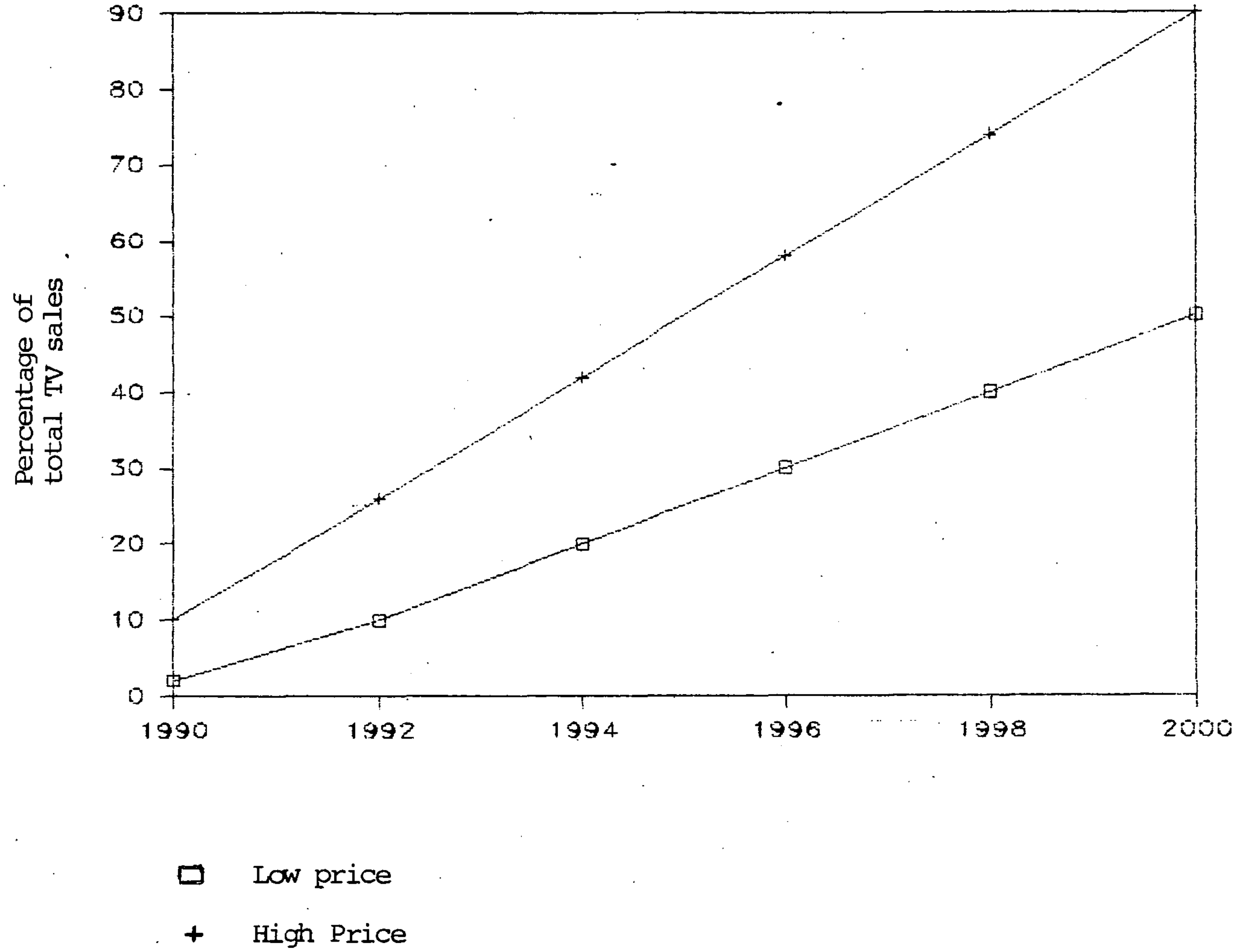


Exhibit 8-6

Projected Demand of Smart Television Sets (in '000 of units)

Year	Scenario 2 "Low price smart TV set"	Scenario 3 "High price smart TV set"
1989	194	35
1990	308	95
1991	465	214
1992	623	292
1993	903	359
1994	1208	495
1995	1523	644
1996	1839	785
1997	2176	933
1998	2555	1106
1999	2803	1288
2000	3088	1489

SCENARIO 4:An early start date of multiple hidef service "broadcast" (1992)

- the incremental effects over and above the smart set entry scenario 2 were considered
- the introduction of 2 or more hidef services would commence in Canada in 1992
- price of hidef receivers will initially be approximately 45% above smart receivers declining to a 35% premium in 2000
- hidef receivers are assumed to replace 15% of smart receiver sales in 1992 growing to 65% by 2000
- penetration rate of televisions per household would achieve 1.77 by 2000
- replacement of existing televisions would tend towards 6 years commencing in 1990

SCENARIO 5:A slightly later start date of multiple hidef service broadcast (1995)

- same as Scenario 4 with 15% of smart receiver sales replaced by hidef receivers in 1995 and 40% by 2000

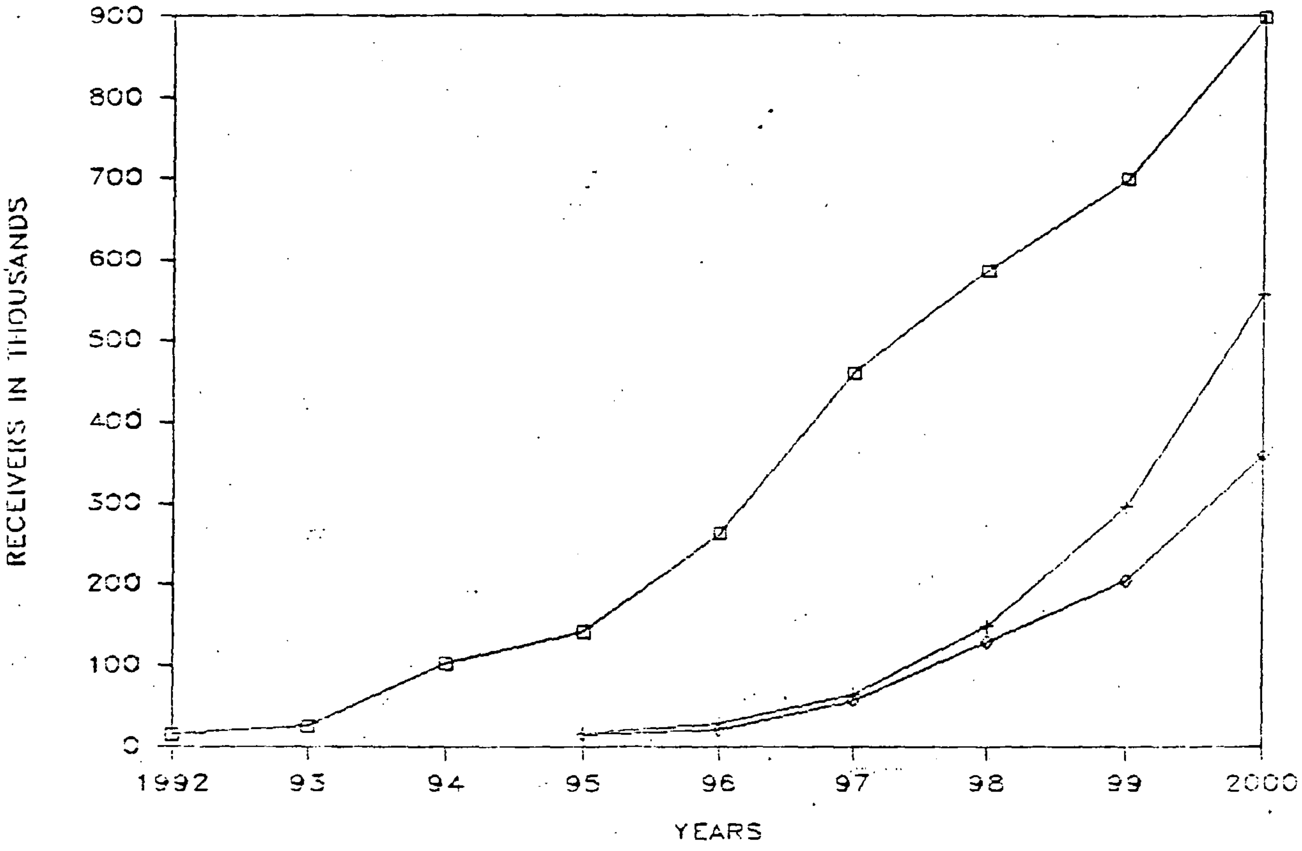
SCENARIO 6: Hidef 'premium' service broadcast in 1995

- same as Scenario 5, however hidef services would be offered as a premium service, with penetration assumed to be roughly analogous to pay-TV in Canada, ie. 10% of cable subscribers in first year of introduction and 25% by year 5 (thus 10% and 25% of smart receiver sales in 1995 and 2000 respectively).

Exhibits 8-7 and 8-8 show, graphically and in units, the demand pattern of hidef receivers for the 3 scenarios.

Exhibit 8-7

Projected Growth in HDTV Receivers - Canada



☐ 1992 start - Scenario 4

+ 1995 start - Scenario 5

◇ 1995 start (premium hidef) - Scenario 6

Assumptions

Scenario 4 - assumes introduction of HDTV receivers in 1992 priced at 45% above smart receivers in 1992, declining to a 35% premium in 2000.

Scenario 5 - assumes introduction of HDTV receivers in 1995 priced at 45% above smart receivers in 1995, declining to a 35% premium in 2000.

Scenario 6 - hidef receiver penetration roughly analogous to the pay-TV experience in Canada; ie, 10% of total cable subscribers in first year, reaching 25% by year five.

Exhibit 8-8

Projected Demand of HIDEF Receivers
(in '000 of units)

Year	Scenario 4 "Early start hidef"	Scenario 5 "1995 start hidef"	Scenario 6 "premium hidef"
1992	16	0	0
1993	26	0	0
1994	103	0	0
1995	142	17	14
1996	263	30	21
1997	461	108	97
1998	587	149	136
1999	700	296	206
2000	898	556	359

8.4 Economic Impact Analysis

The following review is of the macro-economic outputs that have been produced through the examination of the various scenarios discussed in Section 2. The outputs of importance for this multi-scenario study included the incremental effects of the alternative assumptions upon Canada's: (i) balance of trade, (ii) employment, and (iii) GNP.

The sectors of the economy for which these economic variables were derived are (i) the consumer electronic product market (TV receivers, VCRs, etc) and (ii) the broadcast studio facilities production sector.

The major focus within each of these sectors is on the manufacturing structure of the industries. In particular, to what extent is the domestic market capable of providing the Canadian requirement for such goods as TV receivers or other TV related consumer products like VCRs or converters/decoders.

Canadian content was also a variable to be sensitized in the analysis of the sector of studio equipment manufacturing with the resultant multiplier effects on the Canadian economy.

8.4.1 Receivers Manufacturing

Within the consumer electronics market, as stated previously, Canada presently imports 91% of all TV sets and components, producing a negative trade balance at present of approximately $350M. Therefore, as new TV products are made available it is safe to assume that these statistics will become larger. In other words, the major economic impact to be analyzed is Canada's balance of trade, or more specifically the further escalation in import dollars caused by the differing scenario's demand for new TV sets.

The large import factor for all consumer electronic goods implies that Canadian production effects, namely employment and GNP, caused by increased demand for digital or hidef receivers, will be negligible. Exhibit 8-9 compares the outputs resulting from scenario 3 (low penetration of smart TV and no hidef technology), scenario 4 (high penetration of smart and hidef receivers) against the base scenario 1. These results illustrate that total imports over the 15 year time horizon can vary between a 30% ($626M) increase for high price smart TV receivers to a 115% ($1.2B) increase for the low price smart and hidef receivers.

Furthermore, if the VCR market is added to these figures, then an even more glaring negative balance of trade impact can be forecasted. VCRs, now in 25-30% of Canadian households, are still growing rapidly with no safe bet as to ultimate maturity. Hidef displays with disc/tape players can be anticipated in advance of hidef broadcast and then expand in sales when hidef services are available. Thus, the receiver negative trade balance considerably understates the trade picture in consumer products related to new TV technology.

Exhibit 8-9

Economic Output Summary - Receiver Impacts

	BASE SCENARIO		SCENARIO 3 "low penetration of new TV technologies"	SCENARIO 4 "high penetration of new TV technologies"
	1985	2000	2000	2000
SECTORAL OUTPUTS				
Imports (1984 $M)	361	752	987	1610
change from 1985		391	626	1249
Employment	3675	5013	5124	5268
change from 1985		1338	1449	1593
GNP (1984 $M)*	-.3	-1.52	-2.77	-3.35

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* The negative net change in GNP is caused by the large import share TV technologies generate.

With many spin-off products (hidef, VCRs, decoders, etc) that could arise from the introduction of new consumer electronic products, there may be some hope for Canadian participation in some of these areas. For example, in-home decoders will be a requirement with any introduction of hidef services. While the pay-TV decoder opportunity was largely missed by Canadian suppliers there is still potential in that area as discussed in section 3. It is likely, however, that on balance the trade balance would further deteriorate.

8.4.2 Studio Products

The second major industrial sector with ramifications caused by a strong consumer electronics market involves the production of studio and transmission equipment. A number of scenarios were looked at in an attempt to determine the positioning of Canadian manufacturers with regards to the international marketplace. The key assumptions used for this analysis for the base year of 1985 are:

- Canadian share of the domestic market: 47%;
- export orders for Canadian firms as a ratio of domestic orders: 70%;
- investment by broadcasters in studio equipment: $114M.

The scenarios investigated involve trend extensions to the above base scenario as follows:

Scenario 1: Marked decline

- Canadian share of domestic market declines to 22% in 2000

- export orders decline to 40%
- investment by broadcasters declines to $41M by 2000

Scenario 2: Worst case

- approximate doubling of decline from scenario 1

Scenario 3: Status quo maintained

- no decline from base case

Scenario 4: High capital investment

- no decline from base case
- broadcasters investment rises 10% compounded annually from base case

Exhibit 8-10 provides the summary of outputs for the above scenarios.

Whereas the TV set and component production industry had little impact on employment and GNP figures in this country, the broadcast equipment manufacturers have potential to affect these measures by a noticeable degree. For example, if the manufacturing sector can be persuaded to increase capital expenditures 10% a year (approximately $7M/year) and were successful in expanding their domestic market share of studio equipment from 30%-40% at present to 50%; by the year 2000, over 3000 new jobs could be created which is a quadrupling of the present work force employed in manufacturing. Furthermore, the GNP value would increase $375M which represents a 25% yearly return for the Canadian economy on the extra $7M spent a year by the manufacturers. The analysis of the "continue as is" scenario, with its recent historical trend of a worsening import-export ratio, illustrates the potentially

Exhibit 8-10

Economic Output Summary - Studio Equipment Manufacturers

	Scenario 1 decline in sector activity		Scenario 2 worst case	Scenario 3 status quo maintained	Scenario 4 increased capital expenditures
	1985	2000	2000	2000	2000
SECTORAL OUTPUTS					
Exports (1984 $M)	42	64	44	110	317
change from 1985		18	2	68	275
Imports (1984 $M)	49	305	579	119	83
change from 1985		256	530	70	34
Employment	819	1339	1078	2054	3963
change from 1985		520	259	1235	3144
GNP (1984 $M)	63	1.7	-101	154	438
change from 1985		-61.3	-164.2	91	375

harmful effects of ignoring the industry. This is shown by a drop in GNP of $150M and a worsening of the trade balance by $200M by the year 2000.

The SERF analysis did not evaluate the implications of a 'full fledged' movement by broadcasters to higher definition on the satellite industry. As mentioned earlier, this scenario could prompt the launch of an additional satellite - an item which would require a significant investment in the Canadian satellite industry.

The other major scenario not addressed in this analysis, involves the possible implementation of a fibre optics distribution network as a possible HDTV distribution option. Investment of this nature would have a significant impact not only on the domestic fibre optics industry but also the broadcasting, cable television and telecommunications industry.

8.4.3 Relative Employment Importance

While the number of jobs in this sector may not seem large - the range from the worst case to the best case scenarios is about 2500 - it is a type of employment that is highly desirable. Studio equipment is one sector that is high tech - high export in characteristics with employment scattered throughout Central and Western Canada.

To put these figures in perspective, the following employment implications show that in comparative terms, the studio equipment stakes are large:

- 64 smaller manufacturers with annual sales of less than $10 million in communications equipment employed 5,400 Canadians (in 1981);*
- The expected Radarsat direct job generation over 10 years in remote sensing and other high tech companies is 8,000 person-years.**
- The M-Sat project is expected to create 1600 continuing high tech jobs by the year 2000;***
- The direct employment related to the sales of CATV equipment would rise from 1251 in 1982-83 to 2,574 by 1990 in an optimistic scenario or drop to 1073 in a pessimistic scenario (see Exhibit 8-11 showing the equipment investment projections upon which this estimate was based).

Each of these areas has merited a variety of focussed program support, primarily for industrial development reasons. In this light, there is no reason why the broadcast equipment sector is any less worthy of special attention, if not funding.

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* "The Supply of Communications Equipment in Canada, DOC, 1981, p.6

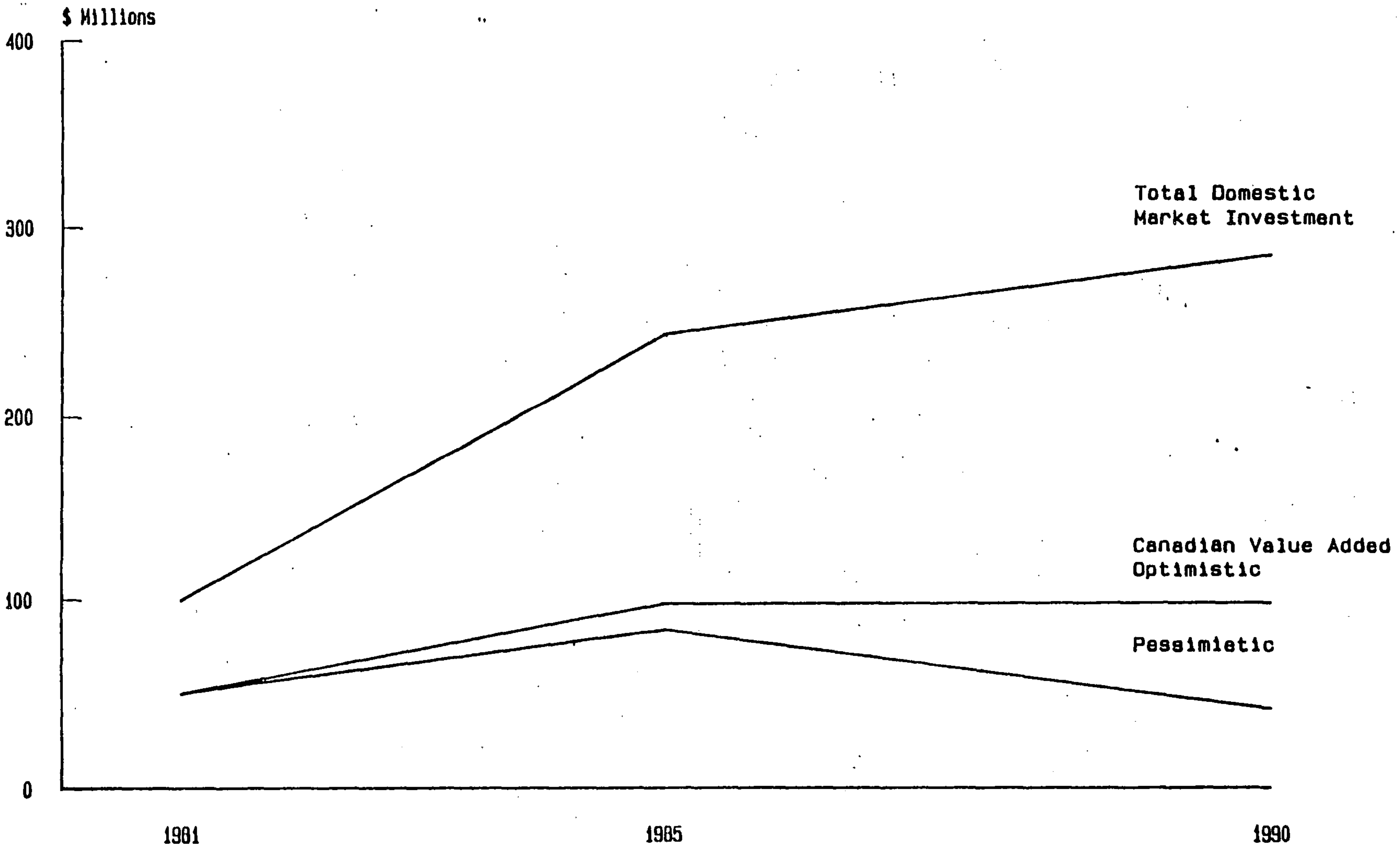
** Notes for remarks by Hon. Robert E.J. Layton, Minister of State (Mines), March 20, 1985. (These figures were originally prepared by Nordicity Group and represented the upper level of three alternative job forecasting methodologies).

***Final Report: The Canadian CATV Industry and Its Suppliers, Phase II, DOC. 01ST-36100-4-4429, p.87-88, Sept. 30, 1983.

Exhibit 8-11

Canadian Value Added Domestic Market Investment Outlook

$ 1983



Source: The Canadian CATV Industry and Its Suppliers, p. 86
Phase II, Sept. 30, 1983. DOC Internal Working Paper.

8.5 Economic Policy Conclusions and Recommendations

The focus of economic policy analysis in this section is related to the broad parameters of employment, GNP and balance of trade.

8.5.1 Employment and Industrial Policy

From the previous discussion on job impact, particularly in comparison with benefits from other industries, it is clear that the broadcasting studio (and transmission/reception systems) product areas are quite important and deserve specific policy focus. In Section 3 the possible initiatives surrounding a specific project and CBC procurement function were fully addressed. The digitization of broadcasting studios is a near term opportunity which will precede the introduction of hidef services and thus merits immediate attention along the lines discussed in Section 3.

8.5.2 Consumer Electronics - Importance

The SERF model outputs depict a substantial worsening of the trade deficit in tv receivers, which grows even more unfavourable if related products (like VCRs) are added to the analysis.

The magnitude of the trade deficit is dependent on how rapidly new products enter the market, rather than on the technology adopted. Whether EDTV or HDTV becomes the adopted new standard route into Canada (which will likely be determined in the US in any case), the Canadian electronics industry will not benefit from it.

A continued stream of entertainment and consumer electronics products can be expected over the next 15 years, led by the new tv technologies. As illustrated by TV receiver/VCR statistics, these products are largely imported. If there is a substantial shift in consumer expenditures toward these product categories, it may represent a trade-off for other leisure activities or consumer durables (like cars) - for which there is a significant Canadian content. Therefore, the continuing and potentially growing consumer electronics popularity has to be viewed from an inter-sectoral perspective; ie. whether the economic impact impinges on the performance of other sectors of the economy.

8.5.3 Policy Options

The economic impact in terms of GNP and balance of payments should be viewed as an advance warning for trade and industrial policy. One alternative is to attempt to slow down the introduction of new services in Canada, or even new digital receivers. Options to do so on the latter product categories are limited apart from the slow customs approval process adopted as a relatively extreme measure by France vis-a-vis VCR imports.

The introduction of hidef services into Canada cannot be postponed for too long once services are initiated in the US. As broadcasting history indicates, TV viewers will vote with their entertainment pocket-books in buying TV antennae, satellite dishes, SMATV, video retail, or subscriptions to private cable operations if the TV product is not available in Canada. Rather than arrest diffusion into Canada, it can be argued that such services should be speeded up to give Canada the edge in vying for participation in the software/content and specialized applications markets.

A second alternative, instead of barring entry in some form or other, is to begin bilateral or multilateral trade discussions. Japan is perhaps the obvious target for such discussions, but the growing importance of other Pacific nations should not be ignored (nor, incidentally Western Europe). For example, it is South Korean firms to which Japanese manufacturers have licensed VCR production, soon for export.

The traditional "concession" of Canadian assembly of new products is not advocated as an objective in this case. Participation in joint ventures for specialized applications for institutional markets, product testing in Canada in anticipation of an assault on the US market (similar to the Hyundai's Pony in automobiles) and content/software aspects should be the focus of trade attention.*

Where governments can get involved in such joint venture developments, is in the trials leading to early introduction of one or other hidef systems. For example, in exchange for adopting a reduced bandwidth transmission system for HDTV, at least for some phase of service introduction, Canadian firms could be levered into the international supply system for at least some subsystems or content element. It should be recognized that such initiatives are gambles with which the marketplace could play considerable havoc. Nevertheless, more focussed trade and industry attention in this area could lead to potential initiatives that narrow the risk.

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* A third alternative is an inter-sectoral approach whereby access to telecom markets would be sought as exchange to market access.

In sum, while specific industrial policies can address the industrial opportunities presented by studio and transmission system markets, a careful examination of the trade policy options must address the broader consumer electronics sector. It is a new perspective that is brought into sharp relief by new TV technologies and should be pursued in more depth in future policy analysis.

9.0 Standards

This section, prepared by the CBC, provides a discussion on current standards issues related to new TV technologies with particular focus on Canadian objectives and required initiatives.

9.1 Introduction

With the advent of research and development in high definition, extended definition and digital television technologies, the topic of standards for these services has become an issue of both national and international impact, and it is being widely and loudly debated from the viewpoints of technology, economics, industrial benefits and potential markets.

Amongst the questions surrounding advanced television systems, the initial question to be addressed is: "Are standards really required"? From previous experience in such areas as AM Stereo and stereo sound for television (MTS), one can answer the question very readily, in the affirmative. A comparison between the introduction of these two recent technologies will quickly show that the adoption of a single standard or related range of standards leads toward much faster development of the market, a more profitable role for industry as a whole, and better performance and value for the consumer.

In the USA, the Federal Communications Commission did not adopt a single standard for either AM stereo or stereo TV sound. In the case of AM stereo, various competing systems have been installed by different station operators. The consumer public has been slow to respond to AM stereo, since they don't know if the equipment they purchase will work with all the AM stereo signals they might receive. Multi-format receivers have been made by several manufacturers, but they are not being sought eagerly by a public largely confused by the whole issue. Even the selection of one of the systems by General Motors and Chrysler has not led to significant development of a single-system AM stereo service in either the United States or Canada.

On the other hand, when Multichannel Television Sound (MTS) was being considered by American industry, both broadcasters and equipment manufacturers worked together through the Electronic Industries Association (EIA) whose Broadcast Television Systems Committee worked 5 years selecting a standard system, and then presented that system in a single proposal to the FCC. The FCC subsequently endorsed that proposal (the Zenith-dBx system), and protected its pilot frequency, thus leaving the marketplace free to introduce other systems, or enhance the MTS system, while ensuring that MTS receivers will be unaffected by these changes. As a result, television receivers, video cassette recorders and adapters for MTS television abound, the public is enthusiastic about stereo audio for TV, and industry has a viable new market to supply.

In the case of HDTV and other forms of improved television, there will be a need for clear standards to be developed for the studio, and particularly for transmission, to allow an orderly and effective development of equipment, services and receivers. Care must be taken to ensure that these standards meet the needs of Canada and do not destroy current services for the benefit of foreign suppliers of goods and services. There will also be a need to resist premature standards and to take the initiatives necessary to examine the technology and proposals so that the standards achieved are meaningful for their area of application, and in the Canadian context.

9.2 Standards - Basic Concepts in Canada

In broadcasting, standards serve several purposes:

- ensure compatibility of transmitting and receiving equipment;
- establish the limits of interference to meet treaty obligations and to set a minimum quality level for the listener/viewer;
- create the basis for the interchange of program material among broadcasters and producers with a minimum of conversion impairment;
- ensure the safety of operating personnel and the general public.

In addition, standards may be used to encourage local manufacturing industry by creating market divisions, or to advance national interests by creating wider markets for hardware and programs. Some countries, such as France, have been quite successful in these respects due to their selection of the SECAM television system which are not available from other countries thereby creating a domestic demand.

For the broadcasting industry in Canada, the Canadian Department of Communications sets out the minimum technical transmission performance standards for television sytems. These values are derived by consultation with members of Canadian industry and government as well as with international forums. The regulations have an impact on many diverse aspects of broadcasting, including basic system parameters, minimum transmitter performance levels, acceptable locations for transmitter sites, common carrier tariffs and practices, studio construction methods, manufacturing practices, and electrical safety. Broadcast receivers are not regulated.

Another governmental organization concerned with this issue is the Canadian Department of Health and Welfare, which sets, amongst other things, the limits for levels of non-ionizing radiation. Concerns have been expressed both in the media and in government circles about safe exposure levels for the Canadian public. This issue will surely be one of continued debate as Canadians become more sensitized to the environment and to their quality of life. The Department of Transport is also striving to ensure that R.F. transmission does not affect air safety.

At this point in time, there is no Canadian body with a mandate similar to that of the United States' Electrical Industries Association (with its Advanced Television Systems Committee); thus there is no recognized Canadian forum where the standards issues can be debated and proposed to government. Such bodies as the Technical Advisory Committee (TAC) and the Radio Advisory Board of Canada (RABC) have not yet taken advanced television systems onto their agenda. Similarly, the adoption of digital television transmission standards for common carriers in Canada will probably follow in the steps of work being done by committees south of the border. While it is valid to encourage the development of standards having North American or even worldwide application, particularly in the small-volume professional equipment market, great care must be taken to ensure that these standards to not compromise Canadian interests in Government, industry, or consumer needs and services. The recent deregulation movement in the US makes it more imperative than ever that Canada be very careful about adopting these standards, as the AM Stereo case pointed out.

9.3 Canadian Objectives for Future Television Standards

One of the larger issues in current HDTV work is that of compatibility. The question of whether HDTV should be introduced as a completely new system requiring new distribution, reception and display systems, or whether it must be tailored to work within the confines of current systems is one that has brought on heated debate in international forums. In Canada, our television system is predominantly a distribution system, with a lesser amount of production capability. As such, therefore, we must ensure that our large investment in the distribution infrastructure is protected when we consider advanced television systems.

There are those who feel that HDTV is so revolutionary and distinctive that the mere attempt to accommodate it in current distribution systems will severely limit its full development. In Japan, NHK, via its proposed production standard and MUSE DBS distribution system, are amongst those who promote this view.

On the other side of the discussion are those who feel that HDTV technology should be tailored to exist within current distribution frameworks. Notable amongst this group are the Americans with, for example, the CBC two-channel system, a quasi-compatible HDTV system.

It has normally been the North American experience to add new services and facilities within the existing structures. Most notably, the addition of colour to monochrome television and the introduction of stereo FM radio service were all accomplished, with no minor effort expended, within the systems that existed at that time. Government, industry and broadcasters have a responsibility to ensure that the public is not sold "soon to be outmoded" technology.

The issue of compatibility has been widely discussed and, due to the complexity of introducing new standards, new services and new consumer products, there are many divergent and frequently opposing viewpoints. Some facts appear that are widely supported:

- The majority of television distribution services to consumers employ 525 lines, NTSC standards, and this situation will continue for some time. Distribution is currently by terrestrial broadcast, tape, disc, multi-channel cable, and by communications satellite. This community of users would be best served by 525 line, 4:3 aspect ratio, component-based video and improvements to the audio, such as multi-channel digital sound.
- The production of television programs of the highest quality requires source devices (cameras) of impeccable performance if the programs released to the viewer are to be "High Definition". The technology to produce TV cameras equivalent to 35 mm film cameras is still developmental and, in places, unachieved. Shooting, producing, transmitting and displaying the picture in the same standard has been shown to be a poor optimisation. The essence of new television standards must then be convertibility without adding impairments, resulting in the need for digital processing.

- Spectral resources for broadcasting to viewers and for inter-studio are scarce. Bandwidth reduction will be needed, with innovative use of digital processing in the receiver, which must also display both HDTV and current 525 line sources. Compatibility based on 525 lines/60 fields per second transmission scanning (but not necessarily display) is highly desirable. For reasons of industrial strategy, there is at present considerable pressure in the USA, Japan and Europe to move in the direction of a single HDTV system based on a scaled-up version of the current television system. Canada would not be well served by the adoption of such a system in North America.

With this background, we see that Canada must be very active in fostering the acceptance of standards appropriate to and compatible with our distribution systems. We should be prepared to accept an "international" standard for the high definition electronic production systems in our studios, in order to take advantage of domestic and international program exchange possibilities, to minimize our acquisition costs for HDEP equipment, and to permit our domestic industry to build to a world standard, for the widest possible market. We should, however, follow a process of evolution rather than revolution vis-a-vis the adoption of standards for the transmission of future television systems. The retention of downward compatibility with our existing distribution system and viewer base would thus be achieved. Since it is likely that the United States will also follow this course, we can expect to be in a position to compete in a North American market when our industry starts to build products for these new television systems.

9.4 Positive and Negative Aspects of Standards

There are basically two extremes in the application of standards: the free-wheeling "marketplace" approach and over-regulation.

The "marketplace" approach has gained great acceptance in the United States, with the advent of the conservative business approach in industry. The previously mentioned case of AM Stereo is a good example of what can possibly happen when there is little regulation, no guidelines and scarce consultation.

Another interesting by-product of the marketplace approach is the "de facto" standard. Without technical standards to form the framework for development and research activities, many manufacturers attempt to promote their approach/system as the "de facto" standard and hope to gain international standardization after their system is fully developed and deployed. A recent example of this effect is the IBM personal computer, which has become the de facto standard of the microcomputer industry. De facto standards must, by definition, be established for several years before they are generally recognized as such. These standards, therefore, cannot reflect the current state-of-the-art (which is indeed the case for the IBM personal computer).

On the other hand, if there is too much regulation in the industry, a system may be created wherein industry is strangled by the requirements of technical performance standards, to the detriment of both the manufacturer and the user. Costs will invariably rise and the pace of growth in industry may become slowed.

There is a necessity of striking a balance somewhere between these two extremes. A group of people familiar with the current technology and requirements can develop a standard that reflects (or may even anticipate) the state-of-the-art. Standards created this way can be the minimum required to facilitate the growth of industry as well as to serve effectively the consuming public's demand for new services. These standards can be wide in scope, specifying interchange with the system in question, but leaving industry free to develop further improvements within this basic framework, by leaving them free of performance requirements.

9.5 HDTV Standards - Current Status

The previous discussion reviewed some of the basic aspects of standardization. With specific emphasis on HDTV, one of the more important developments in recent years is the publication of Recommendation 601 of the CCIR.

Recommendation 601 forms the basis for the digital coding standards for television studios in countries using 525-line and 625-line systems. The coding scheme is predicated on the use of one luminance and two colour difference signals. The intent was the development of an extensible "family" of compatible digital coding standards, wherein a digital interface standard, in which the luminance and colour-difference sampling frequencies are related by the ratio of 4:2:2.

For 525-line 60 field/sec systems, the following specifications were set out:

1. Coded Signals: Y, R-Y, B-Y,
2. Number of samples per total line:
   - luminance signal (Y): 858
   - each colour-difference signal (R-Y, B-Y): 429
3. Sampling structure: Orthogonal, line, field and picture repetitive. R-Y and B-Y samples are taken from the same location line as odd Y samples in each
4. Sampling frequency:
   - luminance signal: 13.5 MHz
   - each colour-difference signal: 6.75 MHz
5. Form of Coding: Uniformly quantized PCM, 8 bits per sample
6. Number of samples per active digital line:
   - luminance signal: 720
   - each colour difference signal: 360

The impact of this Recommendation lay in the fact that there was not an internationally agreed upon standard that would permit the development of equipment with many common features, permit operating economies and facilitate the international exchange of programs. It is now time to consider how this principle can be extended to include a compatible member for HDTV in the studio and for production, and how this member of the family should resolve the incompatibility of Recommendation 601 concerning field/frame rates and interlace. It is essential that future television systems be built in a "family" manner, as no one television standard is likely to meet the myriad technical and economic requirements that now exist.

Contributions currently before the CCIR IWP 11/6 from Japan and the USA suggest an HDTV standard for studio production based on the following parameters:

- Signals coded: Y, R-Y, B-Y (subject to further study);
- Scanning standard: 1125 lines, 60 fields/sec, 2:1 interlaced;
- Samples per total line: 2200
- Aspect ratio: 5.33:3;
- Sampling frequency: 74.25 MHz (Y), 37.125 MHz (C_R, C_B)
- Samples per active line: 1920 (Y), 960 (C_R), 960 (C_B).

While the 60 Hz field frequency is not yet accepted in Europe (where national standards use a 50 Hz field frequency) it seems likely that developments in standards converters combined with economic pressures, may well result in the proposed studio standard being agreed. Questions regarding the definition of colorimetry, gamma correction, matrixing and transmission characteristics are not likely to be resolved for at least 12-18 months.

9.6 Multiplexed Analogue Component (MAC) Formats

To justify the expense of HDTV in both studio and transmission equipment, the performance of the system must be distinctly better than the current performance of NTSC. However, it should also be easily convertible to NTSC and other signal formats and be readily derived from production and studio standards. The undistorted component signals must also be easily recoverable from whatever composite format is used.

To accommodate these requirements, as well as to implement an all digital high quality satellite transmission system, several Multiplexed Analogue Component (MAC) formats have been developed. The underlying concept is a hybrid system in which digital transmission techniques are used for the audio and associated data channels, combined with the analogue component video information. In all the currently proposed MAC systems, the luminance and chrominance components of the video signal are sent in a time-multiplexed manner, with each component appropriately time-compressed so that the complete signal, including the audio and data components, occupies minimum bandwidth.

The difference among the various MAC systems lies in the number of audio and data channels that can be processed along with the video information, and each system is best suited for use on a particular medium, such as DBS, cable, etc., due to the applicable transmission restraints. A recent development, known as E-MAC and suggested by Philips, would send extra time-compressed data during the horizontal- and vertical-blanking intervals, which would be decoded in special receivers to siden the aspect ratio to 5:3, and provide the information for improved picture definition.

Various proposals for multi-channel MAC systems have been made, including those by DBP-FTZ (West Germany) and CBS. Such systems would use more than one channel to provide a full high definition television system that will be compatible with existing displays. The "Basic" MAC channel is a complete 4:3 aspect ratio picture, while the additional channel will carry extra data required to extend the aspect ratio to

5:3 and provide detail enhancement for HDTV receivers and displays. Such receivers would be costly, however, due to the expensive frame stores required, and this could delay their introduction.

9.7 Related Standards Issues

The advent of HDTV technologies does bring into focus several other related areas of concern. The first of these is the lack of a Canadian forum specifically tailored to accommodate this new technology, both from the broadcasters and the common carriers point of view.

With this forum may come the possiblity of taking stronger stances on the issues raised, especially to protect and promote Canadian interests, both in industry and government. With this capability, there may lie the possibility of better protection for Canadian industry competing in international markets, an area where standards promoted by international groups have proven detrimental. In some instances, technical standards (as in the case of "de facto" standards) have been used as tools between countries.

In Canada, for example, some industries have suffered losses in international markets due to the lack of enforcement of existing international standards, standards that Canada as a member of certain committees has played a part in drafting. Yet, they are not enforced within the confines of the industrial sector, with the end result being the loss in revenues and employment.

In summary, therefore, the introduction of HDTV and other advanced television systems may indeed herald new opportunities for suppliers and consumers alike, however, we should remain concerned that these services are effectively satisfying the needs of all interested Canadian participants: industry, government and the consuming public. We must continue our participation in international forums which discuss the future television technologies, such as the SMPTE, CCIR, EBU, RABC and NANBA/WBU. We should also encourage such bodies as the CSA and DOC to become active in fostering the development of appropriate standards in Canada.

9.8 Summary

It is desirable from the point of view of industrial development to have an integrated and compatible family of standards for new television systems.

Canada should set up a new forum to establish the Canadian and international standards committees more vigilantly.

Canadians should undertake some of the relevant committee work in order to assure that Canadian opinion is included in the deliberations towards new standards.

10.0 REGULATORY ISSUES

The introduction of EDTV/HDTV services in Canada will require the creation of regulatory structures designed to both stimulate the development of HDTV services and to fulfill the public policy goals expressed in the current Broadcasting Act. This section will provide an overview of the regulatory issues pertaining to HDTV which must be addressed in the formulation of these regulatory structures.

10.1 Introduction

10.1.1 The Broadcasting Goals

Section Three of the Broadcasting Act (1968) states the intended policy goals of the Canadian broadcasting system. These include the creation of a broadcasting system providing programming of a "high standard", using..."Canadian creative and other resources"...which are.."predominantly Canadian in content and character".

The national broadcasting service must..."contribute to the development of national unity and provide for a continuing expression of Canadian identity". Regulations governing these services..."should be flexible and readily adaptable to scientific and technical advances".

These policy goals form the basis of much of the broadcasting regulation applied and supervised by the CRTC.

In Canada, broadcasting regulation serves multiple purposes, including the advancement of social, cultural and industrial policy goals. While these policy goals have been articulated and expressed in different ways* the goals of broadcasting regulations have been remarkably constant. These include:

- the sustenance and development of a healthy program production industry providing employment to creative Canadians;
- the maintenance and expansion of the domestic share of programming on Canadian networks;
- the increase where possible of export potential for both programming and related hardware sectors; and
- the development and protections of a strong Canadian identity.

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* For example, the DOC document "Towards a New National Broadcasting Policy" and the Federal Cultural Policy Review Committee Report reiterate these policy goals. "Towards a New National Broadcasting Policy" stated three fundamental goals for its new strategy:

- "to maintain the Canadian broadcasting system as an effective vehicle of social and cultural policy..."
- ..."the development of...strong Canadian program production industries"
- "to provide...increased choice of programming...in all parts of Canada".

The FCPRC report states that the Canadian broadcasting sector..."must use all it's technological and creative resources to provide Canadian programs and services...that are competitive in quality with those from other countries."

These goals, as generally articulated in The Broadcating Act, are taken for consideration of the implications for a regulatory structure to govern the introduction of EDTV/HDTV systems.*

10.1.2 Regulatory Issues

There are three central regulatory issues which will determine how the policy goals expressed in the Broadcasting Act should be met by HDTV services. First, regulators will have to select and implement licensing procedures which will provide the institutional structures to stimulate the development of Canadian HDTV services.

Second, the form of delivery for HDTV services will dictate the degree of regulatory control possible over HDTV content and by extension, the ability of broadcasting policy goals to be protected and fulfilled. As well, HDTV services are likely to be available to Canadians via delivery systems which are not regulated (ie. tape or optical disc).

Third, the decision whether to permit or prevent the reception of foreign EDTV/HDTV signals by cable operators or individual Canadians will have implications for the financial health and independence of Canadian broadcasters, as well as for the advancement of social and cultural policy goals.

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* The newly created Broadcasting Task Force could lead to recommendations that alter Canada's objectives in broadcasting.

The strictly technical regulations and standards including the compatibility of transmitters and receivers and format conversion options, have been discussed in Section 9.

Thus, this section concentrates on issues involving: the licensing (as necessary) of EDTV/HDTV services in Canada, content regulation in the face of differing forms of delivery, and the regulation of access to foreign signals transmitted by satellite.

10.2 Licensing of EDTV/HDTV Services

With the introduction of EDTV/HDTV service in Canada, existing licensing procedures must be re-evaluated to determine their applicability to the new services. At that stage it will be timely to develop regulatory policies and procedures to accommodate the new services.

Where possible, licensing regulations should attempt to be flexible, imposing conditions of license which are responsive to the financial incentives governing the activities of broadcasters. The primary regulatory goal is to create an environment to permit economic viability for broadcasters while fulfilling the social and cultural policy goals expressed in the Broadcasting Act.

In the case of HDTV licensing, the major issues are:

1. whether a broadcasting license will be required to operate an EDTV/HDTV service;

2. if so, whether broadcasters can simply extend their existing NTSC service to HDTV without obtaining a new license (as was the case with colour television);
3. how the potential scarcity of available radio spectrum will be allocated among potential licensees;
4. what obligations NTSC license holders will have to continue offering NTSC services;
5. what type of service will be most appropriate for new EDTV/HDTV services.

10.2.1 New License

The forms of carriage delivery for HDTV are as follows:

- optical disc and tape;
- satellite to theatres;
- satellite to cable;
- direct-to-home (DBS).
- fibre optics to home

Only those services deemed to be broadcasting undertakings (or broadcasting receiving undertakings) would be subject to regulation. Content sources such as optical disc and tape fall outside of regulatory control.

Transmission of HDTV programming to theatres (which would likely be delivered via telecommunication common carriers); not intended for direct reception by the general public, would attract telecommunications regulation only. No broadcasting regulations would apply, since such services would be closed circuit point to point, or point to multipoint. However, the same service simultaneously available to theatres and to individual households or cable operators would then be licensable and open to regulation. Many policy hurdles would have to be overcome if the telephone companies were to be granted licenses enabling provisioning of fibre optics for the purposes of broadcast services distribution to the home.

EDTV/HDTV services, delivered either by satellite to cable or direct-to-home (DBS), fall outside of the traditional "off-air" forms of broadcasting delivery for which existing licensing procedures have been developed. However, since the signals are intended for direct reception by the general public, the entities providing them are expected to be considered broadcasting undertakings. A license will therefore be required to operate a new EDTV/HDTV service.

10.2.2 Extension of Existing License

Whether the existing NTSC license holder is required to obtain a new license if extending to EDTV or HDTV service, depends on the specific nature of the service. The answer will likely be no, if no new programming is envisaged, or if the same programming will be broadcast for NTSC and EDTV/HDTV reception.

Since only the transmission characteristics would be altered, a new broadcasting license would not have to be issued.* In that case, only a new radio license would be required from the Department of Communications (DOC) under the provision of section 5 of the Radio Act.**

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* The cost of changing conventional transmission systems, obtaining a new license and sundry administrative costs associated with establishing a new service are estimated to be close to $1 million per station. No estimate is available for the changeover to the EDTV/HDTV transmission formats.

** "The minister shall...regulate the installation and operation of radio apparatus used in broadcasting undertakings to prevent interference to radio reception" (RSC, C323, S.5e)

If a new service is planned by an existing NTSC broadcaster whereby all NTSC programming and transmission facilities would be abandoned in favour of full HDTV service, it is likely that a new broadcasting license and a new radio license would be required. Since this scenario is unlikely to occur in the short to medium term of HDTV development, there is sufficient time for regulators to develop regulatory procedures and institutional structures for this type of service.

10.2.3 Spectrum Scarcity

The bandwidth requirements for HDTV (both bandwidth reduced and 2 channel versions) are too high for terrestrial off-air transmission. Thus, it will not be possible for existing terrestrial NTSC broadcasters to upgrade to a terrestrial HDTV transmission system. Entirely new frequency allocations for HDTV must be established by Canadian and international spectrum managers to permit the orderly development of HDTV services.

Regulators must be careful to ensure sufficient radio spectrum is available to accommodate both terrestrial and EDTV/HDTV space services in the initial stages of development, and full HDTV later on. Bilateral negotiations with the US, and multilateral discussion in the International Telecommunications Union should seek to ensure that Canada is allotted sufficient spectrum to facilitate development of HDTV services. Even with signal compression and bandwidth reduction techniques, HDTV will require considerably more radio spectrum than an equivalent number of NTSC channels. Further, these negotiations should strive to ensure that the specific spectrum allocations for HDTV are compatible with planned and available Canadian satellites.

These issues will be discussed at the upcoming World Administrative Radio Conference (WARC) regarding space services (frequency, orbital slot allocations), with the first session in 1985-86, followed by the second session in 1988.

It is possible that EDTV/HDTV proponents will seek to use MDS for transmission purposes. If so, then the use of this capacity would also require a spectrum allocation plan by DOC, following a policy examination of whether that use was the most appropriate.

10.2.4 Obligations for Continuing NTSC Services

The condition of license is the fundamental tool by which the regulator is able to direct broadcasters towards the fulfillment of social, cultural and industrial policy goals. However, in the preparation of regulations and conditions of license for new EDTV/HDTV services, the regulator should decide whether the new services are intended to replace or merely augment existing NTSC services. There must be enough flexibility in the conditions of license to permit EDTV/HDTV to grow without prejudicing the television services that are now available to all Canadians.

Regulation and preparation of conditions of license for hybrid NTSC/EDTV/HDTV licensees will be complex, requiring the integration of existing forms of regulation with new measures designed to accommodate the needs and circumstances of HDTV service providers. Again, regulators must also be careful to prevent degrading standard NTSC services if the new hybrid services are not available to most Canadians.

10.2.5 License Type

Regulators have three primary options in selecting the type of license to be granted:

- basic
- discretionary pay; and,
- discretionary specialty.

Basic services (ie, existing NTSC off-air services) are advertiser supported and delivered free of charge to the public, either by off-air, cable or DBS. Discretionary pay services have no advertising and charge a fee for delivery via satellite to cable or DBS. Discretionary specialty services are advertiser supported and charge a small fee for delivery by satellite to cable or DBS. They usually have specialized content, providing narrowcasting rather than broadcasting. A fourth licensing option may evolve which would allow a service to receive advertising support and provide omnibus programming, similar to existing NTSC network broadcasters, but would also charge a small fee similar to specialty services. A version of this is the superstation, which involves the regulation of distant signals and their access to cable markets.

The introduction of HDTV is expected to be incremental and could involve one or two NTSC compatible EDTV/HDTV services introduced in the initial stages. Even if both the NTSC and HDTV services have the same programming, the HDTV portion would have to be delivered via satellite to cable or DBS, and could be licensable as a discretionary specialty service.

If different programming is provided by NTSC and new HDTV services, with the HDTV service delivered via satellite to cable or DBS, the option remains to license the HDTV service as either a discretionary specialty or pay service. NTSC services would remain as basic licensees.

If many NTSC services transfer to EDTV/HDTV format, perhaps a competitive pay-TV type scenario could evolve, whereby multiple competitive operators would be licensed in a competitive market model. Alternatively, if operating costs are prohibitively high, a consortium of broadcasters could apply for a single monopoly license until such time that another operator or consortium could be licensed. That decision should be taken as economic and technical issues are clarified over time.

Once sufficient NTSC service providers transfer to EDTV/HDTV via DBS or satellite to cable, a point will be reached where off-air NTSC services would become the "second class" service. To make an orderly transition would require the development of a long range strategic plan to define the role of off-air broadcasters in a changing broadcasting environment. At that time it may be appropriate to consider reallocating the terrestrial spectrum space for television to other uses (eg, data broadcasting).

10.3 Content Regulation

As in conventional broadcasting, the regulatory challenge will be to facilitate the production and distribution of competitive Canadian EDTV/HDTV programs to counter the influx of foreign content. Not only would this produce immediate industrial benefits, but it would also prevent a loss of social/cultural identity through dominance of Canadian television by foreign programming.

10.3.1 HDTV Broadcasting Undertakings

Broadcasters transmit signals intended for direct reception by the general public which makes the content subject to regulation. Canadian content regulations have been the chief instrument of maximizing the societal, cultural and industrial benefits of the Canadian broadcasting system.

While current Canadian content regulations for off-air television broadcasters range from 50% Canadian content for private to 60% for public broadcasters, discretionary services have been granted a more flexible and service-specific set of Canadian content regulations in recognition of the unique nature of each service. For example, Much Music is required to supply 10% in the third year and 30% in the fifth year of operation. This lower percentage reflects the reality that the service could not deliver 50 or 60% Canadian content in the first years of operation because of the paucity of available Canadian content.

A similar regulatory regime may be considered for the introduction of HDTV services due to the expected incremental nature of HDTV development. Canadian HDTV programming will only slowly become available in the first years, preventing fulfillment of a 50 or 60% Canadian content quota. Where possible regulators should exercise maximum flexibility in designing content regulation for HDTV services, balancing the influx of foreign programming in the short term against the long term development of a competitive Canadian HDTV production industry.

10.3.2 Satellite to Cable

A satellite to cable EDTV/HDTV service will be regulated as a broadcasting undertaking and will be subject to content regulation.

10.3.3 DBS

A Canadian DBS HDTV service would likely be regulated as a brooadcasting undertaking although the CRTC and DOC have not pronounced the appropriate regulatory regime for DBS. A DBS HDTV service would be a licensed undertaking with Canadian content and other conditions of license applied as appropriate at that time.

10.4 Signal Spillover

It is likely that HDTV will develop first in the US prior to its development in Canada. Should US DBS, satellite to cable or SMATV HDTV services evolve prior to equivalent services in Canada, many Canadians will buy receivers capable of direct reception of US signals. The fundamental regulatory dilemma is how to foster the development of such an infrastructure while maintaining a future market opportunity for Canadian services.

With respect to DBS, there may be little that regulators could do to stop such a service entering Canada. To continue to prohibit individual home owner access to US signals would be politically volatile, even if such services were duly scrambled and subscriptions had to be purchased.

The impact of US based HDTV programming on Canadian services will be significant. Through an absence of control mechanisms, content that is available by pre-recorded disc or tape, or delivered direct to theatres, will be outside of regulatory control. The pivotal factor in the control of the influx of foreign programming into Canada will be the timing of the introduction of the Canadian EDTV/HDTV service vis a vis the US service. The regulatory policy decisions will be much easier if equivalent Canadian services can be offered about the same time as interest in them by Canadians becomes widespread.

No matter what regulatory procedures and structures are chosen for HDTV, the key to the regulatory thrust will be the creation of a healthy environment for the production of Canadian HDTV programming. Without a viable production sector, the Canadian social and industrial policy goals for HDTV will remain unfulfilled.

10.5 Cable and HDTV - Special Regulatory Issues

Many HDTV services are expected to be delivered to Canadian households via satellite to cable systems. The delivery of content by cable rather than off-air, presents some unique regulatory problems. These problems include:

- "must carry" obligations
- simultaneous substitution of incompatible signals
- priority access on cable systems with finite capacity.

10.5.1 Must Carry

"Must carry" regulations dictate to cable operators the stations and services which are mandatory on their systems. These may include basic services, stereo or multiplexed audio channels, or foreign distant signals. Cable operators are generally unhappy about "must carry" regulations particularly those pertaining to HDTV. For example, if "must carry" regulations continue when HDTV service begins, the cost of upgrading the cable plant to carry HDTV will be considerable. However, if they do not offer the HDTV service, cable companies may lose subscribers to DBS HDTV services or other unregulated HDTV content sources.

Consequently, both cable operators and regulators should seek to define the obligations of the cable companies regarding "must carry" provisions for HDTV. The question is: will a cable operator be obliged to carry HDTV (if they have the equipment) or to upgrade their equipment to enable the carriage of HDTV? In the current pay-TV scenario, the carriage of pay-TV is discretionary for cable operators, allowing those without equipment to forego the service. This is possible because subscribers can still receive the other basic services. The problems will occur in the carriage of HDTV when HDTV replaces NTSC and cable operators "must carry" HDTV as their main service.

The solution is for the cable operators to prepare for HDTV service by gradually upgrading their equipment to HDTV standards. This will reduce the lag between the bypass alternative being available to Canadians and introduction of EDTV/HDTV by cable.

10.5.2 Simultaneous Substitution

Stipulations as to simultaneous substitution of Canadian advertisements on US programming may become a problem for Canadian cable operators. Identical transmission formats would be necessary for simultaneous substitution, as is the case with current NTSC transmissions. This is beginning to manifest itself in the anticipated problems accompanying the transmission of stereo television programs to cable companies from US stations. Without upgrading the cable system and current decoders, Canadian cable operators will be unable to deliver stereo signals from US stations to subscribers. However, if cable companies begin to lose subscribers to off-air stereo receivers, the cost of upgrading to receive stereo signals may be less than the cost of subscriber drop-off.

10.5.3 Priority Access

The question of priority access could become a regulatory problem on cable due to the finite channel capacity. The HDTV service will require between two and four cable channels due to the wide bandwidth of HDTV signals. This may cause problems for cable companies offering HDTV and other discretionary services, due to the limited channel capacity for these services above the basic service.

10.6 Conclusion

The incremental nature of the introduction of EDTV/HDTV services in Canada will allow regulators to implement regulations and institutional frameworks for HDTV over an extended period of time. However, this incremental transformation from NTSC to HDTV service is expected to accelerate dramatically once a critical mass of broadcasters begins to deliver services in HDTV format. It is at that point that serious upheaval in the Canadian broadcsting environment can be expected. Regulators may be forced to choose between NTSC and HDTV systems, with enormous consequences for the concept of universal (or equal) TV service.

The difficulties expected during the transformation to HDTV will also be felt in the licensing of these services. The selection of HDTV licensing options by the regulator must also take into consideration the impact of those decisions on existing broadcasters and their effectiveness in view of unregulated competitive content sources.

The numerous forms of carriage/delivery for HDTV service will provide another challenge for regulators who must decide whether obligations which are relevant to NTSC carriers and present telecommunications carriers are applicable to HDTV services. In sum, the regulatory issues pertaining to the introduction of HDTV services in Canada are considerably more complex than those which arose during the transition from monochrome to colour television. It is expected to be almost ten years before HDTV becomes a major force in Canadian broadcasting, leaving regulators sufficient time to prepare strategies designed to maximize the benefits of HDTV for all players in the Canadian broadcasting environment.

11.0 R&D REQUIREMENTS

In this section we discuss the research and development (R&D) requirements in new TV technologies, identify the criteria for Canadian involvement, recommend areas for Canadian participation, and discuss how best to capitalize on R&D opportunities.

11.1 R&D Requirements

11.1.1 Overview of R&D Requirements

Research and development activities in television technologies are currently driven by the desire to develop new and improved television systems and associated products. While the technology forecasts indicate many of these new improved television products and services will not enter the marketplace for several years, most of the technology development for these products has essentially been completed. The focus of development activities for many of the system components will be on improvement through the engineering and manufacturing aspects of product development. For example, products such as the next generation receivers are currently awaiting the production of specialized chips. Other products will proceed to engineering and production following standards decisions.

Some areas however, have been identified as requiring additional basic research work, specifically in the following areas:

- The psycho-physical aspects of improved television images, as a basis for determining acceptable trade-offs in higher definition television delivery systems.
- Storage devices for HDTV, such as digital VTRs and optical disc and tape recorders.
- Display technologies which will replace CRTs providing larger image capabilities. Wide screen CRTs and improved projectors could likely be developed in the near term; however, technological breakthroughs will be required before flat panel products can be developed.
- Bandwidth reduced transmission options require further research work in the signal sampling and processing areas.

Exhibit 11-1 provides further detail on particular products identified in the state-of-the-art review requiring basic research work.

11.1.2 Context of R&D Involvement

As determined in the state-of-the-art review, several extensive research programs in new TV technologies are currently underway throughout the world. These major programs are all supported by centres with strong motivations such as: the establishment of standards within their country (eg. IBA, BBC in England, CCETT in France), industrial development (eg. NHK with Japanese government backup) and potential programming revenues (eg. CBS in the US).

The centres extensively involved in these major research programs are all well established and well funded research centres. The main ones are:

- NHK in Japan, was founded in 1930 and currently operates with a staff of 360 and an annual budget in the order of $50 million;

Exhibit 11-1

New TV Technologies - Basic Research Requirements

AREA/PRODUCT	CRITICAL COMPONENT	COMMENTS	CURRENT ACTIVITIES
STUDIO SYSTEMS			
Image Sources			
- cameras	saticon tubes	current 1" tubes are limited with respect to modulation depth (40% modulation depth at 800 lines) better temporal response required	- in product development stage, a limited number are available in commercial cameras in Japan
	charged coupled devices (CCD arrays)	will enable cameras at high definition without 'lag and smear'	- preliminary research underway in Japan, US, France
- slide scanners	"	based on 2048 element linear array	- HD slide scanner in the production stage now in Franch
- telecine chain	laser scanner		- some pre-commercial production underway, 70mm now available in Japan - some prototype products expected from France
Signal Processing			
- switchers			
- routing		required before HDTV production suites can be integrated within studio	
- electronic	VLSI crosspoints		- prototype devices are available in Japan and US using VCL building blocks - research ongoing in VLSI electronic switchers

Exhibit 11-1
continued

AREA/PRODUCT	CRITICAL COMPONENT	COMMENTS	CURRENT ACTIVITIES
- optical	optical gain elements and switchers		- research stage in Japan and US
- production		digital production switcher development will preceed HDTV	- prototype of (CCIR 601) digital component switchers (CCIR 601) available in France
		HDTV VTRs currently awaiting definition of digital VTRs	- preliminary research stage
<u>Tape and Disk Storage</u>			
- analogue VTRs		HD analogue format exist now	- Sony has preliminary HD analogue VTR available Further research ongoing
- digital VTRs		development of digital storage devices a key element in A/D studio conversion - considerable work required to enable sufficient data storage (120 minutes record	- digital VTRs (CCIR 601) available in initial production in mid 1986 - experimental 460Mb/s digital VTR shown in Japan
- optical discs/ recorders	require higher bit rates	currently write and read only optical disc utilized for specialized uses (10 min. segments)	- preliminary research ongoing in Japan and US
- optical tape recorders	"	more info can be stored cheaper	- optical tape recorder under pre-production development for data storage in Canada (CREO)

Exhibit 11-1
continued

AREA/PRODUCT	CRITICAL COMPONENT	COMMENTS	CURRENT ACTIVITIES
TRANSMISSION	motion detection algorithms		- preliminary research activities ongoing - various approaches
	digital codecs	required at 140 Mb/s to maintain improved digital studio quality for terrestrial trans.	- little research and development work
	optical fibre systems	for fibre optics implementation for video transmission	- production of system component in Japan and US - research in Germany
RECEIVERS	field/frame memories and support chips		- currently under prototype development in Japan, Germany, Holland and England - product availability announced for 1989 in Japan
	decoders	for satellite service delivery.	- B-MAC decoder products available - US/Canada
		little attention to date on EDTV/HDTV decoders for cable industry	
DISPLAY			
- CRTs	picture tubes	limited in size (40" diagonal max)	- 'data grade' picture tubes products currently available in Japan and US - further research work ongoing

Exhibit 11-1
continued

AREA/PRODUCT	CRITICAL COMPONENT	COMMENTS	CURRENT ACTIVITIES
- projection	lens and light source		- preliminary research stage, early prototype in Holland
- LCD			- on-going preliminary research in US/Japan, however not promising at present
- plasma			- early prototype developed (only 16")
- gas			

- England's BBC undertakes broadcast engineering research and development supported by a staff of approximately 250 and a typical annual budget of $18-20 million. The IBA focuses on television standards issues and has an engineering research and development staff of 100 and smaller annual budget of close to $4 million.
- In Germany the independent non-profit research and development organization, IRT, typically has a staff of 200 and an annual budget of $11M.
- CCETT in France conducting research in both television and telecommunications has 50 people and $7M/yr internal budget plus an additional $3M/yr funding to industry which it oversees.
- In the US, major television research and development is conducted by two of the private television and radio networks, CBS and its technology centre and NBC through RCA, its parent company.

Some additional major research activities are carried out by some of the major manufacturers, like Philips, Thomson CSF and ITT in Europe, Philips, RCA and Zenith in the US and Hitachi, Ikegami, Panasomic and Sony in Japan who all have major stakes in studio equipment and/or the receiver market.

In light of the strength of these major research organizations and the extent of their involvement in new TV technology developments, it would require an enormous commitment for Canada to compete with any major new technology thrust at a comparable scale. However, the thrusts of these larger research organizations focuses on development of major products for studio, transmission and consumer products which will have mass market appeal. Development of smaller complementary products, for which the market is of a smaller scale, is often of less interest to these larger organizations. Thus, the R&D opportunities for Canada are defined in broad terms by this international context.

11.1.3 Criteria for Canadian Opportunity

In developing research and development areas suitable for Canadian involvement several criteria were considered, including:

- Products selected for development build on Canadian industry strengths - both the proven capabilities and established niches in studio, transmission and to a smaller extent display;
- Skills which will be important in new video technologies such as digital processing and graphics animation are developed.
- Products selected should not require extensive fundamental research as the supporting research facilities do not presently exist in Canada (Some small scale fundamental research could be conducted by several Canadian universities or one university could be selected as a focal point for TV technology research, however, only two universities expressed interest through their participation in the industry survey).
- Development of selected products must also be achievable within a short to medium time frame, as the current industry infrastructure does not have the depth and support for long term research endeavours. Initial development activities on components and sub-systems should be complementary providing a coordinated approach to system package development where possible.
- Strategically, Canada is well suited to focus on transmission system development (a proven Canadian industry strength) where the potential to influence the North American market exists, rather than the reception area for example (without any significant receiver industry).

In light of these criteria, development opportunities in new TV technologies have been reviewed and potential products and areas for Canadian involvement selected.

11.2 Niches for Canadian R&D

Based on the industrial opportunities assessment and consideration of the criteria for Canadian industrial involvement, specific product areas for potential Canadian participation have been identified (see

Exhibit 11-2 for a summary of product areas selected). In the following section these items are discussed under the functional system categories of; studio systems, broadcast network/transmission and reception/display.

11.2.1 Studio Systems

Canadian manufacturers have in the past few years been quite successful in the establishment of some specific product niches. In the selection of products suitable for Canadian development, consideration has been given to areas of past market success and Canadian technical capabilities.

Analogue to Digital Conversion

While considerable effort has been committeed worldwide to digital studio conversion there still exists specific product opportunities for Canada. Canadian development of the following digitally based products not yet available would draw on both current Canadian products knowledge base and our strength in digital and signal processing (see section 7):

- video switchers
- digital coders/encoders;
- digital serializers/deserializers;
- special effects equipment;
- character generators;
- key and chroma equipment;
- slide storage equipment;
- post production editing equipment;
- audio consoles (for mixing and distribution);
- video monitors.

Exhibit 11-2

Summary of TV Technology R&D Opportunities for Canadian Participation

AREA	ACTIVITY	ITEM
STUDIO SYSTEMS		
- Analogue to digital conversion	Product Development	- various production switchers - digital coders/encoders - digital serializers/deserializers - special effects equipment - character generators - key and chromo equipment - slide storage equipment - post production editing equipment - audio consoles (mixing and distribution)
- HDTV studio products	Product Development	- distribution amplifiers - cable equalizers - sync generators - switchers
	Component Development (Processing)	- VTRs - standards converters
NETWORK BROADCAST/ TRANSMISSION		
- Scrambling systems	Market Trial	Analogue Component System
	Technical/Market Trial	Wide Screen Analogue Component System
- Digital Processing	Product Development	Higher Speed Digital Codecs
- Cable Systems	Preliminary Research	Impact of Delivery Options on Cable Systems
- Optical Systems	Product Development	Optical Baseband Video Switchers
		243 Mb/s Fibre Optic System Components (NTSC Digital Studio Standard)
		Fibre Optics Routing Jack
RECEPTION	Component Development	Receivers/Decoders
DISPLAY	Preliminary Fundamental Research	HDTV Projector

Based on an estimated $100M-$150M in annual expenditures on broadcasting equipment purchases for the rest of the decade, it is conceivable that Canadian manufacturers could obtain a 50% market share of these purchases (based on equipment items identified above).* Assuming R&D requirements to convert from analogue to digital are in the order of 15% of projected sales, these Canadian suppliers should be investing approximately $10M/yr in R&D over the next three year period.

In addition to the traditional involvement of Canadian industry in studio products, an opportunity for participation in new digital image processing applications exists. For example, in the computer animation field a recent proposal has been made (by Anilex Research Corporation) to involve Canadian companies with expertise in film animation and graphics software with a US based firm possessing software development and computer graphics expertise in the development of a computer-generated animation system.

HDTV Studio Products

NHK and other major centres are well steeped in the research of major HDTV studio products such as cameras, major processing equipment components and recorders. There are however several smaller complementary HDTV studio products and components to which major manufacturers are not likely to devote their efforts. Of these, Canadian manufacturers might focus on the following items:

- distribution amplifiers
- cable equalizers
- sync generators
- switchers.

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* Based on preliminary estimates, to be refined pending official release of the CAB Broadcaster Survey report.

Canada might also contribute to development of some products through a joint venture arrangement. For example, Canadian manufacturers might provide the processing requirements for products such as VTRs or standards convertors.

The required R&D investment in these product activities would be relatively low initially, but could amount to a few million on top of the analogue to digital conversion cited above in the latter part of the decade.

11.2.2 Network Broadcast/Transmission

Considerable research investment has been committed by the major research organizations internationally toward the development of the various improved television transmission proposals. While Canada has strong technical capabilities in the areas of broadcasting (eg. CBC, CTV) satellite systems (eg. SED Systems, Spar Aerospace Canada, Telesat), and terrestrial distribution systems (eg. Northern Telecom/Bell Northern Research, Manitoba Telephone Service, Rogers, Videotron), there has been no one organization driving broadcast research efforts as there has been in other countries. There has been some R&D work at the CRC in Ottawa and an isolated example in analogue component systems. Recognizing an opportunity in the area of scrambling, system development, a Canadian company, Digital Video Systems did initiate development of a multiple analogue component system - B-MAC. However, the company was acquired by Atlanta based Scientific Atlanta which has been successful in selling the system to Australia for fall service implementation.

Initiation of any new transmission format development would be costly and is likely too late. However, Canadian participation in the B-MAC system could be accomplished through an actual market trial of B-MAC or wide screen B-MAC service (discussed further under the Applications section). An additional research commitment might enable evolution of the B-MAC system to a 2 channel bandwidth reduced HDTV system.

There is also a requirement for research and development associated with the various modes of terrestrial video distribution in the areas of digital processing, cable systems and optical technology. Within these areas, research and development activities suited to Canadian industry might involve:

- Digital Processing
  - development of a codec for analogue to digital conversion of video signals at higher processing speeds
  - a prototype 45 Mbps codec could likely be developed for $1M, additional investment would be required to achieve a 140 Mbps prototype
  - suitable project for a small-medium sized manufacturer
- Cable Systems
  - assessment of impact on existing head-end microwave cable and reception devices of the various higher definition transmission delivery options
  - research activities might include (a) preliminary 'paper' analysis ($50k), (b) laboratory simulation and testing ($200-300k), (c) technical field trial of selected options and identification of products requiring development ($400-500k)

- the activities could be carried out by existing engineering groups associated with the Canadian cable companies

- Optical Systems
  - development of optical switching video equipment (a prototype for an opto mechanical switcher might be developed for a $100-200k investment while development of a prototype of a gallium arsenide opto electric switcher - which in the long term will be cheaper - might require a $500k-$1M investment).

11.2.3 Reception and Display

Major research activities are currently underway in both the reception and display areas. Development of a new generation of receivers (ie. with field and frame storage capabilities) has required a massive research commitment. While Canada is not well positioned to develop these consumer products requiring mass production, Canadian participation could include development of a smart signal processing algorithm which might be incorporated into receiver or decoder products. This sort of development activity might require funds in the order of $1M/yr and could be undertaken in conjunction with an overall research and development program.

The display area has been identified as a critical component required to gain higher definition market entry. A current gap in worldwide research programs is found in the area of projection systems. There is currently a requirement for some fundamental research to establish a development approach to next generation projectors. This scale of research project ($200-$400k) would be a suitable size undertaking for a Canadian university. The benefit in this type of involvement can be realized if the research work leads to obtaining a patent in Canada. If a patent is obtained, Canada can then license manufacturers upon the condition that some of the assembly be conducted or some of the components produced in Canada.

11.3 Conclusions re Implementation

Through this research and development requirement analysis it can be concluded that the major research and development projects of the scale conducted by NHK are beyond Canadian industrial capabilities. There are however several product niches which Canadian capabilities are well suited in the digital and HDTV studio, transmission and reception/display systems.

Unlike some other countries, Canada does not have a coordinated approach to research and development. In spite of the CBC's continued active role, there are limits to what it can achieve on its own. Clearly, it will take more than CBC's guidance to foster Canadian industry's participation in these new TV technologies. Without any focus for broadcasting research activities it is unlikely that the currently fragmented Canadian industry will capitalize on the market opportunities presented by the requirements of Canadian broadcasters. The broadcasting research activities in Canada must be restructured to take advantage of the market opportunities available to Canadian industry through the setting of priorities and strategies focussed on the specific areas where resources can be made available and where the best returns and lowest risk are apparent. A large increase in research activities will also be required.

To provide this focus, participation will be required from several organizations. Potential participants in these research and development activities include:

- CBC: With a concentrated engineering organization in place the CBC could eventually assume a research and development role (similar to BBC in England). As a major procurer of advanced television products in Canada, CBC could also be directly (or indirectly) funded to provide product development support for Canadian suppliers.
- CRC: While capable of some internal research and development work, the CRC could stimulate industry through procurement of specific research and development projects. This might be best done through an explicit advisory mechanism linked to the CBC engineering headquarters.
- Universities: Several universities in Canada including Toronto, Waterloo, Sherbrooke, Montreal, Saskatchewan and British Columbia have adequate engineering R&D facilities to conduct some relevant research work. A strategic grant from NSERC to one of them might focus R&D in TV technologies to a critical mass level.
- Manufacturing Companies: Companies currently involved in TV technologies or complementary aspects would undertake the product development, particularly if they could access product development funding and R&D procurement.

It is the recommendation of this study that the Department of Communications pursue the particular opportunity of the Toronto Broadcast Center and develop the elements of the program whose objectives would be industrial development with a clear spin-off benefit for the CBC (and other broadcast centre users) of more advanced facilities. To be considered as possible approaches are the following:

- A well funded capital budget for the Toronto Broadcast Centre; as an alternative to larger federal expenditures, a third party leaseback arrangement could be considered,
  - whereby an independent entity is created to acquire the facilities and lease them back to the CBC and other users (this is not strictly a financing proposition, since some of the payback would come directly from independent producers and other users);

- Existing programs in DOC and DRIE/External Affairs could be tapped for consortium financing, product development, R&D, and export promotion. If priorities within these programs (including that of DOC) can be re-arranged, there may be no need for an actual increase in funds spent by the Federal government;
- Since the benefits of such an initiative are to be derived largely by the Province of Ontario, it is likely that their interest could be elicited and program funding from the provincial government be arranged, possibly in a joint federal-provincial ERDA sub-agreement.

Preliminary estimates indicate a research and development investment requirement of approximately $10M/yr over the next three year period.

Government participation in this endeavour might include 50% funding (ie. approximately $15M over three years) with the other half provided by the private sector companies performing the R&D. The steps to provide a sufficient thrust for exploiting R&D opportunities are:

- development of a strategic plan for Canadian product development with specific products for export and for Canadian input into the CBC studio identified (with reference to the niches identified in this study, and CBC guidance);
- organization of commitment to the plan by interested industry representatives and federal and provincial agencies;
- arrangement of appropriate targetted R&D funding and roles of federal/provincial organizations;
- creation of mechanisms to allocate research and development funds for specific products to individual companies or to companies on a joint arrangement basis.

In view of the immediate need for setting these activities in motion, a working group should be struck comprising key members from the broadcast equipment manufacturing sector, the CBC, DOC, including CRC, selected universities and other organizations with the ability to catalyze R&D investment both from government and private sources. DOC and CBC could take this initiative as a follow-up to this study and the hosting of the 1985 HDTV Colloquium.

Research activities coordinated in this manner would benefit from the technological expertise and guidance from the CBC, allow direct government participation through the CRC, and enable active participation from manufacturers and universities. The proposed working group might also serve to coordinate an official Canadian voice in worldwide standards activities.

In addition to this short to medium term opportunity there is an involvement in new higher definition television technologies. The R&D aspects of these programs can be pursued best in the context of applications programs discussed in the next section.

12.0 APPLICATIONS PROGRAMS

In this section a framework for applications program development is identified, phasing aspects of the program is discussed and specific components of an applications program in new TV technologies are recommended.

12.1 Rationale and Lessons

The distinction between an applications program and an R&D program is as follows:

- R&D projects are geared to produce the knowledge base for the design of a product or range of products and may consider a wide range of alternatives. Applications programs are full system demonstrations;
- R&D is usually required to design certain component products or sub-systems for the applications program;
- the strength of the applications program is in its system demonstration; this system knowhow is what is exportable or applicable to full scale services.

The rationale for considering applications programs lies in the systems orientation of new TV technologies. Canadian organizations involved in the television industry, both suppliers and users, need to prepare themselves for the transformation of the industry. Canadian suppliers of products and services require market opportunities to develop their experience, and to show an acceptable level of capability which applications programs can in part fulfill.

The opportunity for Canadian industry to participate in and be prepared for new TV technology developments could be lost without concerted applications programs. This section provides a framework from which a full applications program can be designed.

From the experience of past government applications and demonstrations programs (eg. Anik B trials, projected Elie and Ida, Telidon, Office Automation) several conditions for a successful applications program can be established.

Timing and Direction

While an opportunity can be lost if action is not taken soon enough, too early an entry can also commit large scale efforts to projects too far in advance of commercialization or before standards are set. In the case of new TV systems, applications programs should recognize that Canada has only a minor role in influencing the direction and pace of development. Therefore, applications program should be sufficiently flexible to allow for changes in direction and timing of new TV systems development.

Affected Interests

Participation of actual TV service providers is an essential aspect of a successful applications program. In the case of EDTV/HDTV all components of TV production transmission and distribution should be included: program producers, broadcasters (both conventional and specialized), common carriers (both satellite and terrestrial) and cable operators. In the course of the study, representatives of each of these industry components manifested sufficient interest to indicate that a positive response would be forthcoming.

Government Need

Often the government can provide an excellant test market because of its own needs (eg. Office Automation Trials). In the case of television technologies the CBC and the NFB represent government need, rather than line departments. They could act as users for the specification of system needs and procurement of appropriate systems. They are also knowledgeable of the needs of users worldwide. In this way, the products, components and sub-systems of each application program will fill a genuine need and be state-of-the-art.

High Pay-off

As well as government needs, the potential benefits of applications must have a high pay-off for Canadian interests. In the case of TV technologies the obvious potential benefit is to Canadian industry, in terms of high tech exportable products. A less obvious benefit is in Canadian program production, and the potential for making a more efficient transition to new TV systems.

Standards Coordination

Coordination of standards issues with the applications program is required so that Canadian firms will produce to meet international demand. Where possible Canadian manufacturing interests should be taken into account as part of Canadian involvement in standards setting. There is a clear need for better methods to develop the Canadian position.

Overall, the program must be developed to respond to the needs, interests and capabilities of Canadian suppliers and users, thus their participation in these activities is essential. Also, the applications program must take into consideration the full range of expected TV system developments, and have the flexibility to adjust to the uncertainties of development.

Some clear direction in TV development can be seen:

- conversion of studios to component operation using digital techniques with some remaining analogue areas;
- a move by major producers of programs throughout the world towards HDTV as the production medium;
- transmission of studio to studio traffic utilizing components formats, with a strong tendancy to digital modulation;
- entry of specialty wide screen services targeted at bars, mini theatres, etc.

Others areas of TV development are less clear:

- standards of HDTV studio equipment;
- transmission formats and modes which will be selected for higher definition delivery to viewers.

The application program should be designed to prepare for the relatively certain developments, yet allow flexibility to accommodate the associated uncertainties.

In the following sub-section several specific trials are suggested from which comprehensive applications could be developed. Exhibit 12-1 provides a summary of suggested applications.

Exhibit 12-1

Applications Programs Summary

PROGRAM ITEM	ACTIVITY	POTENTIAL PARTICIPANTS
PRODUCTION APPLICATIONS		
o Digital Component Studios	o Production methods using digital and computer techniques	o CBC, Canadian industry, NFB, DOC
o The HDTV Studio	o HDTV software production	o CBC - Engineering/Installation o Canadian producers
o Wide Screen/HDTV on Location	o wide screen/HDTV production of special events	o CBC/TSN
SERVICE DELIVERY		
o Telesat Direct-to-home Service	o analogue component format for scrambling purposes	o Telesat Canada o equipment supplier (eg. Scientific Atlanta B-MAC, etc) programming providers (eg. TSN, First Choice, Much Music, etc)
o Wide Screen Specialty Service	o distribution of wide screen special events to bars, mini theatres etc	o Telesat Canada o equipment supplier (eg. Scientific Atlanta B-MAC etc) o programming suppliers (eg. CBC/TSN, First Choice, SuperChannel, etc) o service distributor o cable operators
o Bandwidth Reduced HDTV Specialty Service	o distribution of HDTV programming via bandwidth reduced HDTV format	o CBC o Telesat/DOR/CRC o SPAR o program suppliers, HDTV software, First Choice/ SuperChannel o market distribution players (Cineplex, Holiday Inn)

Exhibit 12-1
continued

PROGRAM ITEM	ACTIVITY	POTENTIAL PARTICIPANTS
o CN Tower Terrestrial Simulation of EDTV/HDTV Distribution	o distribution of EDTV/HDTV software to regional target market	o equipment suppliers o software suppliers o CNCP o cable operators o market distribution players
o Cable Systems Research	o research program to assess implications of transmission options on cable system	o selected cable operator engineering group o selected manufacturer
o Optical Systems Research	o research program to assess HDTV transmission requirements	o optical research organization (eg BNR) o telcos o cable operators o selected manufacturer equipment development

12.2 Production Applications

It is imperative that Canadian program suppliers gain HDTV production expertise if Canadian video software is to remain competitive. Components of weekly programming which is currently sold internationally, sports events, and other specialty programming might be ideally suited to trial production in HDTV. To accomplish this task, Canadian HDTV production facilities would be required for both HDTV studio and location production capability. HDTV properties could then be stockpiled for future release in the EDTV/HDTV networks, such as the 1989-90 season for NHK's planned HDTV DBS service launch. Availability of HDTV/Widescreen signals is fundamental to all service proposals noted below in this section.

12.2.1 The HDTV Demonstration Studio

An existing studio facility (TV or possibly film) should be considered for conversion to HDTV for demonstration and familiarization. Use of a carefully chosen facility would save considerable cost in acquisition, provision of services, etc., but must be of adequate size and include the related services such as audio and video post-production. Note must also be taken of the special requirements of HDTV concerning lighting levels and audio. The size should be adequate to allow production to proceed in an efficient manner.

This showcase studio could spur development of HDTV equipment in Canada and could be used to produce in HDTV programs of wide interest for release in any of a number of media.

The application program should be so arranged that users of this facility such as CBC, private broadcasters or independent producers could use the facility in a number of production methods and at cost levels related to the long-term projections for HDTV. There are several potential advantages for such a proposal.

- HDTV experience for Canadian producers at an early date.
- Development of HDTV properties for the HDTV market.
- Industrial development funds would benefit both manufacturers and cultural industries.
- Foster the development of HDTV program services in Canada.
- Canadian designers and manufacturers would gain experience in HDTV studios and equipment, greatly easing the planning and implementation of permanent facilities.

12.2.2 Location Shooting HDTV/EDTV

Sports events and other external programs are well suited to the wide-screen, higher detail and stereo audio of HDTV. Such programs are also well-suited to the specialty network or mini-theatre display. A demonstration mobile unit, either in a vehicle or as a transportable package could greatly stimulate the acceptance of new television systems and the growth of HDTV and EDTV specialty services.

The capital cost of such a package in HDTV is significantly higher than a similar one using conventional television techniques, due to the additional compexity and developmental nature of the equipment and the need for conversions to current standards.

The operating costs however are unlikely to exceed current figures by large increments. HDTV production could thus be used in many special event situations, if such a unit were available, gaining much valuable technical and production experience and the opportunity to build up a useful inventory of program material.

12.3 Service Delivery Application

Trial programs could include:

- delivery of an analogue component direct-to-home service;
- a wide-aspect ratio analogue component service targetted at bars, mini theatres, etc. either through evolution from initial direct-to-home service or as an independent service;
- trials of one or more of bandwidth-reduced delivery systems to special markets.

A key consideration in the research activities in conjunction with these service trials would be to test all delivery mode options (eg. satellite, microwave, cable systems, fibre optics). Participants would then include the major organizations concerned with distribution in Canada, namely carriers, cable operators, broadcasters, and space system suppliers.

Further description of these suggested trial components is provided in the following sub-sections.

12.3.1 Telesat's Direct-to-Home Service

The direct-to-home service currently proposed by Telesat (through 'Company X', in which Cancom is a partner), with implementation possibly as early as 1986, offers an ideal opportunity for an analogue component system implementation. As a byproduct of the required scrambling system, Telesat could install an analogue componet system (eg. Scientific Atlanta's B-MAC). Such an initiative would:

- support Canadian scrambling system technology development and production;
- provide improved image quality to consumers thus enhancing market promotion;
- improve Canadian pay-TV services image quality to cable markets;
- provide an opportunity for service trials associated with the next generation 'wide screen' MAC (through 'wide screen' programming distribution to bars, mini theatres, etc);
- enable Company 'X' to obtain supplementary markets if initial wide screen service trials lead to full service commercialization.

It is possible that initial implementation of the MAC scrambling option might be more expensive than traditional NTSC scrambling systems. An option for government participation, then, as part of this applications program, would be to provide funds to cover any incremental difference in implementation cost. Since Telesat's board will be deciding on the direct-to-home service in September of this year a federal government initiative in this area would have to be immediate. Participation in a wide screen service trial may be considered separately and is not under as much time pressure. It is discussed in the following sub-section.

12.3.2 Wide Screen Specialty Service

A 'wide screen' (ie. 5.33:3 aspect ratio) enhanced analogue component service trial, targetted at bars and mini theatres, could either be conducted through enhancement of the direct-to-home service or through utilization of independent facilities.

Participants in a trial service of this nature might include; an enhanced MAC provider such as Scientific Atlanta, Telesat Canada, program suppliers such as TSN in co-operation with CBC (for suitable production), First Choice/Superchannel, a service distributor and possibly cable operators.

Bars, hotels, etc would be particularly well suited for delivery of a sports service which provided some special wide screen coverage of special events (such as hockey and football play-offs and baseball finals). Decoders utilized would be 4:3 and 5.33:3 aspect ratio compatible. High quality RGB projectors currently available in the marketplace can be adjusted to project a wide screen image. Canadian development of a specialized projector might also be possible. High quality multi-channel audio would also be a necessary component in this type of service.

Organization of this endeavour would require coordination of financial arrangements, programming and equipment suppliers, preparation of application for service and regulatory approval. However, it should be noted that all of the ingredients for this service option are essentially available today.

Government participation in this endeavour might include provision of funding for a promotional demonstration production, say a Stanley Cup hockey series. It could be organized by the CBC or in response to a private sector initiative.

12.3.3 Bandwidth Reduced HDTV Specialty Service

A trial application might also involve transmission of a bandwidth reduced HDTV signal. Transmission equipment might possibly be obtained from NHK of Japan on a trial basis. NHK is currently interested in product exposure in the North American marketplace, and might be open to some co-operative trial and development efforts or a technology transfer.

The players involved in a trial of this nature might include NHK, Telesat, CNCP (delivery via CN Tower might be an attractive option - as discussed later), program suppliers and producers of HDTV software, First Choice/Superchannel, market distribution players (eg. Cineplex, Holiday Inn, etc), and possibly cable operators. Delivery of bandwidth reduced HDTV to mini theatres for example, could provide a distribution outlet for special HDTV productions.

Organization of this trial would require a project initiator as in the widescreen specialty application discussed above. The key would to be negotiate with NHK and possibly Japanese manufacturing firms to determine (i) the extent they would contribute to such a trial, and (ii) what Canadian participation could be arranged.

12.3.4 CN Tower Microwave EDTV/HDTV Distribution

Delivery of EDTV/HDTV would be an attractive application as the costs associated with a terrestrially based transmission are considerably less than for satellite distribution, though providing much less coverage. Providing a service in this manner would focus activities within a smaller target market yet could serve to provide an outlet for HDTV software developed, and enable participation by other distribution and service providers. The signal would be available for receipt at cable head-ends for delivery to selected locations. In addition to HDTV studio productions, HDTV production of specialized events of regional interest (eg. horse racing) might provide an attractive service package. Government funding could perhaps be limited to the provision of the signal at the CN tower, providing cable operators and mini theatres the option for HDTV service participation. A great deal of technical, economic and market information could be obtained from such a project.

12.3.5 Cable System Research

Little research has been conducted to date on the implications of higher definition television delivery over cable systems. A research program could be conducted to assess the implications of possible transmission options on existing head-end, cable, microwave plant and reception and decoding devices (eg. to determine whether an overlaying structure is required on existing distribution plant). This initial research could be conducted in three separate stages:

Stage 1 - ($50k) identification of critical research objectives and preliminary 'paper' analysis

Stage 2 - ($200-300k) laboratory simulation and testing

Stage 3 - ($400-500k) technical field trial of selected options

This research might lead to further participation in trials of the satellite or microwave delivered service options, in addition to the development of special products (eg. special conditioning equipment and devices for echo cancellation) which may be required if the transmitted signal selected is especially sensitive. Several Canadian companies are capable of conducting these research activities including Cablesystems

Engineering (Roger's Cable engineering group), Communications Engineering Services (McLean Hunter engineering), Cablecasting Engineering and Videotron.

Government might include these research activities as aspects of the MAC, wide screen, bandwidth reduced, or microwave applications projects.

12.3.6 Optical Systems Research

Research in optical systems could be conducted in a manner similar to the cable research program with initial involvement including a preliminary 'paper' analysis and laboratory simulation and testing. Advancement to a full technical field trial might require a significant investment in the development of specialized equipment. The optical system area would be of most interest to the carriers, and possibly BNR in particular. One of the potential applications is demand access video, in which a videodisc "jukebox" would dispense video programming on demand to subscribers. In the past, the cable industry (eg. through CTRI) has shown interest in this concept, since that industry is the carrier for residential delivery of TV services.

12.4 Conclusion and Implementation

As discussed above, there is a strong rationale for a new TV systems technology applications program, whose main elements are:

- awareness and exposure of all facets of the broadcasting industry to the coming transformation of the TV industry;

- stimulus for Canadian product, component sub-systems, and program production development - for domestic and export markets;
- feedback to those charged with Canadian participation in standards setting.

As a result, the federal government should proceed to a full planning, budgetting, and interest seeking phase. The applications program should be conceived in three phases, as follows:

Phase 1

Phase 1 could include the initial discrete engineering and design work and planning activities required for product and service development. In this initial stage evaluation of various options would be conducted and concrete plans for development activities set in place. Activities would include 'paper studies' on technical research projects, development of design and operational plans for trial projects, organization of players involved, and service approval applications. Upon completion of these initial planning activities the trial projects selected would proceed to phase 2, for experimental implementation.

Phase 2

The second stage activities would include development of products and implementation of trial programs for promotional, demonstration and evaluation purposes. Prototype products would be developed where necessary.

Phase 3

Selected projects may lead to full commercialization. It is anticipated that market viability will govern applications selection from the outset. From many initial ideas as to application only those that could stand to be commercially viable would proceed to phase 3.

The federal role would be extensive in phase 1 and 2, similar to the conclusions drawn from the R&D opportunity exploitation. Ideally, federal funding would not be necessary for phase 3 commercialization.

13.0 RISK ASSESSMENT

This section assesses the level of risk associated with possible initiatives with respect to R&D and applications programs, as identified in sections 11 and 12.

13.1 Assessment Criteria

To determine the areas best suited for Canadian TV technology development, and programs which should be implemented, it is essential to evaluate the associated levels of risk by considering the following risk criteria:

- technological: ie, we may fail to meet technological objectives;
- commercial: ie, we may succeed technically, but there may not be sufficient market prospects to proceed to full commercialization;
- institutional: ie, we may have a 'hot' product that is saleable, but we may not be able to transfer it to industry (at least "our" industry);
- scale: ie, the opportunity looks promising, but we simply cannot afford a failure given the investment required (ie, dollars, organization, manpower).

13.2 Selected Programs for Assessment

To conduct this risk assessment, R&D and individual trial applications activities have been grouped in the following categories:

1. Major New Technology System Development: A program similar to major international research centres where activities would involve work associated with development of a full system (eg. HDTV production studio, development of a revolutionary transmission system or a new generation of receiver products). Investment in this type of program would be very major, likely well over $100m if on the scale of comparable efforts.

2. Selected Studio System Participation: This program would involve Canada's participation in both the product development of selected digital studio products and HDTV complementary studio equipment and associated components, and the establishment of an HDTV showcase studio for Canadian HDTV software development. Investment in digital product development would be approximately $30M with perhaps an additional investment of $5M in development of small HDTV complementary components. The HDTV studio showcase would require a $2M-$3M upfront investment. Total program cost, approximately $40M over 3 years.

3. Selected Transmission System Activities: Activities in this full system applications program would include selected research and applications programs related to the delivery of new EDTV/HDTV services (ie. from programs suggested in section 12.0). Activities would focus on both the technical and market aspects of service delivery. To conduct a multi-faceted program involving the suggested transmission formats utilizing the various delivery modes outlined, would likely require an investment commitment in the 10's of millions of dollars depending on the extent of the program selected.

The first category of activity has been included to contrast a massive program with the more feasible Canadian involvement as discussed in sections 11 and 12.

13.3 Assessment

Results of the risk assessment conducted on these groups of activities are summarized in Exhibit 13-1. Further detail is provided below.

13.3.1 Major New Technology System Development

Technical Risk - High

Canada does not currently have the research depth required to tackle major fundamental research, or the manufacturing support necessary for major system production.

Exhibit 13-1

Risk Assessment Summary

PROGRAM	INVESTMENT REQUIREMENT	TECHNICAL RISKNICAL	COMMERCIAL RISK	INDUSTRIAL RISK	Scale Risk
o Major New Technology System Development	$100 million +	High	High	High	High
o Selected Studio System Participation	$40 million (total over 3 years)	Low-Moderate	Low	Moderate	Low-Moderate
o Selected Transmission System Activities	$10's of millions	Moderate	High	Moderate	Moderate

Commercial Risk - High

If technical success in major system development was achieved, competing with well established major players would be extremely difficult without the backing of a full range of broadcasting and manufacturing organizations.

Institutional Risk - High

Under the present fragmented industry structure the institutional risk would be very high without any major organization with a clear broadcast research and development mandate. While it might be possible to mandate the CBC to undertake a program, it could be difficult to justify a massive essentially technological effort in face of CBC cuts in programming.

Scale Risk - High

An investment in the order required would constitute a major risk in view of all other risks associated with the effort. The low odds on a high return in benefits commensurate with the investment make this magnitude of activity highly unattractive.

13.3.2 Selected Studio System Participation

Technical Risk - Low- Moderate

Products suggested for development have been selected based on Canadian industry strengths. There is some risk that product development may not be achieved within the time constraints for CBC studio implementation - which reinforces the urgency of the program.

Major products required for the HDTV studio implementation would be purchased from foreign manufacturers. This would reduce the technical risk considerably.

Commercial Risk - Low

The product niches identified for Canadian development are areas in which Canadian industry has historically been very successful in the world marketplace. There is some risk that the international market for HDTV software is premature, however these products can also be down converted where required.

Institutional Risk - Moderate

The coordination required for a focussed research and development program is in itself a barrier to success. However, the risk could be reduced if existing programs and roles can be used rather than depending on complex organizational mechanisms.

For HDTV software production an independent organizing committee responsible for HDTV production would minimize any organizational risk. Labour difficulties, however, might arise as HDTV production techniques stray from traditional television requirements and move towards 'film' type production methods thus changing the tasks of production personnel (eg. lighting crews, etc).

Scale - Low-Moderate

An investment of approximately $40M in this program has a very low risk of not achieving beneficial results. As identified in the economic impact analysis, the benefits compare very favourably with other targetted investments such as the space program. As well, the implications of Canada not getting involved in these areas would be severe.

13.3.3 Selected Transmission System Activities

Technical Risk - Moderate

Products selected for Canadian involvement are all based on current technical strengths. The major components required for service transmission trials have all been tested in the laboratory, but have not been utilized with Canadian satellites and other terrestrial distribution facilities.

Commercial Risk - High

Since the market acceptance rate and initiatives of other North American major players are not known, commercialization success is not guaranteed.

Institutional Risk - Moderate

The organization of several players would be required to get the service off the ground. Careful service definition will be critical to avoid possible concern within the broadcasting, telecommunications, and cable industries as to any incursion into their traditional bailiwicks.

Scale Risk - Moderate

It is estimated that an investment in the order of 10's of millions of dollars would be required to take selected program activities to phase 2 completion. With considerable strengths in the area of transmission systems, the overall risk of this program is moderate.

13.4 Conclusion - Comparative Risk

Canadian involvement in a major new system development undertaking carries a very high risk. Because Canada lacks a strong TV industry infrastructure, however, programs for involvement in products and services based on current market niches and industry strengths would represent much lower risk, and provide Canadian industry a vehicle to initiate new TV technology activities. As well, if well managed, the application program with respect to full production and transmission system trials is a low risk proposition, in view of the supplier industry and television industry benefits.

While cross program comparisons are difficult, it is useful to review other high tech areas as a point of reference (see Exhibit 13-2). The low risks associated with the TV R&D and applications programs recommended suggest that the TV technology area stacks up well in comparison with these reference programs.

While this study did not seek to provide a cost-benefit assessment, some observations can be made in the context of these other program areas. First, the industrial benefit returns for likely government

Exhibit 13-2

Cross Discipline Comparison of R&D Programs

Project	Expenditure	Benefit to Fed. Govt. Departments	Technical Risk and Maturation Period	10-Year Projected Internal & External Market
Optical Disk	$35M	very high	low to medium (5 years)	$15 billion
Telidon	$95M	small	low (15 years)	doubtful
SPAR ARM	$225M	none	low to medium (7 years)	$200M

Source: Management Strategy Study on Potential and Future Development of on-line Storage and Retrieval Systems based on Optical Disks, by Socioscope Inc. for the Department of Supply and Services, 1984.

investment are quite good. Second, the industry awareness and experience are a definite plus factor in view of the television industry's importance in Canada. Third, an intelligent transition to the era of EDTV/HDTV could result in consumer electronics savings if transmission investment is emphasized over reception equipment investment.

The logic for further serious consideration of the R&D and applications programs identified bears its own internal consistency that compares favourably to other government investment areas. Finally, the scale and scope of federal/provincial investment and participation is likely achievable without the earmarking of new funds to the programs.

NOTE: The concluding section of the report 'Integration of Study Findings' is found at the beginning of this document as Section II.

Glossary of Terms

New Television Technologies

Glossary

Aspect Ratio:	picture width divided by picture height; standard television has a 1.33 (or 4:3) aspect ratio; high definition television will have a wider aspect ratio, perhaps 1.66 or 1.78 (5:3 or 5:33) more like that of motion picture film
Bandwidth:	the range of frequencies required to enable information to be transmitted without distortion or loss of information
Chrominance:	part of a television signal that characterizes the colour (hue and saturation) without reference to its luminous intensity (brightness)
E-MAC:	see MAC
Field:	a sample of 1/2 of the lines in a TV picture (or frame); a field of NTSC consists of 262 1/2 lines transmitted in 1/60 of a second (all the odd or even lines in the picture)
Frame:	smallest number of fields comprising one complete television picture; In NTSC, two fields have a total of 525 lines transmitting in 1/30 of a second (all the lines in the picture)
Interlaced Scan:	a means of displaying a picture whereby the lines of the second field are placed between the lines of the first field in a frame
Luminance:	part of the television signal that characterizes the light intensity (brightness) without reference to its colour (chrominance)
MAC:	Multiplexed Analogue Component video systems current proposals include B-MAC, C-MAC and D2-MAC MAC systems are based on compatibility with the scanning structure of conventional systems (525/30 of NTSC or 625 of PAL/SECAM). Two essential features of MAC are: o it is a component system transmitting the luminance and chrominance information separately (rather than merging them into the same waveform as in NTSC) o it uses time division multiplexing (TDM) techniques to separate the luminance and chrominance by transmitting them at different times

The major different in the various MAC proposals is in the schemes for the combining of audio and data with video.

An enhanced or extended definition version of the analogue component system is a second evolutionary step in the development of TV systems. With suitable source/display signal processing, the quality level at the display of such signals - including a wider aspect ratio - can approach that of HDTV (see below). A baseband signal bandwidth of 6-7 MHz is foreseen.

MUSE	The MUSE HDTV system based on the Japanese NHK initiative for bandwidth reduction in transmission, represents a revolutionary approach to picture quality enhancement. The MUSE HDTV system provides one channel (8MHz baseband), generating an 1125 line, 60 field/sec, 2:1 interlace HDTV picture. Extra digital signal processing capability and memory are required in a smart receiver (4 field stores).
NTSC:	Television broadcasting standard used in Canada, USA, Japan and Mexico using 525 lines and a 60 Hz field frequency
PAL	'Phase Alteration by Line' television broadcasting standard used in Europe (excluding France and the Soviet Union), using 625 lines and a 50 Hz field frequency.
Resolution	The number of lines that may be represented at a distance equal to the height of a display
SECAM	Television broadcasting standard used in France and the Soviet Union using 625 lines and a 50 Hz field frequency not unlike PAL. Secam differs in that signals are transmitted sequentially rather than simultaneously.
Sequential Scan	a means of displaying a picture whereby the lines of a frame are transmitted one after another in sequence, sometimes referred to as progressive scan
"smart" sets	enhanced digital television sets with integrated circuitry offering improved image quality picture manipulation and other features

Source: Nordicity Group
Byte Magazine
Penguin Dictionary of Telecommunications

Appendix A

Delphi Forecast Questionnaire

First Round

STUDY OF FUTURE TV TECHNOLOGY

DELPHI FORECAST QUESTIONNAIRE

FIRST ROUND

NAME:

ADDRESS:

TELEPHONE NO.:

NOTE TO RESPONDENT

This sheet will be torn off by Nordicity Group Ltd. to retain the confidentiality of the opinions expressed.

Please return completed by December 12, 1984 to Stella Walsh at

Nordicity Group Ltd.
350 Sparks Street
Suite 706
Ottawa, Ontario
K1R 7S8

FUTURE TV TECHNOLOGY IMPACT ASSESSMENT
DELPHI SURVEY

QUESTIONNAIRE TABLE OF CONTENTS

5.0 OTHER APPLICATIONS

- 5.1 DELIVERY OF ENHANCED OR HIGH DEFINITION TELEVISION
- 5.2 MOTION-PICTURE HDTV PRODUCTION UTILIZATION
- 5.3 THEATRICAL DISTRIBUTION/DISPLAY VIA SATELLITE

  - 5.3.1 HDTV PROJECTORS
  - 5.3.2 THEATRICAL DISTRIBUTION
  - 5.3.3 STORAGE FOR THEATRICAL NEEDS

- 5.4 DISTRIBUTION OF HIGH DEFINITION VIDEO TO MINI-THEATRES
- 5.5 SPECIAL EVENT CLOSED CIRCUIT DISTRIBUTION
- 5.6 INDUSTRIAL AND INSTITUTIONAL APPLICATIONS
- 5.7 OTHER

1.0 IMPROVEMENTS WITHIN EXISTING TV SYSTEMS

1.1 RECEIVERS

The first area which we would like to address concerns image improvements as a result of receiver enhancements within the current composite systems (eg, NTSC, PAL/SECAM).

The following questions ask for your opinion on how far improvements will go within current transmission standards, in terms of when products will be available which result in:

- embellishments to existing image;
- additional features, and
- the scaling up of display resolution.

1.1.1 Line Storage Capabilities

Please indicate the probability of receivers with line storage capabilities and comb filters (resulting in improvements to image impairments such as cross effects and ghosting) becoming available in most outlet stores carrying high end receiver products in the consumer marketplace by the years 1985, 1990, 1995 and 2000. Please respond for the area(s) for which you are most familiar: Japan, Europe and North America. In the explanation column please briefly explain the reasons underlying your response.

	PROBABILITY			
	Japan	Europe	North America	Explanation
1985				
1990				
1995				
2000				

1.1.2 Special Features

Through digital processing within receivers, features such as 'teletext' and 'overlay captions', are possible. For Japan, Europe and North America please indicate the probability of these features becoming available in most outlet stores carrying high end receiver products by 1985, 1990, 1995 and 2000.

PROBABILITY

PICTURE IN PICTURE

	Japan	Europe	North America	Explanation
1985				
1990				
1995				
2000				

PROBABILITY

TELETEXT

	Japan	Europe	North America	Explanation
1985				
1990				
1995				
2000				

1.1.3 Field/Frame Storage Capabilities

When field and frame store devices within receivers become viable, display resolution could be scaled up to eliminate interlace and large area flicker.

a) Please indicate the probability of receivers with field storage capabilities becoming available in most outlet stores carrying high end receiver products in the years indicated below.

PROBABILITY

	Japan	Europe	North America	Explanation
1985	______	______	______	______________________________
1990	______	______	______	______________________________
1995	______	______	______	______________________________
2000	______	______	______	______________________________

b) Please indicate the probability of receivers with frame storage capabilities becoming available in most outlet stores carrying high end receiver products in the years indicated below.

PROBABILITY

	Japan	Europe	North America	Explanation
1985	______	______	______	______________________________
1990	______	______	______	______________________________
1995	______	______	______	______________________________
2000	______	______	______	______________________________

1.2 VCRS

Please indicate your views on the probability of video cassette recorders which reproduce full bandwidth of composite signals (4.2 MHz/5MHz) becoming available in most retail outlets carrying high end VCR products.

	PROBABILITY			
	Japan	Europe	North America	Explanation
1985	_______	_______	_______	______________________________
1990	_______	_______	_______	______________________________
1995	_______	_______	_______	______________________________
2000	_______	_______	_______	______________________________

2.0 STUDIO SYSTEMS

2.1 PRODUCTS FOR HDTV PRODUCTION

The following section addresses products required for high definition video production. For the equipment items listed below, please indicate the probability that these items will be purchased by some of the major television producers by the years indicated.

		Japan	Europe	United States	Canada	EXPLANATION
HDTV cameras	1985	____	____	____	____	________________
	1990	____	____	____	____	________________
	1995	____	____	____	____	________________
	2000	____	____	____	____	________________
Video switchers and special effects	1985	____	____	____	____	________________
	1990	____	____	____	____	________________
	1995	____	____	____	____	________________
	2000	____	____	____	____	________________
VTRs	1985	____	____	____	____	________________
	1990	____	____	____	____	________________
	1995	____	____	____	____	________________
	2000	____	____	____	____	________________

2.1 PRODUCTS (cont'd)

		Japan	Europe	United States	Canada	EXPLANATION
Optical disc recorders	1985	______	______	______	______	______________________
	1990	______	______	______	______	______________________
	1995	______	______	______	______	______________________
	2000	______	______	______	______	______________________
Telecine	1985	______	______	______	______	______________________
	1990	______	______	______	______	______________________
	1995	______	______	______	______	______________________
	2000	______	______	______	______	______________________
Optical links	1985	______	______	______	______	______________________
	1990	______	______	______	______	______________________
	1995	______	______	______	______	______________________
	2000	______	______	______	______	______________________
Standards converters for transmission	1985	______	______	______	______	______________________
	1990	______	______	______	______	______________________
	1995	______	______	______	______	______________________
	2000	______	______	______	______	______________________

2.2 IMPLICATIONS OF HDTV PRODUCTION

What implicationa do you feel the introduction of high definition television production will have in terms of; labour, organization, etc?

3.0 NEW TRANSMISSION FORMATS

Current research into possible television transmission system improvements are following several different schools of thought. We would like your views on the probability of implementation of the various transmission formats in the area(s) with which you are most familiar; Japan, United Kingdom, Western Europe, United States, Canada and Australia. The various transmission formats are addressed under the following categories:

3.1 TABLE 1: NTSC, PAL/SECAM compatible 2 channel systems which use one channel to carry conventional composite signals and a second channel to carry additional information providing greater number of lines and a wider aspect ratio.

3.2 TABLE 2A: Analogue Component Video systems which use analogue component video, providing current number of scanning lines and aspect ratio (eg. MAC)

3.3 TABLE 3A: Enhanced Analogue Component Video systems which provide enhanced image over the basic Analogue Component Video through pre and post transmission filtering. The signal maintains the same number of scanning lines as the basic approach and can have either current or wider aspect ratio.

3.4 TABLE 4A: Bandwidth Reduced HDTV which has approximately double the number of scanning lines (ie. 1050/1125/1250) and a wider aspect ratio bandwidth reduced for transmission (eg. MUSE, CBS 2 channel, DBP/FTZ)

Recognizing that different evolution paths could be followed in terms of the technology adopted and distribution method employed (ie. DBS distribution or satellite-to-cable distribution) in each area, in the following tables please indicate the probabilities of the various technologies and distribution options being operational by the years 1990, 1995 and 2000.

3.1 Table 1
NTSC, PAL/SECAM COMPATIBLE 2 CHANNEL SYSTEMS

SYSTEM	DISTRIBUTION MEDIUM	YEAR	PROBABILITY					
			Japan	United Kingdom	Western Europe	United States	Canada	Australia
NTSC, PAL/SECAM COMPATIBLE 2 channel systems	DBS/SMATV	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	SATELLITE TO CABLE	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____

Please provide reasons for the probabilities indicated in Table 1.

3.1 Table 2A

ANALOGUE COMPONENT VIDEO

SYSTEM	DISTRIBUTION MEDIUM	YEAR	PROBABILITY					
			Japan	United Kingdom	Western Europe	United States	Canada	Australia
ANALOGUE COMPONENT VIDEO (eg. MAC)	DBS	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	SATELLITE TO CABLE ● converted at cable head-end for distribution to subscribers as conventional NTSC/PAL/SECAN signal	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	SATELLITE TO CABLE ● video analogue component signal distributed directly to subscribers		____	____	____	____	____	____

Please provide reasons for the probabilities indicated in Table 2A.

Table 2B
Analogue Component Video Format

For the area(s) addressed in Table 2A above, please indicate the probability of implementation of the following types of ANALOGUE COMPONENT SYSTEMS:

SYSTEM	PROBABILITY					
	Japan	United Kingdom	Western Europe	United States	Canada	Australia
C-MAC or Equivalent*	______	______	______	______	______	______
B-MAC or Equivalent*	______	______	______	______	______	______
OTHER	______	______	______	______	______	______

* C-MAC or equivalent systems developed as a DBS technology with no baseband signal equivalent
B-MAC or equivalent systems developed as a DBS technology which can also be distributed via cable

3.3 TABLE 3A

ENHANCED ANALOGUE COMPONENT VIDEO

SYSTEM	DISTRIBUTION MEDIUM	YEAR	PROBABILITY					
			Japan	United Kingdom	Western Europe	United States	Canada	Australia
ENHANCED ANALOGUE COMPONENT VIDEO:	DBS	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	SATELLITE TO CABLE ● enhanced analogue component video signal distributed directly to subscribers	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	OTHER	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____

Please provide reasons for the probabilities indicated in Table 3A.

Table 3B
Enhanced Analogue Component Video Format

For the area(s) addressed in Table 3A, please indicate the probability of implementation of the following types of ENHANCED ANALOGUE COMPONENT SYSTEMS:

SYSTEM	PROBABILITY					
	Japan	United Kingdom	Western Europe	United States	Canada	Australia
4/3 aspect ratio	_____	_____	_____	_____	_____	_____
5/3 aspect ratio	_____	_____	_____	_____	_____	_____
OTHER	_____	_____	_____	_____	_____	_____

3.4 TABLE 4A
BANDWIDTH REDUCED HDTV

SYSTEM	DISTRIBUTION MEDIUM	YEAR	PROBABILITY					
			Japan	United Kingdom	Western Europe	United States	Canada	Australia
BANDWIDTH REDUCED HDTV	DBS/SMATV	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	SATELLITE TO CABLE ● signal from a compatible channel only distributed via cable to subscribers	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	SATELLITE TO CABLE ● HDTV distributed directly to subscribers	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____
	OTHER	1990	____	____	____	____	____	____
		1995	____	____	____	____	____	____
		2000	____	____	____	____	____	____

Please provide reasons for the probabilities indicated in Table 4A.

Table 4B
BANDWIDTH REDUCED HDTV FORMAT

For the area(s) addressed in Table 4A, please indicate the probability of implementation of the following types of bandwidth reduced HDTV:

SYSTEM	PROBABILITY					
	Japan	United Kingdom	Western Europe	United States	Canada	Australia
MUSE	____	____	____	____	____	____
CBS FORMAT	____	____	____	____	____	____
DBP/FTZ	____	____	____	____	____	____
OTHER	____	____	____	____	____	____

Table 4B
BANDWIDTH REDUCED HDTV FORMAT

For the area(s) addressed in Table 4A, please indicate the probability of implementation of the following types of bandwidth reduced HDTV:

SYSTEM	PROBABILITY					
	Japan	United Kingdom	Western Europe	United States	Canada	Australia
MUSE	____	____	____	____	____	____
CBS FORMAT	____	____	____	____	____	____
DBP/FTZ	____	____	____	____	____	____
OTHER	____	____	____	____	____	____

4.0 RELATED PRODUCTS

In the following section we would like your views on expected developments for consumer products associated with the various transmission formats.

4.1 IMPROVEMENTS TO EXISTING PRODUCTS

For the items listed below, please indicate the probabilities of these equipment items becoming available in most outlet stores by the years 1985, 1990, 1995 and 2000 for each transmission format specified.

	YEARS	NTSC/PAL/SECAM 2 channel enhanced systems	ANALOGUE COMPONENT VIDEO	ENHANCED ANALOGUE COMPONENT VIDEO SYSTEMS	BANDWIDTH REDUCED HDTV	EXPLANATION
video cassette recorders	1985					
	1990					
	1995					
	2000					
video disc	1985					
	1990					
	1995					
	2000					
consumer video cameras	1985					
	1990					
	1995					
	2000					

4.2 DISPLAY DEVICES

The evolution of technology to enable larger, high resolution receiver displays in the consumer market could complement the evolution of image improvements. Please indicate your views on the evolution of CRTs, projector type displays, and flat panel displays (CRT-based, LCD-based or gas plasma) over the next 15 years as indicated below.

4.2.1 CRTs

Please indicate the probability of CRTs becoming available with approximately 40" diagonal, in most retail outlet stores carrying high-end receiver products.

YEAR	PROBABILITY	EXPLANATION
1985		
1990		
1995		
2000		

Please indicate the probability of CRTs becoming available with an aspect ratio of approximately 5/3, in most retail outlet stores carrying high-end receiver products.

YEAR	PROBABILITY	EXPLANATION
1985		
1990		
1995		
2000		

4.2.2 Projection Displays

Please indicate the probability of a new generation of projection-type displays providing improved resolution and luminance characteristics equivalent to current CRTs, becoming available at most retail outlet stores carrying high-end television products.

YEAR	PROBABILITY	EXPLANATION
1985		
1990		
1995		
2000		

Please indicate the probability of a new generation of projection type displays providing HDTV quality becoming available at most retail outlet stores carrying high-end television products.

YEAR	PROBABILITY	EXPLANATION
1985		
1990		
1995		
2000		

4.2.3 Flat Panel Displays

Please indicate the probability of CRT-based, LCD-based, gas plasma or other method of flat panel colour displays becoming available at levels of performance equivalent to current CRT displays, in most retail outlets for high-end television products.

	YEAR	PROBABILITY	EXPLANATION
CRT-based (ie. with vertical ejection beam)	1990		
	1995		
	2000		
LCD-based	1990		
	1995		
	2000		
Gas plasma	1990		
	1995		
	2000		
Other (please specify)	1990		
	1995		
	2000		

5.0 APPLICATIONS

The following section addresses the evolution towards higher definition video in terms of specific applications which may develop. Please indicate the probability of occurrence for each of the following statements.

5.1 DELIVERY OF HIGHER DEFINITION TELEVISION

In section 3 we obtained your views on the potential for enhanced higher definition television services which might be implemented. In this question we are interested in your views on the number of potential enhanced or high definition networks/channels which will be in the marketplace by 1990, 1995 and 2000. Please indicate the probability of:

a) more than one enhanced or high definition channels being available to home consumers
b) more than two enhanced or high definition channels being available to home consumers

		PROBABILITY			
		Japan	Europe	United States	Canada
a) More than one service	1990	____	____	____	____
	1995	____	____	____	____
	2000	____	____	____	____
b) More than two services	1990	____	____	____	____
	1995	____	____	____	____
	2000	____	____	____	____

If possible please indicate the minimum number of hours a day which you feel might be offered for these services.

	1990	1995	2000
# of hours	____	____	____

5.2 MOTION-PICTURE HDTV PRODUCTION UTILIZATION

Please indicate the expected probability for the following occuring within the motion picture industry:

Equipment for HDTV motion picture production will be utilized widely in film making.

PROBABILITY EXPLANATION

1990 __________ ______________________________

____

1995 __________ ______________________________

____

2000 __________ ______________________________

____

Over 15% of feature films will be produced using higher definition video electronic production.

PROBABILITY EXPLANATION

1990 __________ ______________________________

____

1995 __________ ______________________________

____

2000 __________ ______________________________

____

5.3 THEATRICAL DISTRIBUTION/DISPLAY VIA SATELLITE

The following questions address developments pertaining to the introduction of HDTV in movie theatres. Please indicate the probability of the following developments in terms of HDTV projectors, distribution and storage of HDTV.

5.3.1 HDTV Projectors

High definition video projectors for use in movie theatres will be available for purchase.

	PROBABILITY
1990	________
1995	________
2000	________

5.3.2 Theatrical Distribution

Feature films will be distributed to over 15% of movie theatres via satellite.

	PROBABILITY				EXPLANATION
	Japan	Europe	United States	Canada	
1990	_____	_____	_____	_____	________________________________ ________________________________
1995	_____	_____	_____	_____	________________________________ ________________________________
2000	_____	_____	_____	_____	________________________________ ________________________________

5.3.3 Storage for Theatrical Needs

If replacement of conventional film distribution with distribution via satellite becomes a reality, the need to store high quality video utilizing either new generation video recorders or optical disc recorders could develop. In the following two questions please indicate your views on the probability of these options occuring.

a) Movie theatre higher definition storage needs will be met with HDTV video recorders.

YEAR	PROBABILITY	EXPLANATION
1990		
1995		
2000		

b) Movie theatre higher storage definition recording needs will be met with; optical disc players/recorders.

	YEAR	PROBABILITY	EXPLANATION
optical disc players	1990		
	1995		
	2000		
optical disc recorders	1990		
	1995		
	2000		

5.4 DISTRIBUTION OF HIGH DEFINITION VIDEO TO MINI-THEATRES

We are also interested in the likelihood of the development of an HDTV service being distributed to mini-theatres (eg. hotels, pubs, bars, etc). Please indicate the probability of:

	YEAR	PROBABILITY				EXPLANATION
		Japan	Europe	United States	Canada	
At least one enhanced or high definition service will be available distributing special programming to mini-theatres via satellite	1990	______	______	______	______	____________________
	1995	______	______	______	______	____________________
	2000	______	______	______	______	____________________
At least one enhanced or high definition service will be available distributing feature films to mini-theatres via satellite	1990	______	______	______	______	____________________
	1995	______	______	______	______	____________________
	2000	______	______	______	______	____________________

5.5 SPECIAL EVENT CLOSED CIRCUIT DISTRIBUTION

High definition video broadcasting of special live events via satellite could also appeal to the movie theatre market or become viable for mini-theatres. Please indicate the probability of services of this nature being implemented on a commercial basis by the years 1990, 1995, and 2000.

		Japan	Europe	United States	Canada	EXPLANATION
Live Broadcast to movie theatres	1990					
	1995					
	2000					
Live Broadcast to mini-theatres	1990					
	1995					
	2000					

5.6 INDUSTRIAL AND INSTITUTIONAL APPLICATIONS

Please indicate the probability of sales of closed circuit higher definition systems for industrial and institutional uses such as special exhibits, training, video conferencing, etc. exceeding 200 systems per year.

YEAR	Japan	Europe	United States	Canada	EXPLANATION
1990					
1995					
2000					
1990					
1995					
2000					

5.7 OTHER

Do you see any other major applications of enhanced definition television or HDTV evolving which have not been addressed in this questionnaire?

THANK YOU FOR YOUR PARTICIPATION!

Appendix B

Delphi Forecast Questionnaire

Final Round

STUDY OF FUTURE TV TECHNOLOGY

DELPHI FORECAST QUESTIONNAIRE

FINAL ROUND

NAME:

ADDRESS:

TELEPHONE:

NOTE TO RESPONDENT:
This sheet will be torn off by Nordicity Group Ltd. to retain the confidentiality of the opinions expressed.
Please return the questionnaire prinlout as soon as possible to Stella Walsh at;

NORDICITY GROUP LTD.
350 SPARKS STREET
SUITE 706
OTTAWA, ONTARIO
K1R 7S8

DELPHI FORECAST QUESTIONNAIRE
FINAL ROUND

The response data has been processed for each question with results presented as follows:

```
==========================================================================================

E X A M P L E
_____________

QUESTION            REASONS FOR RESULTS BELOW               PROBABILITY OF OCCURRENCE                    REASONS FOR RESULTS ABOVE
                    INTERQUARTILE RANGE          0   10  20  30  40  50  60  70  80  90  100             INTERQUARTILE RANGE


                                         Country
Product or Format   Comments from answers   1990             ---------------x------  X                   Comments from answers
in marketplace?     below range             1995                       --------------x--      X          above range
                                            2000                                  ---------x X



                                                                                                 LEGEND:
                                                                                                       'x'     = MEDIAN PROBABILITY
                                                                                                       '-----' = INTERQUARTILE RANGE

                                                                                                       'X'     = YOUR REVISED RESPONSE (IF DESIRED)
==========================================================================================
```

If you are influenced by the comments provided, please indicate your new desired response with an 'X' as shown.
No action is necessary if your initial response to the question remains unchanged. Should you wish to make any additional remarks, please write them directly on the printout.
If you have any questions please contact;

CAROL DARLING
NORDICITY GROUP LTD.
TELEPHONE: 613-236-5867
TELEX: Camsharp Ott 0533976

```
QUESTION                           REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                   INTERQUARTILE RANGE                                            0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

1.0 IMPROVEMENTS WITHIN EXISTING TV SYSTEMS
1.1 RECEIVERS
1.1.1 Line Storage Capabilities    .The introduction of line storage only is not im-     Japan                                                               .Now available with comb - will be available for ghost
                                    portant enough to compete with more expansive but      1985                   ---------*-----------------                 impairment.
                                    significantly better methods.                          1990                              ----------------------*        .Quasar units in stores now.
                                   .North America traditionally lags in quality.           1995                                    ----------------*        .NTSC comb filter and PAL/SECAM delay line are common
                                   .Will likely be surpassed by more comprehensive         2000                                   -----------------*         practice
                                    storage systems.                                     Europe                                                              .Line stores and comb filters are already available in most
                                   .There is little evidence that the balance of cost      1985          --*-------------------------                        high-end receivers and VCR's/Europe and Japan
                                    and improvements will make such features               1990                              --------------*--------
                                    consumer attractive.                                   1995                                    ----------------*
                                   .Will depend on public's view as a worthwhile enhance-  2000                                      ---------------*
                                    ment and on lower prices.                            N. America
                                   .Line storage improvements are limited.                 1985                 -----------*---------------
                                   .Research currently being done, cost of mass            1990                              ----------------------*
                                    storage coming down.                                   1995                                    ----------------*
                                   .If digitized TV sets are widely accepted then they     2000                                      ---------------*
                                    will most likely dominate line storage and comb
                                    filter by the year 2000.
==============================================================================================================================================================================================================================
1.1.2 SPECIAL FEATURES
Picture in Picture                 .Most homes have or will have more than one set       Japan                                                               .First demos in 1985.
                                    anyway, so no need for this feature.                   1985         * --------------------------                         .Picture in picture with a 64k RAM introduced in Japan in
                                   .This is a feature which is rarely useful except for    1990                           ----------------*---------          1984 and to be exported in 1985.
                                    novelty value. Japan will see more use than North      1995                              ----------------------*        .Already available in some European receivers.
                                    America due to a smaller living area and better        2000                                 -------------------*        .Digital integrated cicuits for receivers built into proto-
                                    personal discipline.                                 Europe                                                               type systems. Picture memory built into laboratory models -
                                   .North America depends on marketing - Just a gimmick.   1985         * --------------------------                          dedicated VLSI for TV memories finished.
                                   .Requires full frame storage - too expensive in         1990                         -------------------*-------
                                    consumer products.                                     1995                                ------------------*---
                                                                                           2000                                 -------------------*
                                                                                         N. America
                                                                                           1985   -----*--------------------
                                                                                           1990                         ---------------*-----------
                                                                                           1995                                ---------------------*
                                                                                           2000                                 -------------------*

==============================================================================================================================================================================================================================
```

QUESTION

REASONS FOR RESULTS BELOW INTERQUARTILE RANGE

PROBABILITY OF OCCURRENCE

REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE

Teletext

Reasons for results below interquartile range:

- .Development depends how valuable and how costly information is.
- .The availability of teletext will be important only in areas where subtitling is necessary. (Europe)

```
             0    10   20   30   40   50   60   70   80   90   100
Japan
  1985             ----I---------------------
  1990                         ------------------I--------
  1995                                 ------------------I
  2000                                 ------------------I
Europe
  1985                      -------------------------  I
  1990                                -------------------I
  1995                                    ---------------I
  2000                                    ---------------I
N. America
  1985       -----I----------------
  1990                        --------I-----------------
  1995                                -------------------I
  2000                                   ----------------I
```

Reasons for results above interquartile range:

- .Teletext already established in most European countries.
- .Lab models in Japan, no single standard, therefore a fractured market.
- .Expect introduction in N. America in 1990. (no decoders presently available.)
- .Standardization problems only solved in part of Europe.

1.1.3 FIELD / FRAME STORAGE CAPABILITIES

Field Storage Capabilities

Reasons for results below interquartile range:

- .Line storage will be introduced first and then market evaluation will take place to see if consumers will pay for extra quality.
- .Aside from picture in picture feature, field stores less likely to be used than frame stores.
- .As the price of frame storage falls, the number of receivers sold with only field storage will fall.
- .Field stores probably will not occur - manufacturers will go right to frame stores.
- .Digitized TV sets will probably starl with field storage, but with VLSI they will be quickly overtaken by frame storage sets.

```
             0    10   20   30   40   50   60   70   80   90   100
Japan
  1985       I--------------------
  1990                       -------------------I------
  1995                               ---------------------I----
  2000                                 ------------------------I
Europe
  1985       I---------------
  1990                       -------------------I-------
  1995                               ---------------------I----
  2000                                  -----------------------I
N. America
  1985       I-------------
  1990                   -------------I------------
  1995                               ---------------------I----
  2000                                     ----------------------I
```

Reasons for results above interquartile range:

- .Field memory expected to be available in 1984.
- .Technology has almost been completed in Japan.
- .Extension of Teletext and flicker reduction is more important in Europe than in other countries.
- .Technically feasible, will take off after cost problems solved.
- .First, receivers with 2MBit storage capacity will be used for Teletext background memory applications. Introduction will most likely be in 1985.

Frame Storage Capabilities

Reasons for results below interquartile range:

- .Line storage to be introduced first and then market evaluation to see if consumers will pay for extra quality.

```
             0    10   20   30   40   50   60   70   80   90   100
Japan
  1985       -I---------------
  1990                       ---------I----------------
  1995                                 -------------------I-----
  2000                                      -------------------I
```

Reasons for results above interquartile range:

- .Japan is committed to implement NHK HDTV system but will need frame store for data compression.
- .Technology has almost been completed in Japan
- .Expected to take off after cost problems solved.

```
QUESTION                       REASONS FOR RESULTS BELOW                                                           PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                               INTERQUARTILE RANGE                                                 0    10    20   30    40   50    60   70    80   90    100  INTERQUARTILE RANGE

                                                                                       Europe
                                                                                         1985      #---------------
                                                                                         1990                   --------------#-------------
                                                                                         1995                                 ----------------#----------
                                                                                         2000                                       ---------------------#
                                                                                       N. America
                                                                                         1985      #---------------
                                                                                         1990               ------------#-----------------
                                                                                         1995                                 ----------------#-----------
                                                                                         2000                                       --------------------#-
========================================================================================================================================================================================================
1.2 VCR's With Full Bandwidth  .No market - We are used to poor quality TV off-air,    Japan                                                                   .Wideband VCR's will arrive with HDTV, possibly as first
   Composite Signal             off cable and off VHS/Betatape. Needs complementary      1985      #-----------------                                           program choice.
                                breakthrough - eg. All the previous improvements         1990                  ---------------#-------------                   .Expect to be available, however depends on how fast new
                                plus some sort of HDTV.                                  1995                                --------------------#----------   technologies (amorphous metals) develop.
                               .Technology is already available - Demand is uncertain    2000                                                                 -#     .These "full bandwidth" VCR's might well be configured as
                                without changes in aspect ratio.                       Europe                                                                   component VCR's with both composite and component inputs.
                               .Customers appear happy with low bandwidth Beta or        1985      #----------------
                                VHS devices.                                             1990                 ----------------#-----------
                               .Public acceptance of VCR's is very high and will pro-    1995                           ----------------------#------
                                gress into a market for higher quality. Technology is    2000                                 --------------------------#-
                                here now but cost and compatability will delay the     N. America
                                growth.                                                  1985      #---------------
                               .There is little evidence of public demand, but such      1990               -------#---------------------
                                bandwidths would be needed for D2-MAC packet             1995                          --------------------#--------
                                recording.                                               2000                                --------------------#---
                               .By the time market and prices are compatible,
                                component recording will be overwhelming.
                               .Industry aiming at smaller and easier to use machines
                                rather than higher quality.
                               .Desire for higher quality may follow widespread
                                introduction of digitized TV sets but optical discs
                                will probably take over the VTR market by 2000.
                               .Availability of improved format pictures will supplant
                                this trend. Large screen and improved definition will
                                make NTSC VCR's obsolete.
========================================================================================================================================================================================================
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                            0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

2.0 STUDIO SYSTEMS
2.1 PRODUCTS FOR HDTV PRODUCTION
HDTV Cameras                        .Expect to be used for trial use until 1995.         Japan                                                               .Experimental service necessary for the moment. However, expect
                                    .Only if compatible HDTV emerges - only if HDTV re-    1985            #-------------------------                          HDTV to progress to commercial use.
                                     ceivers are in public hands - only if old equipment   1990                         -------------------#------            .Has already happened in Japan and USA.
                                     is written off.                                       1995                                ----------------------#-       .CBS has one now - Others will purchase over next few years.
                                    .Further work required over next few years to achieve  2000                                    ------------------#        .By 1990 most programs will be created and stored in higher
                                     compact size.                                       Europe                                                                quality than NTSC.
                                    .Expect use in Japan - Purchases outside Japan will    1985    ---#-------------------                                    .Sony has already announced complete package for market.
                                     depend on a worldwide standard and need to replace    1990                    -------------------#-------                 (experimental usage only)
                                     film.                                                 1995                             --------------------#-----
                                    .No need in Europe in the short term and a very small  2000                                    ------------------#
                                     need elsewhere.                                     U.S.
                                    .No market for product until high quality standards,   1985        ------#-------------------
                                     converters, VCR's, optical discs arrive. Currently    1990                       -----------------#----------
                                     there are no standards.                               1995                                 ------------------#---
                                    .Only if required for a compatible HDTV 525/1000+      2000                                      ----------------#
                                     system probably using receiver processing rather    Canada
                                     than 1000 line + distribution.                        1985    #--------------------
                                    .Only if HDTV becomes  commercially viable.            1990               --------------#------------
                                                                                           1995                             --------------------#-----
                                                                                           2000                                  --------------------#
================================================================================================================================================================================================================================
HDTV Video Switchers, etc.          .Product not yet available in Japan - will follow    Japan                                                               .Many responses similiar to those of HDTV camaras.
                                     cameras and VTR's.                                    1985    #   -------------------------
                                    .Cameras and switchers will go hand in hand. A great   1990                       ------------------#------
                                     deal depends on what standard is adopted.             1995                             -------------------#-----
                                                                                           2000                                    ------------------#
                                                                                         Europe
                                                                                           1985    -#--------------------
                                                                                           1990                 -----------------#--------
                                                                                           1995                          ---------------------#-----
                                                                                           2000                                 --------------------#-
                                                                                         U.S.
                                                                                           1985      ---#----------------------
                                                                                           1990                      ------------#-------------
                                                                                           1995                               ------------------#-----
                                                                                           2000                                    ------------------#
```

```
QUESTION                      REASONS FOR RESULTS BELOW                                             PROBABILITY OF OCCURRENCE           REASONS FOR RESULTS ABOVE
                              INTERQUARTILE RANGE                                           0   10  20  30  40  50  60  70  80  90  100 INTERQUARTILE RANGE

                                                                                    Canada
                                                                                      1985  #--------------
                                                                                      1990        --------------#-------
                                                                                      1995                  --------------#------
                                                                                      2000                     -----------------#--
=====================================================================================================================================================================================
HDTV VTR's                    .Technical problems have to be solved.                Japan                                                .Many responses similiar to those of HDTV camaras.
                                                                                      1985        #--------------------
                                                                                      1990                  ----------------#----
                                                                                      1995                      ----------------#----
                                                                                      2000                           ---------------#
                                                                                    Europe
                                                                                      1985  #------------------
                                                                                      1990               ---------------#-----
                                                                                      1995                      ----------------#----
                                                                                      2000                           ---------------#
                                                                                    U.S.
                                                                                      1985     -----#---------------
                                                                                      1990                  ------------#--------
                                                                                      1995                         --------------#---
                                                                                      2000                            --------------#
                                                                                    Canada
                                                                                      1985  #---------------
                                                                                      1990           -----------#---------
                                                                                      1995                     --------------#-------
                                                                                      2000                          ----------------#
=====================================================================================================================================================================================
HDTV Optical Disc Recorders   .These have nothing to do with HDTV per se - They     Japan                                                .Expect to be used for special purposes only.
                               will be mostly a data and/or image archiving medium.   1985  #-----------------                          .In use now in small quantities. HDTV adaptation technically
                               (unless the world goes digital)                        1990           -------#-------------               straightforward.
                              .Believe optical technology is at present most          1995                 ---------#-----------
                               advanced in Europe - and do not expect products        2000                          --------------#-
                               until possibly 1995.                                 Europe
                              .This product does not seem to be very attractive for   1985  #------------
                               production.                                            1990      ----#-----------------
                              .By year 2000 long playing (eg 1 hour) discs should     1995               -------#--------------
                               be available.                                          2000                       ------------------#-
```

```
QUESTION                           REASONS FOR RESULTS BELOW                                                PROBABILITY OF OCCURRENCE                 REASONS FOR RESULTS ABOVE
                                   INTERQUARTILE RANGE                                0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                   .Even if read only, it is a difficult technology to  U.S.
                                    develop and really only of archival value for         1985    *----------------------
                                    broadcaster's use.                                    1990             ---------*----------------
                                                                                          1995                      -------*------------------
                                                                                          2000                                  -------------------*-
                                                                                        Canada
                                                                                          1985    *-------------------
                                                                                          1990         -----*--------------------
                                                                                          1995                   ----------*---------------
                                                                                          2000                                 ----------------*-----
==========================================================================================================================================================================================================
HDTV Telecine                      .Do not believe HDTV transmission will occur,        Japan                                                              .Base tool necessary for use of film.
                                    therefore no need for telecines.                      1985    *-----------------------                                 .Laser-scanned film is promising.
                                                                                          1990                    ---------*----------------
                                                                                          1995                            ---------------------*----
                                                                                          2000                                  --------------------*
                                                                                        Europe
                                                                                          1985    *------------------
                                                                                          1990            ------------*-------------
                                                                                          1995                       -----------*--------------
                                                                                          2000                              ------------------------*
                                                                                        U.S.
                                                                                          1985    *---------------------
                                                                                          1990                 ------------*--------------
                                                                                          1995                             ------------------*-----
                                                                                          2000                                   -------------------*
                                                                                        Canada
                                                                                          1985    *---------------
                                                                                          1990          ---------*---------------
                                                                                          1995                         -------------*--------------
                                                                                          2000                              --------------*----------
==========================================================================================================================================================================================================
HDTV Optical Links                 .This is the only suitable transmission medium if    Japan                                                              .Will be used for any signal (especially digital video -CCIR
                                    signals are digitized.                                1985     * -------------------------                             600
                                                                                          1990                     --------------------*-----              .Expect to be available shortly after standards are set.
                                                                                          1995                             -------------------*-----
                                                                                          2000                                  --------------------*
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                    REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                                 0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                                                                          Europe
                                                                                            1985       #-------------------
                                                                                            1990                    ------------#-------------
                                                                                            1995                             ------------------#-------
                                                                                            2000                                    ---------------------#
                                                                                          U.S.
                                                                                            1985    -----#-------------------
                                                                                            1990                       ---------------------#----
                                                                                            1995                              -------------------#-----
                                                                                            2000                                   -------------------#
                                                                                          Canada
                                                                                            1985       #------------------
                                                                                            1990                   -------------#-------------
                                                                                            1995                            ----------------#---------
                                                                                            2000                                   -------------------#
================================================================================================================================================================================================================================
HDTV Standards, Converters for      .High quality conversion still at research stage.     Japan                                                               .Not difficult and extremely useful.
Transmission                         (important problem - movement artifacts)               1985    #---------------------                                     .No problem after standards are set.
                                    .There is no need for standards, converters until       1990                 ------------#-------------
                                     HDTV satellite distribution takes off, possibly in     1995                            --------------------#-----
                                     1995.                                                  2000                               ----------------------#-
                                    .Technically feasible presently, but delayed by       Europe
                                     system use.                                            1985    #----------------------
                                    .The expected cost of standard converters will make     1990                --------------#-------------
                                     them less attractive to investors.                     1995                             --------------------#-----
                                                                                            2000                                  -------------------#-
                                                                                          U.S.
                                                                                            1985    #-----------------
                                                                                            1990                  -----------#--------------
                                                                                            1995                               -----------------#-----
                                                                                            2000                                   -------------------#
                                                                                          Canada
                                                                                            1985    #----------------
                                                                                            1990           --------#-----------------
                                                                                            1995                        ------------------------#-
                                                                                            2000                              ------------------------#
================================================================================================================================================================================================================================
```

3.0 NEW TRANSMISSION FORMATS

3.1 TABLE T: NTSC, PAL/SECAM COMPATIBLE 2 CHANNEL SYSTEMS

QUESTION	REASONS FOR RESULTS BELOW INTERQUARTILE RANGE		PROBABILITY OF OCCURRENCE 0 10 20 30 40 50 60 70 80 90 100	REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE
NTSC DBS/SMATV	.There are better alternatives compatible with TV technology. .Since adequate quality enhancements can be achieved in a single satellite channel - do not see the second channel ever generating extra revenues to pay for its cost. .For the time being consideration is being given to only MUSE of HDTV broadcasting in Japan. .Two channel systems are impractical and undesirable. They won't be implemented. .Japan will most likely adopt HDTV standard in one form or another. By the year 2000, such a standard might be adopted by USA and Canada if compatibility with NTSC standard is built in.	Japan		.Compatibility will allow growth of programming business.
		1990	*----------------	
		1995	*---------------	
		2000	*-------------------	
		U.K.		
		1990	*---------------	
		1995	*--------------	
		2000	*-----------------	
		W. Europe		
		1990	*-----------------	
		1995	*------------------	
		2000	*--------------------	
		U.S.		
		1990	*--------------	
		1995	----*----------------------	
		2000	-*-----------------------	
		Canada		
		1990	*---------------	
		1995	*---------------	
		2000	*---------------------	
		Australia		
		1990	*--------------	
		1995	*-----------------	
		2000	*------------------	
NTSC Satellite to Cable	.There are more bandwidth efficient methods. .Not required in Japan. .This system maintains the susceptabilities to transmission degradation in the current color system thus reducing the chance of a common standard. Added complexity is particularly awkward, relative to other systems. .No one is going to revamp cable systems to provide extra quality.	Japan		.This approach alleviates the burden on the consumer - receiver simpler. .Compatible systems have a much better chance for commercial success but DBS costs are very high for a pure Canadian service. Overspill from USA satellites is more likely, particularly from DBS. A combined service from a series of satellites would be logical. (eg 4 USA programs 1 Canada) .A wider aspect ratio can be achieved easily by an additional channel. Compatibility to standard channels seems to be essential.
		1990	*----------------	
		1995	*--------------------	
		2000	*------------------	
		U.K.		
		1990	*----------------	
		1995	*----------------	
		2000	*------------------	

QUESTION

REASONS FOR RESULTS BELOW INTERQUARTILE RANGE

PROBABILITY OF OCCURRENCE

REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE

.Cable systems unlikely to use 2 adjacent channels for such transmission in N. America.

```
           0    10   20   30   40   50   60   70   80   90   100
N. Europe
  1990     *--------------------
  1995          *-------------------
  2000          *-------------------
U.S.
  1990          *---------------
  1995         ------*------------------
  2000          -----*--------------------
Canada
  1990     *----------------
  1995               *-------------
  2000       -----------*--------------
Australia
  1990     *---------------
  1995     *-----------------
  2000     *------------------
```

.Relatively cheap displays will not be available for some time but cable companies will have ample channel capacity to distribute dual channel (6MHz) signals. They will also be in the position to convert other formats, such as the proposed CBS signals, into a format for distribution over 6MHz channels.

3.2 TABLE 2A: ANALOGUE COMPONENT VIDEO

Analogue DBS

.Japan is committed to HDTV for high quality picture satisfied with conventional system for NTSC with interim requirements.

.Direct DBS - Who cares!

.Not clear that DBS is viable from an economic standpoint, future in USA doubtful.

.After a shaky start, Europe likely to adopt DBS in Mac form.

.Do not feel Mac is superior to the improvements which can be achieved through existing system.

.Analogue components do not provide sufficient picture quality advantages to justify their adoption.

.Present policy excludes DBS, but policy must change to serve thinly spread population. (Australia)

```
Japan
  1990          *--------------------
  1995         -*------------------------
  2000           ----*---------------------
U.K.
  1990                      --------*-----------------
  1995                            ------------------*-------
  2000                              ------------------------*
W. Europe
  1990                    ----------*---------------
  1995                          ---------------*----------
  2000                             --------------------*-----
U.S.
  1990          -------------*------------
  1995               --------------*------------
  2000                   ----------------*---------
Canada
  1990        *----------------------
  1995            --------*-----------------
  2000                -------------*-------------
```

.Expect to be broadcasting with digital sound (going to composite systems loses the quality and flexibility, multilingual programs of the sound and of the picture.

.Component system best suited to satellite - Mac-type system will be standardized, approved and operated.

.Australia has committed to a B-Mac system.

.The principle of DBS in a Mac format makes sense for most European countries.

.Expect Mac to be used in countries except Japan with eventual transition to HDTV.

QUESTION | REASONS FOR RESULTS BELOW INTERQUARTILE RANGE | PROBABILITY OF OCCURRENCE | REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE

```
                       PROBABILITY OF OCCURRENCE
           0    10   20   30   40   50   60   70   80   90   100
Australia
 1990                   ------------*-------------
 1995                           -------------------*------
 2000                             ------------------------  *
```

Analogue Satellite to Cable

REASONS FOR RESULTS BELOW INTERQUARTILE RANGE:

.Cable unlikely because of thinly spread population in Australia.

```
Japan
 1990         *--------------------
 1995        ---*----------------------
 2000          ------*-------------------
U.K.
 1990                 --------------*-----------
 1995                      ------------------*--------
 2000                        ---------------------*----
W. Europe
 1900                   ------------*-------------
 1995                     --------------*-----------
 2000                       -----------------*--------
U.S.
 1990                 ----------------*----------
 1995                     --------------*------------
 2000                       --------------------------*
Canada
 1990        ---------*----------------
 1995               -------*------------------
 2000                   -----------------*--------
Australia
 1990          --------------------*------
 1995                   ------------------------*-
 2000                     -------------------------    *
```

REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE:

.Other countries likely to follow, but there is a chance that this type of system will be bypassed.

.Scientific Atlanta, IBA and others driving this technology/system.

.B-Mac has useful data rate (1.8Mb/s) and is compatible with VTR's and cable systems.

.Cable systems may be upgraded to FM or Mac to improve transmission quality.

.Mac systems will probabty be implemented before other transmission technologies. Cable companies are most likely to convert to Mac signals to conventional TV but only if the Mac service differs from other conventional ones.

Satellite to Cable - Direct

REASONS FOR RESULTS BELOW INTERQUARTILE RANGE:

.Cable unlikely because of thinly spread population.

.Cable compatibility will preclude Mac on cable.

```
Japan
 1990      *-----------------------
 1995       ----*----------------------
 2000           *-------------------------
U.K.
 1990             ---*----------------------
 1995                         -------------------------*
 2000                           -----------------------*--
```

REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE:

.B-Mac has useful data rate (1.8 Mb/s) and is compatible with VTR's and cable systems.

.Expect bandwidth expansion at head end - Cable includes fibre optics.

.Cable companies are unlikely to distribute HDTV programs to subscribers as FM signals but might send B-Mac signals in a 6MHz bandwidth.

QUESTION

REASONS FOR RESULTS BELOW INTERQUARTILE RANGE

PROBABILITY OF OCCURRENCE

REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE

```
            0    10   20   30   40   50   60   70   80   90   100
W. Europe
 1990               -----------------#--------
 1995                        ---------------------#----
 2000
U.S.
 1990            --------------------#-----
 1995                  -------------------#------
 2000                       ----------------------#--
Canada
 1990       ----------#---------------
 1995            -----#--------------------
 2000               ------------#-------------
Australia
 1990           ----------------#---------
 1995                   ------------------------- #
 2000                    -------------------------      #
```

3.2 TABLE 2B: ANALOGUE TO COMPONENT VIDEO FORMAT

C-MAC Option

.Mac in its C-Mac form seems an unlikely candidate. Variants with baseband capabilities and coding adaptibility have been proposed and could be attractive.

.D2-Mac believed to be most likely for most European countries.

```
            0    10   20   30   40   50   60   70   80   90   100
Japan
            #-----------------
U.K.
                        ------------#-------------
W. Europe
               ------------#-------------
U.S.
            #--------------------
Canada
            #----------------
Australia
            #--------------
```

B-MAC Option

```
            0    10   20   30   40   50   60   70   80   90   100
Japan
              --#------------------------
U.K.
                     ---------------#-----------
W. Europe
                          ----------#----------------
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                                    0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                                                                          U.S.
                                                                                                                    --------|------------------
                                                                                          Canada
                                                                                                                ------------|--------------
                                                                                          Australia
                                                                                                                                 --------------------|
================================================================================================================================================================================================================================
Other Options                                                                             Japan
                                                                                                   |----------------------
                                                                                          U.K.
                                                                                                   ----------|------------
                                                                                          W. Europe
                                                                                                     -------------|-------------
                                                                                          U.S.
                                                                                                   -------------|-------------
                                                                                          Canada
                                                                                                   -------------|-------------
                                                                                          Australia
                                                                                                   |----------------
================================================================================================================================================================================================================================
3.3 TABLE 3A: ENHANCED ANALOGUE COMPONENT VIDEO
EACV - DBS                          .Not practical or desirable.                          Japan                                                               .Enhanced TV is European answer to Japan HDTV projects.
                                                                                            1990   |-------------------                                       .This is the most likely approach. Its introduction depends
                                                                                            1995   ---|---------------------                                   on the economic climate, government intervention and growth
                                                                                            2000      |--------------------------                              in receiver capability. Current climate indicates unlikely
                                                                                          U.K.                                                                 introduction before 1990, except possibly for minor exper-
                                                                                            1990   ----------|----------------                                 iments. Remaining probabilities (1995, 2000) indicate high
                                                                                            1995               ---------------|-------------                   probability of introduction but tempered by alternate possi-
                                                                                            2000                      ------------------|--------              bility of a basic analogue component system being adopted.
                                                                                          W. Europe                                                           .Enhanced system provides better qualities with minor
                                                                                            1990   ----------|----------------                                 compatibility issues.
                                                                                            1995               -------------|------------
                                                                                            2000                     ---------------------|----
                                                                                          U.S.
                                                                                            1990   -----|----------------
                                                                                            1995       ------|--------------------
                                                                                            2000              --------------------|------
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                      PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                             0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                                                                          Canada
                                                                                            1990    #-----------------
                                                                                            1995    ------#------------------
                                                                                            2000       #-------------------------
                                                                                          Australia
                                                                                            1990    #-------------------
                                                                                            1995    #-----------------------
                                                                                            2000    #  -------------------------
================================================================================================================================================================================================================================
EACV - Satellite to Cable           .Do not believe mechanism (eq. HDTV production,       Japan                                                               .A compatible method of this kind is attractive. If an aspect
                                     receivers etc.) will be in place. -- What would the    1990    #-----------------                                         ratio greater than 4/3 is adopted, distribution via cable
                                     viewer see?                                            1995    #---------------------                                     as a standard composite signal will not be possible.
                                    .Rather see a "compatible" enhanced system distributed  2000    #------------------------                                 .Once Mac type systems are approved and in operation it is
                                     via digital fiber.                                   U.K.                                                                 easy to extend, as these systems have a flexible organization.
                                    .Not practical or desirable;                            1990    --------#---------------                                  .Availability of enhanced analogue components requires
                                    .Japan likely will have its own HDTV standard. DBS is   1995             -----------#--------------                        satisfactory channels, acceptable receiver costs, high
                                     not attractive compared to satellite cable TV          2000                  --------------#-----------                   quality source material. (most probably film) This can only
                                     services. By 2000 some HDTV standards will probably  W. Europe                                                            be introduced in a progressive way.
                                     be accepted in N. America.                             1990     ---------#---------------                                .Conversion from satellite to composite cable distribution
                                                                                            1995             ----------#---------------                        to component cable distribution expected to move smoothly.
                                                                                            2000                  ---------------#----------                  .High level of activity growing in western world to provide
                                                                                          U.S.                                                                 perceived more economical alternatives to HDTV.
                                                                                            1990    #---------------------
                                                                                            1995       ------#------------------
                                                                                            2000            -------#-------------------
                                                                                          Canada
                                                                                            1990    #-----------------
                                                                                            1995    -----#-y-------------
                                                                                            2000     ---------#----------------
                                                                                          Australia
                                                                                            1990    #-------------------
                                                                                            1995    #-----------------------
                                                                                            2000    #  -------------------------
================================================================================================================================================================================================================================
EACV - Other                        .Not practical or desirable.                          Japan                                                               .Eventual winner will be an "HDTV-Mac" (probably B-Mac) with
                                                                                            1990    #-------------                                             time frame determined by agreed standards in place in USA
                                                                                            1995    #-------------                                             and Canada and availability of the large solid state display
                                                                                            2000    #-------------                                             device.
```

```
QUESTION            REASONS FOR RESULTS BELOW                         PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                    INTERQUARTILE RANGE                0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                              U.K.
                                                1990   ---*-----------
                                                1995   ---*-----------
                                                2000   ---*-----------
                                              W. Europe
                                                1990   ---*-----------
                                                1995   ---*-----------
                                                2000   ---*-----------
                                              U.S.
                                                1990   *------------------
                                                1995   *-------------------
                                                2000   *---------------------
                                              Canada
                                                1990   *------------------
                                                1995   *--------------------
                                                2000   *-------------------------
                                              Australia
                                                1990   *--------------
                                                1995   *--------------
                                                2000   *--------------
```

QUESTION | **REASONS FOR RESULTS BELOW INTERQUARTILE RANGE** | **PROBABILITY OF OCCURRENCE** | **REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE**

```
                        PROBABILITY OF OCCURRENCE
         0    10   20   30   40   50   60   70   80   90   100
```

3.3 TABLE 3b: EACV FORMAT

EACV - 4/3 Aspect Ratio Option

```
Japan
                ---*----------------------
U.K.
                      -------*------------------
W. Europe
              --------*-----------------
U.S.
                        -----*--------------------
Canada
                 -----*--------------------
Australia
                 ------------*-------------
```

Reasons for results above interquartile range:

- .Both EDTV systems will exist simultaneously (4/3, 5/3) but reduced bandwidth HDTV will probably replace them.
- .Expect a new system will show some flexibility with respect to the aspect ratio.

EACV - 5/3 Aspect Ratio Option

Reasons for results below interquartile range:

- .The higher aspect ratio, while highly desirable, does not in general seem practical unless one assumes that the majority of displays in the future will be large - doubt will be the case.

```
Japan
                     -------------*------------
U.K.
                    ---------*----------------
W. Europe
                       -----------*--------------
U.S.
                        ---------------*----------
Canada
                       -----------*--------------
Australia
           ---------------*----------
```

Reasons for results above interquartile range:

- .The enhanced system should be able to switch to both ratios; as in the IBA E-Mac proposal, the 4/3 ratio is the standard mode but the system can equally well adapt to the 5/3 ratio
- .A wider aspect ratio would constitute much of the advantage of an enhanced viewing experience.

EACV - Other Aspect Ratio Options

```
Japan
         *--------------
U.K.
             ----------*--------------
W.Europe
             ----------*--------------
U.S.
                  -------------*-----------
Canada
         -------------*-----------
```

Reasons for results above interquartile range:

- .Expect 5.33/3 to be adopted.

QUESTION	REASONS FOR RESULTS BELOW INTERQUARTILE RANGE		PROBABILITY OF OCCURRENCE 0 10 20 30 40 50 60 70 80 90 100	REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE
		Australia		
			▮---------------	
3.4 TABLE 4A: BANDWIDTH REDUCED HDTV DBS / SMATV	.DBS and cable have to address mass market - hence severe chicken/egg situations expected unless inexpensive converter to NSIC/PAL is available for incorporation in DBS frontend and cable units. This condition will not be met early, since large video memories are needed. .USA will not implement enhanced syslem on tape, hence DBS. Japan's incompatible tape format might achieve some penetration in USA but probably never higher than 20% .Much ambiguity remains on popular use of HBTV but if used would be distributed nation wide after 10 years.	Japan		.Muse system will be applied in Japan. .HDTV broadcast will depend upon sponsorship by a large broadcasting company such as CBS. Signals of the T-Mac compatible channel would be converted to a composite signal for distribution if the program was different from those on other channels. The full HDTV signal converted to a composite lwo channel compatible signal, would be distributed once cheap wide aspect ratio high resolution displays become available. .The time line in the question is very distorted. Possible introduction in most countries in 1986-87 time frame. (Look at the recent mass acceptance of VCR's and micro computers) .Japan already committed. By 1995 current development efforts on bandwidth reduction will bear fruit and be economically attainable. .Given agreed standards and availability at reasonable cost of large screen displays - HDTV service in 1990's. Cable should distribute both NTSC and HDTV versions of same program. Also available by SMATV and DBS modes though satellites likely in 54dBW range.
		1990	---------------▮-----------	
		1995	------------------------▮-	
		2000	---------------------▮	
		U.K.		
		1990	--▮--------------------	
		1995	-----▮-------------------	
		2000	-------------▮------------	
		W. Europe		
		1990	--▮---------------------	
		1995	-----▮------------------	
		2000	-----------▮--------------	
		U.S.		
		1990	----▮--------------------	
		1995	-----------▮-------------	
		2000	--------------▮-----------	
		Canada		
		1990	-▮--------------------	
		1995	----▮--------------------	
		2000	------------▮------------	
		Australia		
		1990	▮---------------------------	
		1995	--------▮------------------	
		2000	------▮--------------------	
SATELLITE TO CABLE Signal from compatible channel only distributed via cable to subscribers		Japan		
		1990	-------▮------------------	
		1995	------▮-------------------	
		2000	------------▮--------------	
	.The Transcoding of an already compressed HDTV signal at the cable head-end is very unlikely and if it comes, will not last long before compressed HDTV distribution to the home takes over.	U.K.		.HDTV may be the effective means for distribution but the ordinary digital processor may not be economical. .Possible introduction in most countries in the 1986-87 time frame.
		1990	▮--------------------	
		1995	----▮-------------------	
		2000	-------▮------------------	

```
QUESTION                            REASONS FOR RESULTS BELOW                                                    PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                            0    10   20   30   40   50   60   70   80   90   100     INTERQUARTILE RANGE

                                                                                         N. Europe
                                                                                           1990    -#-------------------
                                                                                           1995    ----#---------------------
                                                                                           2000       --------#-----------------
                                                                                         U.S.
                                                                                           1990    ----#-----------------
                                                                                           1995       ----#---------------------
                                                                                           2000             --------------#-----------
                                                                                         Canada
                                                                                           1990    #-------------------
                                                                                           1995    ----#--------------------
                                                                                           2000         -#-----------------------
                                                                                         Australia
                                                                                           1990         #----------------------
                                                                                           1995         ----#-------------------
                                                                                           2000        ---#--------------------
==================================================================================================================================================================================================================================
        SATELLITE TO CABLE                                                               Japan
           HDTV distributed directly                                                       1990          ---#----------------------
           to subscribers          .Australia - no cable, Britain - a big maybe, Japan -   1995                -----------------#--------                    .In Japan satellite to neighborhood mode transmission
                                    strong DBS, weak for cable. Existing cable systems     2000                     ----------------#---------                    is likely to succeed because of dense population. Distrib-
                                    can maybe handle 2 separate channels (where there    U.K.                                                                 ution will have full bandwidth signal on optical fibre.
                                    is spectrum) but technical performaance of commercial  1990    #---------------------                                    .Expect compressed HDTV distribution to the home. (eg 8MHz)
                                    system makes HDTV extremely doubtful.                  1995     ---#---------------------
                                   .There is a chance that the Japanese system will also   2000            ----------#----------------
                                    be used in the USA.                                  N. Europe
                                   .Expect Japanese technology to first be imported to     1990    #----------------------
                                    USA and Canada for movie production, then later for    1995       -----#--------------------
                                    DBS (maybe) and fibre optics distribution.             2000              -------------#------------
                                                                                         U.S.
                                                                                           1990    #---------------------
                                                                                           1995      ------#-------------------
                                                                                           2000              -------------#------------
                                                                                         Canada
                                                                                           1990    #---------------------
                                                                                           1995     ---#----------------------
                                                                                           2000         -------------#------------
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                  0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                                                                          Australia
                                                                                            1990    #-------------------------
                                                                                            1995         --#------------------------
                                                                                            2000           ----#----------------------
====================================================================================================================================================================================================================================
         OTHER                                                                            Japan                                                               .Japan will also introduce BW HDTV on tape.
                                                                                            1990   #---------------------                                     .It is much too early for a standard - The discussion
                                                                                            1995   #--------------------------                                 937/787 lines vrs. 1249/1125/1049 lines has not yet been
                                                                                            2000   # --------------------------                                started up.
                                                                                          U.K.                                                                .Time line distorted. eg VCR's, microcomputers
                                                                                            1990    --------------------#-----                                .Other distribution is by compatible bandwidth reduced
                                                                                            1995      --------------------#-----                               cable, terrestrial broadcast and leasing of pre-recorded
                                                                                            2000        ---------------------#---                              media.
                                                                                          W. Europe
                                                                                            1990    ---------------------#-----
                                                                                            1995      --------------------#------
                                                                                            2000        ---------------------#---
                                                                                          U.S.
                                                                                            1990        #--------------------
                                                                                            1995        ----#-------------------
                                                                                            2000       -#-------------------------
                                                                                          Canada
                                                                                            1990   --#----------------------
                                                                                            1995   ----#----------------------
                                                                                            2000         --------#-----------------
                                                                                          Australia
                                                                                            1990    -#------------------------
                                                                                            1995     #--------------------------
                                                                                            2000     # --------------------------
====================================================================================================================================================================================================================================
3.4 TABLE 4B: BANDWIDTH REDUCED HDTV FORMAT
HUSE                                                                                      Japan
                                                                                                                        ------------------#--------

                                                                                          U.K.
                                                                                                  --------#------------------

                                                                                          W.Eur
                                                                                                  --------------#---------------
```

```
QUESTION          REASONS FOR RESULTS BELOW                                                   PROBABILITY OF OCCURRENCE                 REASONS FOR RESULTS ABOVE
                  INTERQUARTILE RANGE                                           0    10   20   30   40   50   60   70   80   90   100   INTERQUARTILE RANGE

                                                                      U.S.
                                                                                          ------------#-------------
                                                                      Canada
                                                                                     ----------#-----------------
                                                                      Aust.
                                                                                          -----#--------------------
==============================================================================================================================================================================================
CBS Format        .If there are not any standards, the whole thing    Japan
                   is likely to die.                                            #------------------
                                                                      U.K.
                                                                                #----------------
                                                                      W. Eur
                                                                                #-------------------
                                                                      U.S.
                                                                                -----#-------------------
                                                                      Canada
                                                                                -----#-------------------
                                                                      Aust.
                                                                                #-------------------
==============================================================================================================================================================================================
DBP / FTZ                                                             Japan
                                                                                #-------------
                                                                      U.K.
                                                                                #---------------
                                                                      W.Eur,
                                                                                  ----------#---------------
                                                                      U.S.
                                                                                #---------------
                                                                      Canada
                                                                                #--------------
                                                                      Aust.
                                                                                #-------------
==============================================================================================================================================================================================
Other                                                                 Japan                                                             .Expect worldwide one channel system to dominate.
                                                                                      ---------#----------------
                                                                      U.K.
                                                                                                    ---------------#----------
```

```
QUESTION              REASONS FOR RESULTS BELBW                                        PROBABILITY OF BCCURRENCE                REASONS FOR RESULTS ABOVE
                      INTERQUARTILE RANGE                                0    10   20   30   40   50   60   70   80   90   100  INTERBUARTILE RANGE

                                                                W. Eur.
                                                                                       ----------|---------------
                                                                U.S.
                                                                                       ----------|---------------
                                                                Canada
                                                                                      --------------|-----------
                                                                Aust.
                                                                              -------|------------------
======================================================================================================================================================================================
4.0 RELATEB PRODUCTS
4.1 IMPROVEMENTS TO EXISTING PRODUCTS
New Format VCR's      .Japan is the driving force.              NTSC                                                                   .Expect VCR's to develop in conjunction with new transmission
                      .HDTV expected to be the winner.            1985   |-------------                                                 formats.
                                                                  1990   |-----------------
                                                                  1995   ----|----------------
                                                                  2000   |-------------------
                                                                ACV                                                                    .Chart provided did not reflect fact that pickup or storage
                                                                  1985   |---------------                                               could be done in any related format and encoded for output
                                                                  1990     ----------|--------------                                    as any of the listed systems, given that a system chioce
                                                                  1995             --------------|-----------                           is Mac.
                                                                  2000                 -------------|-------------                     .Drive for wider aspect ratio and improved picture quality
                      .1985 - too early                         EACV                                                                    will likely be focused in VCR systems rather than "over"
                      .1990 - insufficient demand                 1985   |-------------                                                 the air systems. The enhanced analogue componeot technique
                      .2000 - optical disc will dominate          1990   ----------|-------------                                       is likely to be most competitive in the marketplace.
                                                                  1995          ------------|-------------                             .Most significant enhancement for USA is wide-aspect ratio
                                                                  2000                 ----------|----------------                      movies. Will probably introduce tape products ahead of OBS in
                                                                B.R.-HD                                                                 enhanced analogue component format.
                                                                  1985   |-------------                                                .Expect to introduced at same time as broadcast service.
                                                                  1990   -----|-----------------                                       .Expect enhanced EDTV and HDTV to be sold through cassette
                                                                  1995        ---------|----------------                                distribution.
                                                                  2000                ------------|------------
======================================================================================================================================================================================
New Format Video Disk .Japan is the driving force.              NTSC
                      .No future for video disc.                  1985   |-------------
                      .Look at the demise of the NTSC disc.       1990   |-----------------
                                                                  1995   --|------------------
                                                                  2000   |-------------------
```

```
QUESTION                             REASONS FOR RESULTS BELOW                                                    PROBABILITY OF OCCURRENCE                    REASONS FOR RESULTS ABOVE
                                     INTERQUARTILE RANGE                                                    0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                                                                           ACV
                                                                                             1985   |--------------
                                                                                             1990   ----------|---------------
                                                                                             1995            ----------------|---------
                                                                                             2000               --------------|------------
                                                                                           EACV
                                                                                             1985   |-------------
                                                                                             1990   -----|------------------
                                                                                             1995        ---------------|-----------
                                                                                             2000               -------------|-------------
                                                                                           B.R.-HD                                                             .Expect to be more popular for HDTV than VCR's.
                                                                                             1985   |--------------                                            .Best way to distribute motion picture product.
                                                                                             1990   -----|----------------
                                                                                             1995           ---------|-----------------
                                                                                             2000                ------------|--------------
====================================================================================================================================================================================================================================
New Format Cons. Video Cameras       .Japan is the driving force, products possibly        NTSC
                                      available for both bandwidth reduced HDTV and en-      1985   |-------------
                                      hanced analogue component system in 1990/95 time       1990   |-------------
                                      frame.                                                 1995   |--------------
                                                                                             2000   |---------------
                                                                                           ACV                                                                 .Expect to come out at the same time as VTR's.
                                                                                             1985   |--------------
                                                                                             1990   -----|------------------
                                                                                             1995        ----------|---------------
                                                                                             2000              --------------|------------
                                     .By the year 2000 HDTV will dominate.                 EACV
                                     .Enhanced Mac is probably the only viable product.      1985   |------------
                                                                                             1990   -----|--------------
                                                                                             1995     ---|-----------------------
                                                                                             2000         -----|--------------------
                                                                                           B.R.-HD                                                             .More technical problems for cameras than cassettes.
                                                                                             1985   |------------                                              .Follows current camera pattern.
                                                                                             1990   ---|----------------
                                                                                             1995       ------|------------------
                                                                                             2000             -------|-------------------
====================================================================================================================================================================================================================================
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                            0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

4.2 DISPLAY DEVICES
4.2.1a CRT's - 40" Diagonal         .CRT's, if they are to fit through the doorways,        1985   ▮---------------                                           .CRT's with 30 inch diagonal will be available in 1985 with
                                     cannot achieve this size.                              1990    ---------▮---------------                                  diagonal increased by 2 inches a year.
                                    .Direct CRT's systems likely to be displaced.           1995             ----------▮---------------                       .In prototype now/full production by 1990
                                                                                            2000               ---▮----------------------

4.2.1b CRT's - 5/3 Aspect Ratio     .True HDTV will be too expensive to do with projection  1985   ▮---------------                                           .Introduced simultaneously with enhanced AC transmission on
                                     devices.                                               1990      -------▮-------------                                    BBS or tape.
                                    .Expect 5/3 HDTV push within Japan but rest of world    1995                  ----------▮---------------                  .Japan and Europe already demonstrating feasibilty.
                                     would follow slowly.                                   2000                         ------------------▮-------           .In prototype now.
===================================================================================================================================================================================================================================
4.2.2 PROJECTION DISPLAYS
4.2.2a New Generation Displays      .The market is too small to drive large research        1985   ▮-------------------
                                     in developing a really new system.                     1990         ---------▮----------------
                                    .The technology just cries for improvement.             1995                     ------------▮-------------
                                    .To get the same light output will really be very       2000                           ----------------------▮----
                                     difficult and may be physically impossible.
                                    .The desire for improved picture quality by the
                                     public will be generated when large screen (1m)
                                     displays are available for the home. Projection
                                     TV's not the answer. The catalyst will be the
                                     large screen solid state type display device. (525
                                     Mac will not be good enough for these services)
===================================================================================================================================================================================================================================
4.2.2b Proj. Disp. - HDTV Quality   .Lack of a breakthrough in this respect may remove      1985   ▮---------------                                           .Only technology in view for larger size HDTV at just
                                     need for 5/3 a/r and also affect form of signal        1990   -----▮-------------------                                   acceptable cost.
                                     used for distribution.                                 1995              ---------▮----------------                      .Technology exists if someone wants to make the investment
                                                                                            2000                         -------------------▮-------           in manufacturing.
                                                                                                                                                              .Projection type disptay will never give brightness and
                                                                                                                                                               contrast ratio equal to kinescope tube
                                                                                                                                                              .Enhanced projection more cost effective than CRT.
===================================================================================================================================================================================================================================
```

```
QUESTION                             REASONS FOR RESULTS BELOW                                                      PROBABILITY OF OCCURRENCE                    REASONS FOR RESULTS ABOVE
                                     INTERQUARTILE RANGE                                             0    10   20   30   40   50   60   70   80   90   100       INTERQUARTILE RANGE

4.2.3 FLAT PANEL DISPLAYS
4.2.3a F.P.D. - crt-based            .Technology probably obsolete.                          1990    -----*----------------                                      .Convergence problems could occur at the beginning, however
                                                                                             1995     ----------*----------------                                 expect viability by 1995.
                                                                                             2000            ------------*-------------                          .The market for either CRT or solid state displays would
                                                                                                                                                                  be excellent given HDTV programs - Convinced on meter
                                                                                                                                                                  and larger screen is the key for HDTV success.
======================================================================================================================================================================================================================================
4.2.3b F.P.D. - LCD-based            .More work necessary, quantum leap from watch           1990    -----*----------------                                      .Expect to be available in small sizes.
                                      technology                                             1995        ---------*----------------                              .LCD-based flat panel with several inches has already
                                     .Will not achieve quality of CRT.                       2000                -------------*------------                       been available.
======================================================================================================================================================================================================================================
4.2.3c F.P.D. - gas plasma           .Too new to tell.                                       1990    --*-------------                                            .When question of color, grey scale and manufacturing get
                                     .Will not achieve brightness of CRT.                    1995    -----*-------------------                                    resolved - best for lounge size
                                                                                             2000            ------------*-------------                          .Medium sized screen.
======================================================================================================================================================================================================================================
4.2.3d F.P.D. other                                                                          1990    *-----------------                                          .Very large screen
                                                                                             1995      ---*----------------------                                .Solid state driven light valve image source, possibly
                                                                                             2000            -------*------------------                           using flat panel format using fibre optics.
                                                                                                                                                                 .Progress in integrated optoelectronic circuits will
                                                                                                                                                                  likely provide a low cost flat panel.
======================================================================================================================================================================================================================================
5.0 OTHER APPLICATIONS
5.1 DELIVERY
5.1a More Than One Service                                                                 Japan
                                     .PLEASE EXPLAIN IF YOUR ANSWER FALLS BELOW RANGE.       1990               --------------*-----------                       .PLEASE EXPLAIN IF YOUR ANSWER FALLS ABOVE RANGE.
                                                                                             1995                            ---------------*-----------
                                                                                             2000                                    -------------------*
                                                                                           Europe
                                                                                             1990       *----------------------
                                                                                             1995                 ------------*-------------
                                                                                             2000                              ---------------*----------
                                                                                           U.S.
                                                                                             1990       --------*------------------
                                                                                             1995                      ------------*-------------
                                                                                             2000                                  --------------------*
```

```
QUESTION                           REASONS FOR RESULTS BELOW                                                    PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                   INTERQUARTILE RANGE                                  0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

                                                                                         Canada
                                                                                           1990   ▮----------------------
                                                                                           1995              --------------▮-----------
                                                                                           2000                        --------------▮-----------
=================================================================================================================================================================================================================================
5.1b More Than Two Services                                                              Japan
                                                                                           1990     --------▮-----------------
                                                                                           1995                ------------▮-------------
                                                                                           2000                           --------------------▮----
                                                                                         Europe
                                                                                           1990   -▮------------------
                                                                                           1995        -------▮------------------
                                                                                           2000                        ----------------▮---------
                                                                                         U.S.
                                                                                           1990   -----▮------------------
                                                                                           1995                --------------▮-----------
                                                                                           2000                           ------------------▮------
                                                                                         Canada
                                                                                           1990   ▮---------------------
                                                                                           1995         ----▮---------------------
                                                                                           2000                   ---------▮----------------
=================================================================================================================================================================================================================================
5.1c Min Hours                                                                             1990   --▮--------------
                                                                                           1995   ------▮-------------
                                                                                           2000   ------▮-----------------
=================================================================================================================================================================================================================================
5.2 MOTION PICTURE PRODUCTION UTILIZATION
5.2a Widely Used                   .Expensive equipment even when rented.                  1990      ----------▮---------------                             .Expect a mix of technologies to be used in producing a
                                   .Insufficient quality except for resolution             1995                 -----------▮--------------                   feature film.
                                   .Conservatism in film industry.                         2000                          -----------------▮---------        .It seems virtually certain that there will be at least
                                   .Video assisted editing seems to mitigate one problem                                                                     some film making using HDTV by 1990.
                                    in film industry.                                                                                                       .HDTV already in motion picture production in the form of
                                   .HDTV cameras etc. are too expensive compared to                                                                          computer synthesized graphics.
                                    film cameras. For special effects you need at least
                                    twice the resolution of HDTV.
                                   .35mm film about equal to HDTV in resolution.
=================================================================================================================================================================================================================================
```

```
QUESTION                      REASONS FOR RESULTS BELOW                                     PROBABILITY OF OCCURRENCE                            REASONS FOR RESULTS ABOVE
                              INTERQUARTILE RANGE                                   0    10   20   30   40   50   60   70   80   90   100    INTERQUARTILE RANGE

5.2b HDTV For Over 15% Of Feature                                           1990     ---------#----------------
     Films                                                                  1995                   ----------#--------------
                                                                            2000                             ---------------------#---
=================================================================================================================================================================================================
5.3 THEATRICAL DISTRIBUTION / DISPLAY VIA SATELLITE
5.3.1 HDTV Projectors                                                       1990             ----------------#--------                           .Available today.
                                                                            1995                        ---------------------#----
                                                                            2000                             ------------------------#
=================================================================================================================================================================================================
5.3.2 Theatrical Distribution .Satellite distributors not expected to be attractive Japan                                                        .Will be driven by anti-piracy advantages.
                               because of the investment and cost of equipment      1990    ---#--------------------                             .These will be new electronic movie theatres.
                               required.                                            1995          ----#--------------------
                              .Direct viewing wide screen seems to give a better    2000                   ----------#--------------
                               solution.                                            Europe
                              .Theatrical films no, but live events yes.            1990    --#---------------------
                              .Inferior to transporting film.                       1995         -----#--------------------
                              .Enormous bandwidth (20-30 MHz) required for HDTV     2000                    ---------#---------------
                               transmission.                                        U.S.
                              .Video discs a much better candidate.                 1990    -----#----------------
                              .Satellites, not an efficient medium for HDTV in      1995            ---------#----------------
                               un-compressed form                                   2000                     ---------#---------------
                              .No flexibility of screening times with direct        Canada
                               satellite without recorder.                          1990    #---------------------
                                                                                    1995         -----#--------------------
                                                                                    2000                ---------#-----------------
=================================================================================================================================================================================================
5.3.3 STORAGE FOR THEATRICAL NEEDS
5.3.3a VTR's                  .Only if HDTV VTR's are first developed for other     1990       ----#---------------                              .Exist today
                               applications.                                        1995               --------------#------------               .There is a need for HDTV video recorder, not only for
                              .Not likely - video disc look like a much more cost   2000                   ---------#----------------             storage but for editing.
                               effective distribution medium.
                              .Storage initially with VTR's, then optical disc
                               will take over.
                              .Doubt films would be distributed via satellites.
=================================================================================================================================================================================================
5.3.3b Optical Disc Players   .No movement toward HDTV quality in sight.            1990    -----#-------------                                  .Expect central means of disc replication with conventional
                              .10 to 20 minute film do seem to be an attractive     1995          --------#----------------                       distribution means.
                               alternative to film.                                 2000                   ----------#---------------
```

```
QUESTION                            REASONS FOR RESULTS BELOW                                                     PROBABILITY OF OCCURRENCE                   REASONS FOR RESULTS ABOVE
                                    INTERQUARTILE RANGE                                                 0    10   20   30   40   50   60   70   80   90   100      INTERQUARTILE RANGE

=====================================================================================================================================================================================================================================
5.3.3c Bptical Disc Recorders       .Technology has a long way to go.                       1990   |-----------------                                         .There will be record/play/erase on same disc.
                                                                                            1995   -----|------------------
                                                                                            2000          ------|-------------------
=====================================================================================================================================================================================================================================
5.4 DISTRIBUTION TO MINI THEATRES
5.4a Special Programming            .Nobody is going to install special receivers for     Japan                                                               .Sports specials.
                                     a couple of hours programming a day.                   1990           -------|------------------                         .Service could be received but not expected to be produced
                                    .Cannot see a reason.                                   1995                  ---------------|----------                  in Canada.
                                    .Unlikely - only sports could create market - will      2000                          ------------------|--------         .Such a programming service cannot be totally "live" and
                                     be grabbed by mass distributors.                     Europe                                                              therefore will require both events and features to fill
                                                                                            1990    ------|-------------------                                schedule.
                                                                                            1995            ----|---------------------
                                                                                            2000                   ------------|-------------
                                                                                          U.S.
                                                                                            1990         ---------|---------------
                                                                                            1995                   ---------------|-----------
                                                                                            2000                            --------------------|------
                                                                                          Canada
                                                                                            1990     ------|--------------------
                                                                                            1995                ---------------------|--------
                                                                                            2000                       -----------------|--------
=====================================================================================================================================================================================================================================
5.4b Feature Films                  .New feature films could create market. Would         Japan
                                     probably earn more money selling to cable/DBS          1990          ---|----------------------
                                     subscribers.                                           1995                 --------------|------------
                                                                                            2000                        -----------------|---------
                                                                                          Europe
                                                                                            1990   -----|--------------------
                                                                                            1995           -----|---------------------
                                                                                            2000                ---------|-----------------
                                                                                          U.S.
                                                                                            1990      ------|--------------------
                                                                                            1995               ----------------|----------
                                                                                            2000                      ----------------|----------
```

QUESTION

REASONS FOR RESULTS BELOW INTERQUARTILE RANGE

REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE

```
                  PROBABILITY OF OCCURRENCE
         0    10   20   30   40   50   60   70   80   90   100
Canada
  1990      ------#------------------
  1995                ------------- #-------------
  2000                     ------------------#-------
```

5.5 SPECIAL EVENTS CLOSED CIRCUIT

5.5a Movie Theatres

Reasons for results below interquartile range:

- .All live events sufficiently interesting to create a market, would be mass distributed.
- .Unlikely to justify a permanent investment in a complete HDTV chain. Conventional TV systems will be sufficient for this type of service most of the time.
- .In Japan, NHK will dominate for a while over commercial networks. Closed circuit distribution might become popular because of high cost of tickets for live events.

```
Japan
  1990        ------#--------------------
  1995              ---------------#----------
  2000                      -------#------------------
Europe
  1990    ----#--------------------
  1995           ---#----------------------
  2000                   ---------------#----------
U.S.
  1990      ------#--------------
  1995              ---------------#-----------
  2000                     ---------------------#-----
Canada
  1990    ----#--------------------
  1995            -----#--------------------
  2000                 ----------#----------------
```

Reasons for results above interquartile range:

- .This type of HDTV service is by far the most attractive. This is also the most technically difficult.
- .Exists today in standard definiton.

5.5b Mini Theatres

Reasons for results below interquartile range:

- .Watching championship boxing etc. at a theatre died long ago, and HDTV won't bring it back - we're homebodies.

```
Japan
  1990           ---#----------------------
  1995               --------------#------------
  2000                       ----------------#----------
Europe
  1990   --------#----------------
  1995            --#-----------------------
  2000             ----------#----------------
U.S.
  1990       ------#--------------------
  1995               --------------#------------
  2000                       -------------------#---------
```

Reasons for results above interquartile range:

- .Very likely in mini theatres.

QUESTION | REASONS FOR RESULTS BELOW INTERQUARTILE RANGE | PROBABILITY OF OCCURRENCE | REASONS FOR RESULTS ABOVE INTERQUARTILE RANGE

```
                 PROBABILITY OF OCCURRENCE
        0    10   20   30   40   50   60   70   80   90   100
Canada
  1990  -----#--------------------
  1995           --------#----------------
  2000                 --------------#----------
```

==

5.6 INDUSTRIAL APPLICATIONS

.Systems, including cameras, VTR's and large projectors could well become rental business and sales, but then it is unlikely.

.In Japan, because of tendency to follow fads, more systems per capita might be sold than in other countries.

```
Japan
  1990            ----------#--------------
  1995                    -----------------#-------
  2000                            ----------------#-------
Europe
  1990       ----------#--------------
  1995                  -------------------#------
  2000                         -----------------------#--
U.S.
  1990          ---------------#----------
  1995                   ---------------------#----
  2000                          --------------------#----
Canada
  1990   ----#---------------------
  1995            ---------------#----------
  2000                  ---------------------#----
```

.Industrial and institutional applications will follow consumer introduction.

.Canada not likely to surpass 30 to 50 units per year.

Appendix C

Transmission Workshop Highlights

TRANSMISSION WORKSHOP HIGHLIGHTS
Ottawa - January 30, 1985

Present:
C. Darling, Nordicity Group Ltd.
E.J. Tarnai, BNR
L.C. Gooddy, Telecom Canada
P. Balodis, Larcan Communications Equipment Inc.
A. Vincent, DOC/CRC
P. Julien, DOC/Marketing Support
J. Carson, DOC/DTA
Yun-Foo Lum, DOC/DCN
T. Chislett, Rogers
M. Akgun, DOC/DCN
D. Weese, Telesat
E. Hara, DOC

Chairman: Gerald Chouinard, System Engineer, Space & Communications, CRC/DOC (613-239-3401)

Raporteur: Carol Darling, Senior Consultant, Nordicity Group Ltd. (613-236-5867)

DISCUSSION HIGHLIGHTS

In the transmission workshop individuals representing interests in the broadcasting, terrestrial transmission, satellite transmission and cable television industries participated. The workshop discussion focussed around the most likely development paths of higher definition television in Canada. Potential manufacturing opportunities were discussed with reference to network transmission systems (ie. studio to studio) and distribution transmission systems (ie. broadcast to consumer). Highlights of the discussion are outlined below.

Network Transmission Systems (studio to studio)

- It is expected that the trend towards digital production in studios will result in the need for improved studio to studio transmission quality.

- For inter-studio transmission on the terrestrial network, the trend will be towards more and more digital transmission (eliminating the need to convert to NTSC), thus a need for improved picture processing codecs.

- Currently, 45 Mb/s codecs can be obtained on a limited basis, however, the need for 140 Mb/s codecs will develop. This appears to be an area in which Canada has a significant knowledge base and could be a good niche market for a small manufacturer to get into. Standards for codecs have not yet been determined (CCIR is addressing through an ongoing study program) therefore any standard would have to be forced.

- For studio to studio transmission via satellite the tendancy will most likely be towards adopting a form of Multiple Analogue Component (MAC) transmission where associated products are expected to be available in the near future.

Distribution Transmission Systems (broadcast to consumer)

- Discussions on the most likely distribution method from the studio to the consumer focussed on the implications to the cable industry.

- Recent emphasis in cable systems has been on achieving greater system capacity. Before higher definition can be contemplated, improvements within the existing system are required. In addition to increased attention to maintenance and improvement programs, a requirement for products providing ghost cancellation, electronic noise reduction and elimination of other impairments will develop. Possibilities for development of these types of products could be addressed in Canada.

- The most attractive system reviewed by Cablesystems Engineering to date for cable delivery of higher definition television is the Philips two channel system. This system provides a channel compatible with existing receivers and a supplementary channel containing additional lines as well as additional information to increase the aspect ratio.

- Although in the near term, cable distribution of higher definition to the home is unlikely, applications for cable delivery of higher definition television for industrial, institutional and other entertainment service purposes (eg. the mini-theatre market) might develop. Decoders for delivery of higher definition signals via cable have not yet been developed, thus might be a suitable product for Canadian manufacturers to look into.

- Diverse opinions on when fibre optics to the home might be in place were expressed. It was recognized that in Canada the introduction of fibre to the home faces several regulatory hurdles. However, it is expected that other countries will move into fibre optics before Canada offering potential product export opportunities. As Canada has considerable expertise in the field of fibre optics technology, an opportunity to develop specialized products might be pursued. Presently CRC holds two patents on opto-electronic switching products which are available to interested manufacturers.

Canadian Broadcasting Corporation
Société Radio-Canada

REPORT ON THE DISPLAY DEVICES

WORKSHOP - JANUARY 30, 1985

Present: D. McCart , SB Capital Corp. Ltd.
K. Davies , CBC, Engineering Headquarters
M. Evans , Gigatek
J. Koenig , Interactive Image Technologies
S. Lyman , CBC, Engineering Headquarters
B. Patterson, DOC
A. Powell , McGill University
J. Storey , DOC/CRC
F. Symons , DOC
M. Edmunds , University of Toronto, Instructional Comm.
W. Vivian , Kalba Bowen Assoc.

POINTS RAISED

There is a market for a very high resolution graphic display. Users first tried broadcast type monitors, but were frustrated. The lessons learned in building a graphic display can be applied to a new generation of broadcast displays.

The new broadcast display will be a multi-scan rate (up to 80 kHz) multiple decoder device.

HDTV requires the wide (about 5:3) aspect ratio. The wider (and usually larger) screen requires higher resolution. Therefore, increasing the resolution without increasing the aspect ratio brings very little benefit.

Projectors

Projectors are expensive now and lack the quality required to produce an acceptable "small theatre" size image. The theatre market package would have to include the projector and delivery system. Signals could be delivered by satellite, cable or in recorded form.

.../2

Telesat has plans to exploit this market, but is afraid that the telephone companies may get there first with optical fibers. Optical disk players would be the only playback system cheap enough to make replacement of existing 35 mm film projectors worthwhile. The main benefit of the theatre/lounge market is that the volume will bring the projector costs down enough to make domestic projection systems affordable. Laser light sources for projectors show some promise although they are expensive. An Ottawa firm (Lumonics?) has some experience building projectors.

There is also a new requirement in universities for a projector that can be used for displaying computer information to groups of 30 to 50 students. The projector should have sufficient resolution (probably 700 to 1000 pixels), color and about twice the light output of current projectors. They should also accept the output from the various personal computers that will be used to drive them.

CRT Displays

CRT's are currently the most cost-effective display devices. They are also the most costly component in a complete display. The Japanese manufacturers have a virtual monopoly on the 5:3 format tubes and on the larger 4:3 format tubes. There is a market for a very high resolution graphic display for computer-generated data. This grew from dissatisfaction with broadcast monitors (previously the best device available). The developments made for the graphic display will be reapplied to broadcast monitors, improving their performance.

A new generation of broadcast monitors should (i) handle multiple scanning standards; (ii) accept several composite and component signal coding schemes as well as having the proper aspect ratio, colorimetry etc.

The broadcast monitors will have to be available within 5 years and the design should be flexible enough to have a 15 to 20 years useful life span. There is a market for about 4,000 monitors/year for 10 years.

.../3

Interactive displays combine a touch-screen display with whatever other knobs, buttons etc are necessary for the operator to interact with the information presented. These systems also have all the hardware and software necessary to combine video signals from disk players etc with computer-generated information. This can include rather a lot of hardware.

Joe Koenig made the point that interactive displays were the "seed device" for a brand new "interactive entertainment" industry, as well as the computer aided instruction industry.

The last topic was a summary of the various markets for display devices.

- Projectors theatre, industrial, educational and domestic.
- Domestic receivers in normal and wide-screen (about 5:3) format with "smart" signal processing capabilities.
- Computer Graphic Displays: these have to be able to accept the variety of scanning standards generated by the various computers in use.
- The new broadcast quality monitor as mentioned above.
- Integrated displays that accept and combine both video and computer-generated information etc.
- The projector market is expanding rapidly, with new manufacturers entering the field.
- The general feeling was that the lack of HDTV and EDTV standards is fragmenting development efforts. Any means possible of deciding on a standard should be pursued.

Steve Lyman

Steve Lyman

85.02.15

Studio System Workshop Minutes
Nordicity Study - Ottawa - January 30, 1985

Present:
R. Bradley, CDL Montreal
J. Bastion, CDL Montreal
G. Hurtubise, CBC
F. Fox, CBC
R. Lehtonen, Leitch Video, Toronto
A. Reeve, CJOH, Ottawa
T. Walker, CRC, Ottawa
O. Skrydstrup, Ross Video
A. Vanags, Image Video, Toronto
A. Makarewicz, Image Video, Toronto
B. Prasada, BNR
T. Nagara, BCTV, Vancouver

Chairman: B. Baldry, CBC

- The chairman outlined the result of the workshop should produce the following:
  - identify what Canadian industry can produce
  - identify what is required to produce it
  - outline time-frame for these developments
  - develop specific answers for Nordicity consideration

- The chairman started by expressing the view that the traditional Canadian share of the marketplace is being erroded.

- A manufacturer indicated there was a need to develop new digital products and have R & D underway which would result in near term new products. The need was expressed to develop a new generation of products but costs were considerable. Canadian sales amounted to 15% of products produced, rest to U.S. and international.

- The question was asked if the rate of new product development in Canada was as high as the rest of the world. Yes in some areas, no in others due to lack of capital and manpower resources. Typical 11% of revenue is invested in research.

- The view was expressed that there were no representatives present to speak for the audio industry. It was felt that audio must not be forgotten in the development of a new HDTV system.

- The question was asked, what government assistance had been used in the past by manufacturers for new product development. Two manufacturers related bad experiences in dealing with government i.e. "too slow", "wanted to freeze my personal investment in the Co". One manufacturer indicated a positive experience.

- The subject of standards was raised in relation to planning new products. It was stated by several manufacturer that the CBC should play a larger role in defining future standards for manufacturers. A typical manufacturer does not have the time or resources to attend all conferences and standards committee meetings. The CBC should be funded to provide this service to make manufacturers aware on a regular basis, what is happening in this regard. It was stated that sometimes standards lag behind a products acceptance in the marketplace. If it fills a need it will be purchased, regardless of standards. It was felt that for HDTV particularly, standards were important. Manufacturers are unwilling to invest time and money for long-term development if they face the risk their product may not be marketable because of a change of standards after development.

- It was stated that small companies tend to spend R & D on products they know they can sell 2-3 years into the future. Long-term product development (7-10 years) was too risky and costly for small companies, only large companies have the resources for this kind of development. One manufacturer felt that he spent 99% of R & D funds on development and 1% on research. The pay-off is much faster and secure. The opinion was expressed that the CBC should be funded to undertake long-term research. The CBC has the radio and television system knowledge and could influence standards.

- The question was asked, should an organization be established to develop and fund R & D for future TV requirements? Some suggestions were:

    - Fund the CBC to undertake this
    - Government funding to universities
    - Government funding to certain manufacturers
    - Contributions by all manufacturers plus government to form a pool of R & D funds to be administered by the CBC or a new Corporation or a university.

  It was felt that perhaps the Nordicity Study presently underway could recommend this.

- Manpower availability was a concern. It is available but difficult to find.

- The use of Canada's expertise in LS1 technology for manufacturers was suggested. Presently some canadian manufacturers use U.S. firms.

Some Conclusions:

1) Near term (up to 2 years) industry is willing to (where possible) fund its R & D since return on investment is foreseen.

2) Mid to long term investment (5-7 years) industry felt they could not invest in R & D due to uncetainty about return on investment and the inability to project sales of products and in some cases lack of standards.

3) CBC was recommended as being the most likely agency to fund R & D for future products and identify which future products would be required.

4) CBC could task universities/research organizations/companies to undertake basic R & D with results available to all manufacturers.

5) Industry should become more visible and vocal to make their needs and contribution to the economy known.

FF

Fred Fox

FF:vol
January 31, 1985

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