POTENTIAL

FOR INTERNATIONAL COOPERATION

IN

INFORMATION TECHNOLOGY R & D

IN

JAPAN

A Report to the
Department of External Affairs
Government of Canada
and to
Participating Companies

by

A. Kwan & G. Dobbin
Broadcast & Technologies R & D
Communications Research Centre
Department of Communications
Ottawa, Ontario, Canada

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FOREWORD

INTERNATIONAL COOPERATION IN INFORMATION TECHNOLOGY R&D

A Department of Communications (DOC) project

The Project

This project seeks to identify opportunities for international cooperation in precompetitive R&D in Information Technology and help Canadian industry initiate and develop such cooperation. It specifically seeks to:

1) collect information on current R&D activities in Japan in areas of priority to Canadian industry;

2) identify potential partners in specific areas identified as promising for cooperation in IT R&D; and

3) facilitate initial contacts and follow-up activities between interested Canadian and Japanese companies.

The project is an initiative of the Department of Communications in support of the Technology Inflow Program (TIP) of External Affairs. It seeks to enhance Canadian research capabilities in Information Technology by identifying and promoting longer term, mutually beneficial collaborative R&D activities in Information Technology (IT) with Japan, which has made significant progress in IT and whose industry or government laboratories are committed to programs of IT R&D as a means of establishing, maintaining and advancing market position in the fast growing field of IT. R&D activities considered most amenable to cooperative effort would be those focussing on specific problem areas, the resolution of which would enable application and commercialization of benefit to all the participants. Such R&D is generally of a longer term nature, in effect, the early stages of investigation, development and trial of highly promising areas that will lead to profitable market applications. This early stage of R&D may be thought of as being precompetitive and an excellent one in which to begin building strong professional and personal working relationships.

The Report

This Report represents the results of a survey of R&D activities in Japan. The Report may be regarded as a compendium of the many advanced information technology research projects being carried out in Japanese companies of all sizes from small to large. The Report can be a valuable source of initial information leading to possible mutual transfer between Canadian and Japanese companies of complementary technologies. All relevant contact personnel and addresses are given.

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EXECUTIVE SUMMARY

Information Technology (IT) comprises the techniques, tools and procedures for acquiring, creating (or composing), extracting, storing (or filing), retrieving, conveying and presenting information for ready assimilation, understanding and utilization. Thus, it affects most, if not all, aspects of business and personal communication.

Increasingly, the technology is becoming more electronic as advances in computing and telecommunications technologies continue to be made at an unprecedented rate. Thus, microelectronics, a high growth area on the materials side of Information Technology, continues to integrate more and more complex electronic circuitry into tiny semiconductor packages, both lowering cost and increasing affordability of products and services. Moreover, Artificial Intelligence (AI), an emerging area of Information Technology, is leading the way toward computational machines which will perceive, learn, understand, plan, decide and act within limited contexts of specific environments, situations and scenarios to achieve limited objectives. As time progresses, these limits will widen and allow greater potential, versatility and autonomy for machine assistance and automation.

The application of Information Technology to the office and manufacturing sectors alone can greatly facilitate access, processing and utilization of data and thus favorably impact product or service design, production and delivery, quality and price, and ultimately competitiveness and market acceptance.

This document reports the findings of a survey undertaken in Japan in September-October '87 to assess the potential for Canada-Japan private sector cooperation in Information Technology R&D.

The survey focussed on 14 private company laboratories and one government-industry agency in Japan which are carrying out advanced Information Technology R&D. The R&D activities are reported in Appendix A which, in effect, provides a database as to what organization visited in Japan is conducting what R&D to what purpose.

Japan has a wide range of IT R&D activities under way in both the public and private sectors. Already leading in productivity, innovation, quality and marketing, Japan has given priority to R&D to ensure that its current position of leadership in world markets will not only be maintained but expanded.

At present, Japan appears to be in step with the USA in advanced research and application in most areas of Information Technology including Artificial Intelligence. In active display device and large semiconductor memory technology, Japan may even be ahead. Given its knack for fashioning clear and realistic market and economic objectives, its ability to mobilize its resources effectively, and its determination to follow through, Japan will be in the forefront of even the most advanced Information Technology within 5 years.

The most significant findings from the survey was that virtually all the Japanese companies interviewed were quite receptive to the prospect of cooperative R&D in Information Technology with foreign companies, especially those of the USA and Canada, and that they are looking forward to meeting with interested Canadian companies to discuss opportunities and procedures for pursuing common or complementary interests and objectives.

One can only conclude that we have here an historic ambience and opportunity for Canadian companies and organizations to seize the initiative, formulate and propose mutually beneficial projects to prospective Japanese partners, and build strong linkages of trust, effective working relationships, and bridges to new markets.

Communications Canada is prepared to assist in this process.

ACKNOWLEDGEMENTS

The authors wish to thank those responsible for the Technology Inflow Program (TIP) of External Affairs for their continued faith and support of the project, in particular, the manager of TIP, Mr. Brian Cox, and the members of the TIP Steering Committee. Additional thanks are due to the manager of external relations with Japan, Mr. Carl Kuhnke, for his advice and support throughout the project. Special thanks are due to Mr. Peter Eggleton, the Science Counsellor in charge of the Science and Technology (S&T) office of the Canadian Embassy in Tokyo, Japan, and his most able assistants, Dr. Seiichi Tanaka and Miss Noriko Abe, all of whom helped to make the survey a success.

Despite short notice, Abe-san, the Visits and Information Coordinator (S&T office), managed to set up a very full itinerary of visits to 14 Japanese companies, an important industry government agency, and the Ministry of Posts and Telecommunications, and in addition provided detailed instructions and assistance that greatly facilitated our prompt arrival at our many destinations throughout the greater Tokyo and Osaka areas. Tanaka-san, who has a doctorate in physics from the University of Toronto, provided very valuable technical interpretation especially in the areas of materials technology and superconductivity which involve extensive physics and chemistry.

Finally, the authors wish to thank their own management for their support throughout the project, notably, Dr. Bill Sawchuk, Director-General of Broadcast Technology Research, Dr. Yun-Foo Lum, Director of Systems and Networks Research, Mr. Bill McCrum, Director of Systems Interconnection Research, Mr. Peter Booth of Wescom Communications Research International Inc. and, of course, the many others throughout Communications Canada and the private sector in Japan and Canada who generously provided invaluable information, assistance and advice to the project.

1. INTRODUCTION

1.1 Background

As a result of intensive research and refinement at ever increasing levels of complexity in the equipment, systems, and techniques used in manufacturing, Japan now leads in the realization and utilization of a vast array of quality products and systems tailored to and competitive in markets worldwide. Underpinning this position is the manufacturing technology that Japanese industry now has.

The driving force behind Japan's momentum in manufacturing is an inherent and intense desire to master and apply any new technology. The current targets of this driving force are developments which will stabilize and rationalize the seeming disarray of the software technology and which will equip machines with computational capabilities comparable to man's ability to perceive, learn, understand, plan, decide, and act in a given environment, situation, or scenario. Major participation in the former by the large computer multinationals implies possible de facto standards and considerable impact in the not-too-distant future for all software developers worldwide. The implications of computationally intelligent capabilities in office work and manufacturing are many and their deployment will have significant impact on utility, quality, productivity, and competitiveness. No business or industry sector will escape this impact.

Japan has therefore undertaken a wide range of Information Technology (IT) R&D activities in both the public and private sectors. Industry-government shared-cost projects like the Fifth Generation Computer System (FGCS) project and the Sigma Project provide national focus, planning and seed funding around which to rally and work toward economic and national goals.

This document reports the findings of a survey undertaken by the Communications Research Centre (CRC) of Communications Canada between September 1987 and October 1987 to assess the potential for Canada-Japan private sector cooperation in Information Technology R&D.

1.2 Survey Objectives

The survey's primary objectives were to conduct the broadest possible review of IT R&D activities in Japanese companies in the short time available and to establish from this information on IT R&D database as to what companies in Japan are doing what R&D in Information Technology and which of these might be willing prospects for cooperative undertakings in IT R&D.

Ultimately, the survey aims to:

1) establish a database on current IT R&D activities in Japan;

2) identify prospects for mutually beneficial cooperative undertakings for Canada;

3) observe Japan's perceptions of trends in IT and priorities for IT R&D; and

4) comment on the relevance to Canada of current IT R&D activities in Japan.

1.3 Scope of Report

This report covers the onsite visits by the authors to the Ministry of Posts and Telecommunications (MPT), the Information Technology Promotion Agency (IPA), and 14 private-sector Japanese companies.

Chapter 2 defines Information Technology and discusses its applicability to business, industry and the home. Chapter 3 summarizes the role of government in Japan relative to the survey. Chapter 4 draws conclusions and makes recommendations.

Appendix A details the information obtained during each individual onsite visit. Appendix B identifies additional prospective Japanese companies which should be considered in any future onsite survey. Appendix C lists IT R&D topics deemed relevent by Canadian Industry as a result of a survey within Canada and which formed the basis of discussions with those visited. Appendix D gives a brief overview of abbreviations used.

2. INFORMATION TECHNOLOGY (IT)

2.1 Definition of IT

Information Technology (IT) affects most, if not all, aspects of business and personal communications. It is a broad field which touches virtually all human activity. It concerns the techniques and tools for handling information. Information, acquired by the senses, processed by the mind, and retained in memory, can be represented, conveyed, and presented to other humans. Information can also be processed to create new information or imbedded in processes and materials to create goods and services for human use. These natural processes may also be accomplished, enhanced or assisted using artifices such as transducers (acquisition and presentation), computers (retention and processing), and various media technologies (conveyance). Accordingly, information technology may be defined as follows.

Information Technology (IT) comprises the techniques, tools and procedures for acquiring, creating (composing), extracting, storing (filing), retrieving, conveying or presenting information ultimately for human assimilation, understanding and utilization.

While Information Technology would cover all information media whether tactile, aural, or visual, most current interest emphasizes the visual because of relevant progress in electronic microcomputer technology. Historically, visual media have been dominated by paper for both processing and conveyance as well as for input-output and storage. Paper is still the dominant input-output and storage medium for origination, presentation and retention despite some progressive displacement by the increasingly ubiquitous CRT or television display. However, the use of paper for processing and conveyance is diminishing rapidly in favor of electronic media.

Increasingly, the technology is becoming more electronic as advances in computing and telecommunications technologies continue to be made at an unprecedented rate. Thus, micro-electronics, a high growth area on the materials side of Information Technology, continues to integrate more and more complex electronic circuitry into tiny semiconductor packages, both lowering cost and increasing affordability of products and services. Moreover, Artificial Intelligence (AI), an emerging area of Information Technology, is leading the way toward computational machines which will perceive, learn, understand, plan, decide and act within limited contexts of specific environments, situations and scenarios to achieve limited objectives. As time progresses, these limits will widen and allow greater potential, versatility and autonomy for machine assistance and automation.

It is not surprising that Information Technology (IT), of which communications is a major part, is a recognized instrument of social and economic change shaping directions and levels of business and employment well into the future.

2.2 Precompetitive IT R&D

A stage in applied R&D critical to success yet amenable to cooperation is the precompetitive stage where scientists exchange ideas, approaches and experiences. This is a transitional stage where specific applications are contemplated, technological approaches evaluated and trade-offs explored. Here, new products and business relationships are forged. Here, international cooperation can be significant.

2.3 IT R&D Survey Topics

The IT R&D topics to be emphasized were established in consultation with a representative cross-section of the Canadian IT industry through seminars and questionnaires. These topics were used for the ITRD database.

Analysis of the database topics led to a more refined list of R&D topics for survey use. Appendix C includes both lists of topics and a cross-reference between them.

3. JAPANESE INDUSTRY

3.1 Role of Government

The Ministry of Posts and Telecommunications (MPT) has the responsibility to develop, implement and administrate electronic communications policy and to provide for three postal services: postal delivery, postal savings and life insurance.

MPT has three bureaus, each responsible for specific aspects of telecommunications:

Telecommunications Policy Bureau

- regulations
- international relations
- CCITT/CCIR relations

Telecommunications Bureau

- regulation of radio operators, allocations/approvals

Broadcasting Bureau

- management of radio frequency of broadcasters
- development of new media technology

Basic policy for electronics R&D is set by the Telecommunications Policy Bureau as is that related to international cooperation in R&D.

A major policy of MPT is to encourage and coordinate the undertaking of R&D between government sectors and industries and international parties to mutual advantage.

MPT endorsed the role of DOC to carry out surveys in Japan to facilitate industries in exploring possibilities for cooperative IT R&D, especially at the precompetitie stage.

3.2 Companies Visited

The ITRD Japan survey focussed on the Kanto region, mainly metropolitan Tokyo-to and environs, and on the Kansai region, in and around Osaka, Nara and Kyoto. Altogether, the survey comprised 17 visits. These included the Ministry of Posts and Telecommunications (MPT), the Sigma System Project office of the Information Technology Promotion Agency, 14 companies and a return visit at the request of NEC. A list of the organizations visited is provided in Appendix A.

3.3 Other Prospective Companies

A list of other prospective Japanese companies to visit is provided in Appendix B.

3.4 Survey Discussions and Synopses

Survey discussions and synopses are provided for each company or organization visited along with contacts in Appendix A.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 General Findings

This report provides a small but significant view of a cross-section of Japan's current principal thrusts in R&D in Information Technology and a sense of their willingness to explore mutually beneficial cooperative opportunities in IT R&D with foreign partners such as Canadian companies.

Despite limited survey time, coordination difficulties and other related factors precluding a more extensive and exhaustive survey, considerable information on private sector IT R&D in progress in Japan was gathered as indicated in Appendix A.

From the discussions with the various Japanese companies and organizations, a number of general observations can be made.

First, the Ministry of Posts and Telecommunications (MPT) agreed to the purpose of the survey and were most supportive in facilitating access to Japanese companies and organizations. The MPT said they value Canadian-Japanese friendship and cooperation highly and wish to continue the long history of exchange between the two countries in science and technology. Finally, the MPT endorsed the role of DOC to carry out such surveys and facilitate companies in exploring opportunities for cooperative IT R&D especially at the precompetitive stage where scientific and research technological development linkages may be less encumbered by the competitive forces of products and services formulation, development and marketing. This stage allows the opportunity to create a climate of respect and trust, develop sound working relationships stage allow freer exchange and a chance to formulate both the common and individual objectives. It affords the opportunity to develop sound working relationships, and more importantly, it helps to nurture mutual respect and trust both as professionals and as friends.

Second, the working environment for non-Japanese speaking persons is manageable for Canadian researchers. Most of the R&D laboratories and key management persons speak excellent English. Communication in the workplace is thus greatly simplified. Familiarity with some spoken language and a few written characters such as the phonetically-based kana characters and a few basic kanji characters while not absolutely necessary, would of course be helpful.

Third, the study and application of Information Technology in Japan, as in other countries, continues to gain momentum and exert powerful and pervasive influences on not just their own but also our entire way of living, inter alia: communications, computing, control, industrial production, employment, commercial and financial translation, trade, entertainment, and culture.

Behind this momentum is their recent and spectacular development of electronic technology in general, and microchip technology in particular. This successful development is due to a high level of innovation, motivation, and determination in R & D, all of which continue to contribute generously to the overall vitality, productivity, international competitiveness and wealthbuilding of Japanese goods and services.

Fourth, Japan is now rapidly increasing its emphasis on the development of software technology with at least the same degree of innovation, motivation and determination in R & D as shown in the development of their electronic microchip technology. Software is one area in which many Canadian companies and individuals excel and have established reputations. It may be in the best interests of some of these companies and individuals to consider potential cooperative undertakings in IT R&D.

Fifth, the Japanese are becoming increasingly aware of their global influence and impact, and hence of their growing global responsibilities. Pragmatic by nature, they are determined to enhance their technological advantage, or at the very least maintain it, and to do so through well-funded, well-supported domestic programs and efforts in IT R&D in both government and industry. Some companies are already supplementing this through technological cooperation in IT R&D with international partners. Others are interested.

4.2 International Cooperation and Exchange

With one possible notable exception, all 14 companies and one agency visited were receptive and open, and in some cases even eager to meet with Canadian companies and explore what they might do together in common and complementary aspects in applications of Information Technology. Intellectual contributions in conceiving and developing applications and their underlying technologies were suggested by most, but in a few instances, financial support of the common effort was suggested.

4.3 Cooperative R&D and Technology Transfer Opportunities

A company might, for example, provide expertise in teletext and videotex technology in return for expansion to kanji, kana and other character sets or for integration of image and sound technologies in an established brand of television. Specific opportunities for technology transfer can originate from either side. Dissemination of the detail survey results is expected to raise awareness and arouse interest and to permit each company to see where its best opportunities might be.

4.4 Recommendations

While the selection of specific companies for potential cooperation is simply a matter of diligent search and comparison, such selection is labor-intensive and time consuming. Computer assisted selection could facilitate the process but to be really effective would require more sophisticated techniques based on artificial intelligence. The development of such techniques is itself a proper topic of longer term research. Meanwhile, in the interest of time and efficiency, a simpler, speedier and more effective process is to disseminate the information to Canadian companies with a letter indicating what can and should be done to make contact and get the next step of dialog and negotiation underway.

APPENDICES

APPENDIX A

JAPANESE ORGANIZATIONS VISITED

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JAPANESE ORGANIZATIONS VISITED

This appendix outlines the itinerary of a ITRD Japan survey by the DOC team of Messrs. Kwan and Dobbin. The survey focussed on the Kanto region, mainly metropolitan Tokyo-to and environs, and on the Kansai region, in and around Osaka, Nara and Kyoto. Altogether, the survey comprised 17 visits. These included the Ministry of Posts and Telecommunications (MPT), the Sigma System Project Office of the Information Technology Promotion Agency, and a return visit at the request of NEC.

ITINERARY

KANTO REGION

Sep 28	Embassy - briefing	Minato-ku, Tokyo
	Ministry of Posts and Telecommunications	Chiyoda-ku, Tokyo
	Sigma System Project Office	Chiyoda-ku, Tokyo
Sep 29	NEC Corporation	Miyamae-ku, Kawasaki-shi, Kanagawa
	S&T Office - ITRD database installation	Minato-ku, Tokyo
Sep 30	Canon Inc.	Ohta-ku, Tokyo
	NTT	Yokosuka-shi, Kanagawa
Oct 01	Mitsubishi Electric Corporation	Ofuna-shi, Kamakura
Oct 02	Japan Radio Co., Ltd.	Mitaka-shi, Tokyo
	Ricoh Co., Ltd	Koho-ku, Yokahama-shi

KANSAI REGION

Oct 05	Sharp Corporation	Tenri-shi, Nara
	Omron Tateisi Electronics Co.	Nagaokakyo-shi, Kyoto
Oct 06	Matsushita Electric Industrial Co., Ltd.	Moriguchi-shi
	Sumitomo Electric Industries, Ltd.	Konohana-ku, Osaka

KANTO REGION

Oct 07	Fujitsu Ltd.	Nakahara-ku, Kawasaki-shi
Oct 08	Hitachi Ltd.	Kokubunji-shi, Tokyo
	Oki Electric Industries Ltd.	Hachioji-shi, Tokyo
Oct 09	Toshiba Corporation	Saiwai-ku, Kawasaki-shi
	NEC Corporation	Minato-ku, Tokyo

The following pages are an index to the organizations.

OVERVIEW OF IRTD

An overview of the IRTD project was presented to each organization visited as follows...

Working closely with External Affairs Canada, DOC created the ITRD project under External's Technology Inflow Project (TIP). The project seeks to facilitate the inflow of technology from Japan and Western Europe to Canada by seeking out and encouraging cooperative initiatives, agreements, and undertakings in IT R&D between companies. Its mandate was to obtain current information on R&D in Japan and Western Europe and to make this information available to Canadian government and industry so as to identify opportunities for mutually beneficial cooperation in R&D in Information Technology (IT) for Canadian industry. Since most Canadian firms are already well aware of US opportunities, the USA is not included at this time.

The project was introduced in Canada at two industry consultation meetings in January '87, one in Ottawa and one in Vancouver. Japan's Minister of Posts and Telecommunications was the guest speaker at the luncheon for the Ottawa session and where he spoke on the value and desirability of international cooperation.

Of 214 Canadian IT industries surveyed, favorable responses were received from 75 firms. Their responses to 12 categories and 35 topics provided necessary industry input to ensure topical relevancy and focus. These categories and topics were further refined into 12 high focussed topics on which to base the Japan and Western Europe surveys. They are listed in Appendix C.

The survey work was divided to maximize the utilization of limited resources. Accordingly, the Japan survey was undertaken by DOC directly and the Western Europe survey by a consultant under contract to DOC.

DOC/CRC wishes, and MPT has requested, that it be the focal point for contact and facilitation in the bridging function.

INDEX OF ORGANIZATIONS VISITED

CANADIAN EMBASSY SCIENCE and TECHNOLOGY OFFICE

ITRD JAPAN SURVEY BRIEFING

When dealing with the diversity and complexities of different countries, languages and cultures, it is recognized that the government network of Science and Technology (S&T) Counsellors and Technical Development Officers (TDO's) of External Affairs can help greatly to locate and make initial contacts, facilitate introductions, and assist follow-up.

Similarly, it is useful to note that, when dealing with the many diverse and complex emergent technologies of today, technology-based departments, like Communications Canada, can help identify and interpret the technologies involved, establish key contacts, and assist in follow-up.

The itinerary of the planned survey also included medium and small-size companies.

Coordination and interpretation was provided by Ms. Noriko Abe and Dr. Seiichi Tanaka. Dr. Tanaka, a graduate physicist of the University of Toronto, also assisted in interpreting scientific discussion using his broad knowledge of science and his facility in English and Japanese.

S&T Office - ITRD database installation

An early version of the ITRD database, Version 2.0, was installed at the S&T office in an IBM PC/AT-compatible personal computer workstation as a test. It proved fully operational.

Ministry of Posts and Telecommunications (MPT)

MPT has the responsibility to develop, implement and administrate electronic communications policy and to provide for three postal services: postal delivery, postal savings and life insurance. MPT is Japan's counterpart to Canada's DOC. MPT includes post office services while DOC does not. DOC includes culture while MPT does not.

In Canada, postal delivery is under Canada Post, a Crown corporation, while savings and life insurance is entirely in the private sector and education is a provincial responsibility. In Japan, culture and education are considered national functions and therefore under the Ministry of Education.

Contact:

Mr. Takio Yamamoto, Chief, First Planning Section
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Phone: +81 3 504-4940 Telex: J29100 Gentel J

Location of Visit:

Chiyoda-ku, Tokyo

Met with:

Akio Motai
Takio Yamamoto
Ryoichi Tsuchida

from the following areas....

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International Affairs Division

Takio Yamamoto, Chief, First Planning Section
Phone: 03 504-4799

Ryoichi Tsuchida, First Planning Section
Phone: 03 504-4794

MPT Discussion

MPT noted at the outset that bilateral relations with Canada are friendly and increasing in importance. In February and March '87, reciprocal visits held between the Ministers of MPT and DOC both in Canada and Japan yielded concrete results. Several items are now under consideration. The Canada/Japan Technology Exchange Seminar of September '87 and the S&T Consultations of September '87 addressed these items. MPT is pleased with the overall status.

MPT has the responsibility to develop, implement and administrate electronic communications policy and to provide for three postal services: postal delivery, postal savings and life insurance. To fulfill the first responsibility, MPT has three bureaus, each responsible for specific aspects of telecommunications:

Telecommunications Policy Bureau

- regulations
- international relations
- CCITT/CCIR relations

Telecommunications Bureau

- regulation of radio operators, allocations/approvals

Broadcasting Bureau

- management of radio frequency of broadcasters
- development of new media technology

Basic electronics R&D policy rests with the Telecommunications Policy Bureau as does that related to international cooperation in R&D. This is Mr. Motai's division.

Expressing appreciation for the DOC team's having come all the way from Canada to facilitate further cooperation between Canada and Japan, notably in the R&D aspect of information technology development, Mr. Motai said they value Canadian and Japanese cooperation and friendship highly and noted a long history of exchange between the two countries. They wish to continue such exchange.

In their September '87 discussions, Mr. Rob Gordon, Assistant Deputy Minister (Spectrum Management) and Mr. Ron Barrington, Director General, Radio Communications Research, of the Department of Communications (DOC), discussed information technology development and the R&D activities of the department. They noted the situation was changing rapidly in the field and hence for DOC as well. Mr. Ron Barrington referred to the present survey and noted that such surveys of government and industry groups result in greater knowledge of and increased potential for cooperation between Canada and Japan. Mr. Motai hoped that this cooperative relationship between the two countries would continue to increase for both in the years to come.

A major policy of MPT is to encourage and coordinate R&D between government sectors and industries and international parties to the mutual advantage of all concerned.

On behalf of MPT, Mr. Motai endorsed the role of DOC to carry out such surveys and subsequently to facilitate industries in exploring possibilities for cooperative IT R&D, especially at the precompetitive stage, and hoped the DOC survey team would have many opportunities to explore such possibilities during the 14 or so visits arranged with Japanese industries.

Mr. Motai noted the MPT blue book on policy reflects two issues:

- rapid change in electronics and telecommunications; and
- rising impact of foreign countries on telecommunications.

To address these issues, Japan's Key Technology Center (KTC) was established in Oct '85. Government owns a third and expects future dividends from it. Its key technology fund comprises $250M from loans and investments.

A typical investment is ATR which aims to develop intelligent use of unused rf wave spectrum. In '95, ATR funding increases to $1.1B (70% from KTC and the rest mainly from NTT). There are Canadian researchers working there! ATR is located in Osaka as is also the MPT Radio Research Lab noted for its remote sensing research.

Mr. Eggleton promised that, after the survey, feedback will be provided to MPT.

MPT noted that it might be possible for MPT also to facilitate any "getting together" should DOC identify a specific corporate item.

Information Technology Promotion Agency (IPA) - Sigma Project

The Information Technology Promotion Agency (IPA) oversees the Sigma Project whose principal aims are to improve the quality and productivity of software, to minimize duplicated effort at software development, to accumulate software knowhow, and to provide an enhanced software development and training facility. Specific approaches are to establish a standardized software development environment which is independent from hardware and in which to run programs and to establish a network system for the retrieval and dissemination of technical information for programming.

Contact:

Mr. Noboru Akima, Director of Planning Section

Location of Visit:

Chiyoda-ku, Tokyo

Met With:

Yasuo Uchida,

from the following area...

Development Planning Office

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Development Planning Office
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Phone: (03) 255-0421

IPA Discussion

Starting in 1986 and ending in 1990, this industry-government cooperative project is aimed at rationalizing and automating the production of software generation systems to the fullest extent possible.

The total investment and budget is 25 B yen (approximately 250M C$) with 50% from government and 50% from private companies (both contributions and investments). About 180 private companies are participating.

Major aims are: 1) to resolve the present software dilemma; and 2) to produce useful, more universal software, and hence achieve greater productivity.

To address the first aim, two areas are targetted:

a) software development support tools; and network systems
b) connecting databases, providers and users.

Software development support stresses software tools that are:

- application specific (such as: C-language for micro-computer, Forth for process control; Fortran for scientific uses; Cobol for business)

- application general and utility and above all, hardware (ie, machine) independent.

Sigma's Operating System (O.S.) is Unix-based. Sigma maintains close contact with POSIX (USA) and XOPEN (Europe) which are Unix-based forms. Also under development is a Sigma Syntax for the IPA Sigma Center.

Standardization by 1990 is an objective. Many big U.S. branches (Burroughs, Xerox for example) are involved. Contributors include IBM Japan and Xerox.

The IPA Sigma Center now has 50 PY with more then 40 seconded from the private sector.

Basic criteria for Office Systems (O/S) and Work Stations (W/S) in the form of interface (I/F) specifications and definitions based on Sigma are established by the Sigma Center. The tools are also developed at the Center. Post-1990, each contributing company will "own" the tools designed from the basic criteria established.

The tools are actually owned by the Center and may be sold by the Center. Whether to sell, license, or give away is not yet decided. A target feature is built-in key or copy protection.

Sample tools, but still real products, will be available for experimental use in October '87 and commercial use in January '88. A participating company can use them in any way it wants. Sigma will only test conformance within the interface definition environment it established. Verification tools are being developed under Unix. All products claiming Sigma conformance will be verified.

So far, no foreign companies have asked to participate. Thus, Sigma has no precedent on which to give a defined response except to say that participation is theoretically open to any company prepared to invest or contribute yen or dollars. No level is specified.

Starting Oct '87, Sigma will monitor feedback and corrections. After March '90, the system will be standardized and fully commercialized. Workstations are already among the first real products available October '87. Two are already selling. Eventually, there will be 12 companies producing workstations.

For relatively independent software development packages, the linking logic is still the problem of the application developer.

Each toolset or kit would include "inter alia": documentation, compilers, assemblers, and IOS's.

In the future, Sigma plans to use artificial intelligence (A.I.) technology to adapt the tool kits in various applicational contexts. While a Canadian company could be directly involved, its involvement could also be indirect via an internal arrangement with a Japanese participant.

Companies can connect with Sigma through a Sigma promotion office run by Fujitsu. The right person to talk to there remains to be established.

It is important Canadian companies be continually attune to the progress of Sigma as it will greatly influence the interfacing and interaction of equipment produced in Canada for what will be large markets if Sigma succeeds in its aims.

Sigma will send people to Canada to brief us if we request it.

NEC Corporation

C&C Systems Research Laboratories

A major maker of computers and communications equipment. Deeply committed to seeing society benefit from the integration of C&C (ie., Computers and Communications) technologies. Products include supercomputers, laptop computers, and business computers; high resolution color graphics, video and television displays; fibre optic communications systems, pagers; mobile phones; facsimile, satellite communications; microwave radio systems; audio systems and components.

CONTACT:

Dr. Yasuo Kato, Senior VP, Head of NEC R&D Lab
Dr. Satoshi Goto, Manager
Application System Research Laboratory
C&C Systems Research Laboratories
NEC Corporation
1-1, Miyazaki 4-chome, Miyamae-ku, Kawasaki, Kanagawa 213
Phone: (004) 855-1111

Location of Visit:

C&C Systems Research Labs, Miyamae-ku, Kawasaki, Kanagawa

Met With:

Dr. Satoshi Goto

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NEC Discussion

Company Profile

NEC is one of the top 10 companies in Japan. Its activities are evenly balanced in all fields.

Nine operational groups carry out R&D and Product Engineering in switching, transmission, radio, information processing, electronic devices, home electronics, and special projects. With its subsidiaries, NEC employs some 120,000. NEC itself has 40,000. Each year, NEC hires 1200 more. Of these, 100 will join R&D. At present, there are 1200 in R&D. 1000 are researchers. 1% of NEC's budget goes to R&D.

Research in Artificial Intelligence (AI) has high priority. More than 100 work in AI in the R&D division. More than 300 work in AI across all of NEC.

In the R&D Division, there are 9 laboratories ...

1. Fundamental Research

2. Microelectronics Research
   - ultra large scale integration (ULSI)

3. Optoelectronics Research
   - optoelectronics integrated circuits

4. Computers and Communications (C&C) Systems Research
   - digital switching
   - languages
   - terminals
   - AI applications, for use in VLSI design, financial planning, and diagnosis of switching systems

5. C&C Information Technology Research
   - basic research
   - pattern recognition as in fingerprinting, computer vision
   - media recognition, speech recognition, speech synthesis, and character recognition.

6. Software (S/W) Products Engineering
   - architecture, interfaces
   - computer-aided engineering, auto S/W generation
   - management of S/W product, S/W quality control

7. Microcomputer Software Development
   - S/W for the V-series (NEC) microprocessor
   - Operating Systems (O/S), languages, S/W quality control and performance measurement

8. Resources & Environment Protection Research
   - vibration and sound control, microwave, magnetic sensing and guiding, composite materials
   - chemical and pollution control

9. Materials Development Center
   - IR sensors, optoelectronic crystals, ceramics

R&D Topics Discussed

NEC's objective is to make Computers and Communications more efficient, universally useful and easier to use. Artificial Intelligence (AI) for "intelligent" processing is therefore a major priority! AI will be integrated using VLSI and ULSI.

The R&D topics discussed below were selected by the Company.

a) **Hardware Intensive:**

NEC is working on high speed Prolog machines CHI and PHI for ICOT which employ sequential, parallel, and super-parallel inference including all of the areas...

- deductive logic
- inductive logic
- higher level inferential computation (fuzzy logic)
- surface knowledge, deep knowledge, abstract knowledge
- high speed processors for fifth generation computers
- architectures: the CHI Prolog machine, the TIP data flow machine, and a string search engine.
- devices using superconductivity
- nemanode biotechnology
- the CHI machine for ICOT and a new CHI, smaller & more powerful, using new VLSI processes.

b) **Software Intensive**

- Expert shells - EXCORE - now commercial
  PEACE - no details given

- Manufacturing Applications
  - LSI routing system
  - LSI logic synthesis
  - mechanical design
  - Fortran language
  - Job Control Language, JCL
  - SEA/I auto software generation (COBOL)

Example: translating assembler language into the design

of an actual LSI gate layout.

- PGEN auto language generation for banking programs based on Japanese
- diagnostic systems for switching
- financial systems
- pc-based systems
- music systems
- airline scheduling

c) Pattern Recognition

Optical Character Recognition (OCR) for personal computers and for post office mail handling use including:
- alphanumeric OCR
- kanji and kana OCR where problem is rate (speed)

Color recognition to capture and change colors in an image

Fingerprint recognition to classify and correlate them

- Voice Recognition:
  Speaker dependent - 500 words
  Speaker independent - still in research stage
- Machine Translation:
  PIVOT - translates English to Japanese using an intermediate language protocol with neutral syntax and semantics. Available.
- A "Book for the Blind" total system for reading a book aloud to a blind person and includes image scanning and character recognition through sentence parsing and speech synthesis.

Observations:

For reasons of time only, discussions with researchers working in areas other than AI were not possible. A follow-up visit to the Corporate Office was accordingly requested by NEC.

NEC is open to cooperation but prefers proposals for longer range projects which they view as a lesser risk.

NEC Corporation

Corporate Office

A leading international supplier of communications systems and equipment, computers and industrial electronic systems, electronic devices, and home electronics products.

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NEC Discussion

Company Profile

NEC has 22 plants outside Japan throughout North America, England, and Southeast Asia and 24 sales offices.

NEC buys 30% of its electronic components from outside sources and 20% of this is from foreign countries.

Technical Discussion

The R&D topics discussed below were selected by the Company.

- Microprocessor Development - for MS/DOS

- Pattern Recognition - for postal and other character recognition applications and for fingerprinting

- Voice Recognition - NEC is concentrating in this area

- Satellite Application - MPT & MITI concerned with the introduction of MSAT & INMARSAT. Problem - NEC thinks that the application should be international

- Microelectronics - regarded as important for all further applications, especially large volumes

- Sensor - microwave sensor for car motion detection and high speed

- Electronic Switching - NEC is developing software

- Broadcasting - the business group is working toward HDTV

- Direct broadcasting - NEC will make the second DBS satellite

- Optical Disk - CD ROM for entertainment and business use. One hour video disk available soon. Also, working on DAT

- High Speed Computer - NEC is working on superconductive elements (Josephson junctions) for faster speed. In Japan, NEC is working on parallel computing and pipeline processing. In England, NEC's parallel processing method with switching technique is quite advanced

- Workstation - NEC is developing a more user-friendly portable terminal using flat panel displays such as PDP, EL, LCD. Target is 5 years. NEC It is for the announced NEC concept of the satellite office and will develop an infrastructure to support this new concept.

NEC's style is to invest in foreign countries and use local manpower and material. This is the best form of international cooperation they have found so far.

NEC regards international cooperation as important, especially in production where products will be made in foreign countries according to technologies available there. Such manufacturing plants will be connected by a worldwide network. NEC will develop and make the high tech portion but consuming countries will make the low tech portion.

The NEC view of international cooperation is to:

1) start with the training of NEC personnel,
2) exchange information on present technology; and then
3) do joint work on research or manufacturing toward jointly-set targets.

NEC already sponsors and exchanges scientists with foreign countries. NEC also sponsors "chairs" in foreign universities.

NEC is weak on documentation because of language translation problems and is looking to AI technology to resolve the problems. CICC,sponsored by MITI, has started into international cooperation to develop language dictionaries.

Observations:

NEC is open to international cooperation but prefers longer range projects as they are lower risk.

Potential for cooperation may be machine translation of natural language and electronic processing of documentation in support of their need to prepare good multilingual documentation in English, French, etc.

Canon Inc.

A major maker of office and personal typewriters, copiers, fax machines, laser and inkjet printers, desktop publishing, and cameras.

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Met With:

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Canon Discussion

R&D Topics Discussed

The R&D topics discussed follow the DOC R&D survey topic list.

1. Image & Voice Synthesis

Dept 1 is working on voice synthesis of Japanese. They think synthesis of native languages should be done by native speakers, but they recognize there are common techniques.

Dept 4 is working on visual pattern recognition and on picture understanding which differs from recognition.

For effective voice recognition, Canon feels that both Artificial Intelligence (AI) and digital signal processing (DSP) technologies are required. Noting that NEC developed a speaker-dependent system of 50 words and NTT a speaker-dependent system of 100 to 1000 words, Canon is working on a speaker-independent system of around 1000 words. They noted DSP technology is only good for 60-70%. The rest will need AI technology.

2. Dielectric Materials

Canon has no R&D activities here at present but would consider cooperation should Canadian proposals be forthcoming.

3. Parallel Processing technique

Though working on this area right now, Canon is looking at apossible application to the handling of color images in printers, cameras, and especially color.

4. Display Systems

They are working on a monochrome, flat-panel, LCD display system for wordprocessing (WP) applications. The specification is proprietary. They are also working on HDTV display devices.

5. Light Sources

They are working with an unspecified company on excimer lasers.

6. Expert Systems

Dept 2 is developing special software using AI for semi-automatic software generation to speed up production of their software products. They are also working on an expert system diagnostic shell for debugging use in production.

Dept 3 is working on natural language processing (NLP). Work in this area could support work on an intelligent database.

7. Printed Circuit Board (PCB)

Canon is a user not a developer of printed circuit (PC) boards.

8. Radar

Canon is not working in this area currently, but has plans for the future.

9. Videotex/Teletext

In Videotex, Canon developed and produced Captain terminals, but as they were not profitable at the time, they stopped making them.

In Teletext, they have a prototype but have not yet brought it to market.

10. Application Specific Integrated Circuits (ASIC's)

Canon is working with Siemens on ASIC components to access ISDN, specifically for G4 Fax.

Canon is third largest maker of G3 Fax products in Japan. They use Siemens techniques. Canon engineers the design and then transfers it to a semiconductor producer.

They also supply components for digital PBX machines to provide ISDN capability.

Canon is interested in developing OSI protocols and implementing communications protocols with other Japanese companies.

11. Satellite

Canon has no interest in this area.

12. Fiberoptics

Canon is mainly a user, not a developer, of this technology. It is looking into its possible use in LANS.

Supplementary R&D Topics (suggested by Canon)

Canon has a long and successful history in hardware development and is planning to go into Information Technology (IT) using its existing technology base.

They expressed special interest in digital signal processing (DSP) and compression technology.

They are interested in all future technologies, especially:

- Laser Beam (LB) technology for flat displays and sensors
- Synchronous Orbital Radiation (SOR)
- Biotechnology: "Bio-mutation" or biomutetics (ie., mutation for purpose)
- X-ray control systems, particularly X-Y control
- Electron Beam (E-Beam or EB) technology, viz., lithography.

Observations:

Canon is quite interested in cooperating in the areas of digital signal processing and data compression. Also, in voice recognition and synthesis. They are also interested in exploring process control theory applications with others.

Nippon Telegraph and Telephone (NTT)

A major provider of telecommunications services and systems.

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NTT Discussion

NTT's general position in R&D is that the "gate is open and NTT is actively searching worldwide for best partners". Since privatization, NTT has developed many relationships with many companies and universities for cooperative effort. These take many forms and include:

1. Procurement, trade system, "built R&D" based on competitive open bid. NTT is experienced in this.

2. Joint research - where the target for product development is not yet sufficiently specifiable. This form is relatively new to NTT.

3. Sponsor research where NTT sponsors research in areas other than communications research. This form also is relatively new in NTT.

4. Technology transfer - licensing out of NTT technology. No reverse buying (ie., no buying in from outside) within the last 2 years, except for some patents licensed out by NTT.

5. Personnel exchanges based on personal contact, trust, etc. NTT is very active in this area.

Currently, 6% of NTT R&D budget is spent on contracts to foreign companies.

R&D Topics Discussed (See Brochure on R&D activities.)

The R&D topics discussed below were selected by the company and introduced by way of demonstrations in each area.

A. Computer Graphics - Architecture & Rendering Algorithms

   Architecture - "Naruse" utilizing SIGHT, a dedicated 32-bit CPU employing parallel processing techniques and executing a Ray Tracing Algorithm. Both pixel processing and 3D processing are performed in parallel. The demo showed a display of 512 x 512 pixels with 32 x 32 bit blocks using only one processing element.

B. Expert System Shell/Knowledge Based Management System (KBMS) for

   - Computer Aided Instruction for routing utility cables
   - Implemented on a DEC 20/60 and based on Prolog and Ada.

- each course has 200 scenes
- each method has 150 strategies or routes
- science, audio, narrative and scene data on laser disk
- uses single sequential inference.

C. Urban map database: input, storage and retrieval

D. Voice recognition and synthesis.

Observations:

NTT stressed repeatedly the "gate is open and NTT is actively searching worldwide for partners".

NTT stressed that it is more oriented to R&D than most companies and generally does the research itself even more so since going private. NTT is now leaning more towards basic research.

In the best interests of working towards a viable cooperative working relationship, NTT wants a preliminary discussion phase first to explore ideas, options and implications; then a "free, no holds barred" phase to ensure all facets are covered thoroughly; then a confidential phase for in-depth discussion and negotiation to select the kind of cooperation. NTT noted that the mutual aspect may be a challenge.

NTT again emphasized the importance of preliminary contact of researchers as prerequisite to cooperation. Establishing the common interests, compatibility and communicability of those who would be working together is an important first step in the cooperative process.

NTT wants DOC to be the Canadian interface. NTT suggests DOC use Dr. Ieda of their New York office or Dr. Tomita of their California office. Both are researchers from NTT R&D headquarters.

Mitsubishi Electric Corporation (MELCO)

A major diversified maker of high technology products in leading-edge high technology fields such as new media (eg., videotex, television, cable television), biotechnology, space (eg., space stations, broadcast satellites), new materials and electronics (eg., electronic mail, office automation, computer-aided design and manufacturing).

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Videotex Group

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Mitsubishi (MELCO) Discussion

Company Profile

Mitsubishi has 11 labs altogether, mainly in the Osaka area, with a total of 3000 employees. Support and administration account for about 10% of the total. Two labs are located at Ofuna:

1) the Information Systems and Electronics Development Lab (ISEDL) with 300 employees, and
2) the Communications Systems Development Lab (CSDL) with 260 employees.

The first stresses artificial intelligence, expert systems and knowledge-based systems. The second concentrates on digital and optical systems

Technical Discussion

The R&D topics discussed below were selected by the company.

1. In LANS
   - having achieved 32 Mbps, MELCO is now aiming at 10 Gbps
   - initially for internal use, CSDL developed equipment for MIND, (Mitsubishi Information Network Digital) products

2. In satellite communications systems, MELCO is active but no details were discussed.

3. In fiberoptics, high-speed digital systems for trunking are under study.

4. In data processing, as a member of ICOT, MELCO is developing:
   - a Prolog-based Personal Sequential Inference (PSI) machine
   - machine translation using PSI and is the only company of ICOT so far to use PSI for this application
   - software development tools and workstations
   - the TRON operating system with the University of Tokyo

5. In video codec, MELCO has achieved video compression down to 64 Kbps and made a commercially available system but it is not compatible with NTT and KDD

6. In antennas, MELCO is strong and actively developing Ku- and Ka-band earth stations for digital satellite communications and 64 meter-diameter deep space dish antenna

7. In AI, again the PSI-I was the center of attention. An AI presentation was made including the PSI-II a commercial version

of the Prolog language-based PSI-I prototype. PSI-II uses LSI, is 5 x faster and 3 x smaller than the PSI-I, has an 80 MB RAM memory but is not yet portable. It uses ESP, a new AI operating language. Applications for development on PSI-II include:

1) Extended Self-contained Prolog (ESP): A Sophisticated System Development Language providing a total environment for developing AI programs and which allows both object-oriented and predicate expressions to enable user to describe complex and varied system types, and which further provides easy-to-use program development tools to greatly speed software development.

2) Expert Shells:
- Ext Kernel (EXT): Expert System Development Tools to represent knowledge in the form of production rules to facilitate the building of expert systems and describe the knowledge database as structures to assist knowledge entry and verification
- ACEKIT
  to develop spreadsheet functions
- SIGMA
  frame set with fuzzy sets
- KAPPA
  semantic, network, frame, nested relations, TERMS (rules)

3) Knowledge-based systems to provide expert knowledge to assist decision-making in medical diagnosis, fault locating and management consulting systems

4) Intelligent systems for robots, processing, transmitting, designing to boost productivity, natural language)

MELCO is also working on a parallel inference engine. Hardware, which is almost ready, was demonstrated.

In videotex, with an installed base of only 30,000 terminals all in Japan, MELCO is now pursuing specific application programs such as the MELCO transportation system operating in Hiroshima and a hotel reservation system with equal effort being put on terminal and application systems.

Observations:

In Japan, big companies historically dealt only within their own divisions or with a subsidiary or an affiliate, and not usually with foreign companies. The trend is to include cooperation with foreign companies. MELCO is looking intently at the possibility of such cooperative relationships in R&D and otherwise.

Japan Radio Co., Ltd. (JRC)

A leader in marine electronics, radio communication equipment and systems, satellite communications, digital technology, systems control and computer graphics. Its R&D activities are aimed at satisfying increasingly complex demands of "system electronics" for communication, control and data processing.

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Japan Radio Discussion

Company Profile:

Founded in 1915, Japan Radio Co. Ltd. manufactures integrated electronics based on Information Technology. With 3800 employees and U$26 million issued capital, "86 sales were U$ 405 million.

R&D Department

1. Mitaka plant
   - maritime radio, radar, a graphic display terminal for gas pipeline application, amateur radio, broadcast equipment, audio equipment for industrial use, water supply control for hydro dams, fish-finding equipment

Affiliate companies include:

2. New Japan Radio Co. Ltd. (jointly with Raytheon Company, USA)
   1000 persons
   - microwave parts, semiconductors (diodes, transistors, ICs, LSIs)
   - optical instruments, sensors and elements

3. Aloka Co. Ltd.
   840 persons
   - ultrasonic diagnostic and surgical medical equipment
   - color flow imaging system

4. Nagano Japan Radio Co. Ltd.
   1070 persons
   - radio communication
   - computer peripheral equipment

5. Ueda Japan Radio Co. Ltd.
   830 persons
   - radio communication equipment
   - medical use equipment
   - airport surveillance radar
   - air traffic control
   - tanker collision avoidance system (CAS)
   - radio navigation equipment (LORAN, GPS, NMCC)
   - on board ship optical communications systems
   - on board ship-to-shore fax-via satellite systems
   - flight simulator/trainer systems for flying and maintenance (eg. Boeing 767)

R&D Topics Discussed:

The R&D topics discussed below were selected from the survey topic list by the company. JRC is active in all of these areas.

#4 high resolution computer graphics display to show map detail as in Tokyo Gas pipeline and CAD/CAM applications

#11 satellite based systems - especially Geographic Position (GPS) and VHF Systems

#9 JNAPLPS (or NAPLPS with Japanese Kanji and Kana characters) for the construction industry

#2 ceramic materials for medical and fishing-oriented transducers

#3 initial studies in parallel processing systems

#10 VLSI for radio and radar application

#12 fiberoptics (F/O) for shipboard communication applications

#14 Geographic Position System (GPS) receivers

Each topic was touched on but discussion centered on Geographic Position Systems and High-Resolution Computer Graphics Displays as follows:

- The GPS program began in '79 and achieved its first prototype in '87 but still considers subsequent units as largely prototypes as they are not yet widely implemented. Their GPS is based on received signals from a satellite to be launched in '89 by the USA. Communication is at 20 GHz and is line-of-sight. Current accuracy is up to 30 meters. It can be used onboard to locate a car or truck or other vehicle for fire, police and other civic department, highway or hydro or gas or fuel delivery vehicles, interstate or interprovincial trucking, trains, planes and ships. Potential customer population is very large. Significant size reduction is targetted (30:1 mid'87, 60:1 end '87, and possible compaction to pocket size for use by mountain climbers, hikers, iceberg tracking, virtually any beacon function, etc.

- GPS is useful also for large-scale long-range surveys with one receiver at a known point and a second and third receiver each up to 100 km away to locate position to an accuracy of 10 to 20 cm.

- JRC expects to reduce the price of GPS receivers below $1000 US by integrating more circuitry, especially analog

- GPS can also be used to detect the height, direction and speed of a receiver relative to an earth reference

- in '89, Toyota and other car manufacturers will install a competing (non satellite-based GPS) system using dead-reckoning to locate car on a map.

In High-Resolution Computer Graphics Displays, JRC takes great pride in its achievements in...

...high resolution
...high speed, and
...high interactivity capability

for tracking and dynamic updating.

Stemming from JRC's radar image storage tube technology, the computer graphics and image processing project was introduced 10 years ago aiming at high end, high resolution graphics equipment for radar data processing systems. JRC's first development was a 1K x 1K pixel raster-scan 2-dimensional monochrome display with a raster memory and a storage cathode-ray tube. Then followed with a 2D color display and later with a 3D color display for radar, mapping and CAD/CAM/CAE applications. OEM products are based on:

2D - CORE by ANSI
3D - MAP - 2D GKS now (3D PHIGS in future)

JRC will introduce a 2K by 2K unit shortly and thus the highest resolution in the world, but is aiming at a 4K by 4K pixel high resolution, high performance color display with interactibility in real time.

JRC only works on special-purpose applications. HDTV is not an activity. They use their own algorithms to implement CORE and GKS. They consider mapping to be currently very important and are developing a MAP system in conjunction with Tokyo Bus and the Utility Systems using the same database as NTT's.

Observations:

Interest is very strong at JRC for cooperative R&D with Canadian firms in all topics discussed but especially in realtime position locating and tracking and in realtime, highly interactive, high resolution, high speed color graphics displays for mapping and other applications.

Potential here is high for Canadian firms interested in aircraft crash position locating, tracking the movements of icebergs and ships, tracking shipments of strategic or dangerous items. All this, through feedback telemetry for presentation on map displays in command and control systems. Both dead-reckoning as well as satellite-based systems should be considered in applications. For example, dead-reckoning might be more cost-effective and thus more competitive in street-highway map based position-finding for vehicles.

Recent examples include the $1,000 - 2,000 (US) video terminal and computer system called "Navigator" by Etak of Menlo Park of California for General Motors for Canadian-and US-produced cars and trucks and for Clarion Co. Ltd. of Japan for Japanese-produced vehicles, or 'Travel Pilot' by Blaupunkt of West Germany's Robert Bosch GmbH aimed at Porsche, Volkswagon, Volvo and Saab. Etak, it is noted, uses no satellites and no external signals and claims accuracy to within 15 meters. Etak is considering coupling the navigation system with radio or cellular telephones, eventually to be used by police and fire departments, ambulances, taxis, trucks and buses to allow dispatch operators to keep track of everyone. Meanwhile, Ford and Chrysler are experimenting with satellites to pinpoint a car's whereabouts even though tall buildings in dense cities (eg., New York, N.Y.) and heavy foliage (eg., Washington, D.C.).

Ricoh Company Ltd.

A leader in high technology equipment for office, home and industry with the top market share in copiers and fax machines. Its quality equipment results from diligent and creative research and development by the Research and Development Center which does pure research and development in advanced technological fields, particularly in the areas of optics, artificial intelligence and recognition technologies, and new materials.

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Ricoh Discussion

Company Profile

Ricoh has top market share in copiers and fax machines. Some 7.2% of total sales goes to R&D. It has modern plants in Germany, USA, South Korea and Taiwan, an R&D Center in Japan and an R&D lab in the USA. R&D Center in Japan has 334 staff (84% are R&D).

The Ricoh Research and Development Center in Japan does pure R&D in advanced technologies of optics, artificial intelligence and recognition and new materials as follows:

1) Optics Technology

Optical solid state devices, including imaging devices, thin-film optical devices, optical measurement and digital image processing input/output systems.

2) Artificial Intelligence and Recognition Technology

Information processing, optical character recognition, speech recognition and communications technology vital to advanced office automation.

3) New Materials Technology

Organic and inorganic materials for semiconductors, magnetic substances, sensors, recording processes and display technology.

In the R&D Center, there are 3 labs with complete freedom in their work, like universities. Their work focusses on:

- Office Automation (OA) in 3 areas...
  - ...multimedia (ie., voice, image, graphics, characters)
  - ...distributed and integrated systems
  - ...user-machine interfaces
- large Unix-based database systems jointly with AT&T at a software lab in downtown Tokyo
- image processing technology at an R&D center in Tokyo
- precise machine injection molding et al. at a production technology R&D center
- ASIC's at a semiconductor lab in Osaka
- developing amorphous materials for copiers at a satellite lab
- laser beam printing technology for write-once optical disk but working toward the re-usable disk
- voice and character recognition using artificial intelligence technology

The Yokoyama laboratory differs from the rest in that it is totally flexible and free of traditional constraints thus creating an atmosphere for creative thinking.

R&D Topics Discussed

Ricoh selected and discussed 4 topics which may be considered as a partial list of potential areas for cooperation but not necessarily commitments at this stage.

1) Voice Recognition

In Yokohama, Ricoh is working on a speaker-independent voiced-speech recognition system and is concentrating on Digital Signal Processing (DSP) and Binary Time Spectrum Pattern (BTSP) techniques employing fuzzy logic. They have achieved a system of 120 words or groups. Average for a closed type system is 15 groups (a group is actually a frequency dependent spectrum). Ricoh is most proud of this achievement.

2) Display Systems

In Yokohama, Ricoh is working on multicolor electro-luminescence (EL) for flat-panel color display with adjustable brightness for use in laptop computers and televisions. Multi-color EL mainly uses ZnS (Zinc sulphide). Blue is still the hardest color to obtain in both color and brightness. Ricoh believes it has developed the purest blue for EL using a mix of SrSe:Ce (green-blue) and SrS:Ce (blue-green) and a phosphor co-activator (Note: L.G. Tannas Seminar Lecture Notes '86 SID, International Symposium, San Diego). Methods used to generate multicolor include: Spatial or side-by-side versus coincident color - RGB multiplane to generate pixels with full color range. Brightness is about 100 candela and can go from 2-300 candela individually but reduces to 70% in combination with multiplanar color. Driving voltage is 200-250V, 200 mA/sq. cm., 40mA for an A4 size display.

3) Expert Systems

In Osaka, Ricoh is working on machine translation (MT) of Japanese to/from English. A product is available which allows an OCR or keyboard input and translates by auto syntactic transfer using word and grammar dictionaries and intra and post phase user interactive editing. It uses "deep" semantics and further provides tools to update and utilize the dictionaries.

Ricoh is also working on an AI shell using Dempster/Shaefer fuzzy shell for diagnostic, administrative, and other uses.

Based on the theory of fuzzy logic, it infers from inexact knowledge. As an example to demo the concept, Ricoh had made an Expert System for an animal encyclopedia where you describe the animal and the system guesses by choosing candidates from among say 100 possibilities for which you have defined a domain. Applications will be largely in the medical diagnostic area.

4) New Materials

In Osaka, work is going on in semiconductor circuits, particularly ASIC's.

5) Superconductivity - Ricoh attaches great importance to any breakthrough, is interested and would like to share informa t i o n in this new area in a cooperative arrangement.

Each of the Expert Systems, machine translation and EL display technologies were demonstrated.

Observations:

The many questions about seminars and follow-up contacts indicate much interest in cooperation with Canadian firms.

Mr. Kubo asked how many Canadian companies are involved and what might be the nature of cooperation. Exchanges of scientists or joint projects were suggested.

Dr. Onoe says he is very much for international cooperation and noted there is even a Canadian student from the University of Waterloo at the R&D center arranged through ISTE. ISTE is an international organization involved in the exchange of engineering students. Last year's student was also from Waterloo. While they could not recall offhand the name of this year's student, he is nevertheless on board.

Ricoh, already among the most advanced in the transmission of "still" color pictures by phone with its color telephone available September '88 for $775 (US), is starting now to focus on the transmission of "moving" color pictures. They suggest Canadian research in data compression and error control for transmission over narrow band might be a possible basis for joint R&D.

Ricoh would like to receive feedback by way of the survey report and especially hear from Canadian industry.

Expert systems and fuzzy logic related to natural speech recognition and natural language processing and machine translation may also be a fruitful area for cooperation.

SHARP Corporation

A major manufacturer of computer and communication systems and equipment. Products include: televisions; radios; audio equipment; office equipment; computers; calculators. Research interests include: LSI's; materials for new media systems and molecular electronics; software development (especially with respect to AI, multi-media processing, and productivity improvement); CAD/CAM and CAE systems; opto-electronic and power electronic devices.

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SHARP Discussion

Company Profile

Founded in 1925 in Osaka to produce crystal radio sets, SHARPcontinues to explore, develop and exploit advanced technology in unique and innovative ways in products for home and industrial use. Quick to foresee the future of electronics, the company began large-scale integrated circuit (LSI) production in 1970 and aggressive research and development of LSI technology and its application. Today, it is an acknowledged leader.

Research and development are carried out by an Engineering Center with 6 research laboratories, an Urgent Projects Office, and also the research laboratories of each of 5 product development groups. Overall, there are 6100 persons for the research laboratories plus an engineering staff attached to the factories. About 800 researchers work in the Engineering Center.

There is also a Research Business Support Group whose role is to advance the intensive research and development done under the auspices of the Engineering Center. To this purpose each member of the group is engaged in a wide range of research projects including materials analysis, environmental control, device testing, patent application, and the accumulation and retrieval of technology informations and documents.

The Engineering Center comprises 6 labs focussing on fundamental research and development:

1) Central Research Laboratories - Tenri-shi, Nara Pref.

These laboratories do fundamental research and development to establish highly advanced original technologies that meet modern business demands. To create high quality products, innovative research and development of new materials and unique devices are stressed.

2) Tokyo Research Laboratories - Kashiwa-shi, Chiba Pref.

The Tokyo Research Laboratories do primary research in basiccommunications and new media systems to meet the demands of a high-tech information-oriented society. Projects stress LSI's and new materials essential for producing creative new media systems as well as promoting molecular electronics.

3) Energy Conversion Laboratories - Kita-Katsuragi-gun, Nara Pref.

Backed by experienced semiconductor and thermal conversion technologies, the Nara Shinjo laboratories carry out research in energy conversion, storage technologies and other practical applications. Stressed are solar energy conversion, solar heating, solar heat pump technology and amorphous techniques. Sharp is also a member of the Japanese government's national "Sunshine Project" to develop new solar cells.

4) **Precision Technology Laboratories** - Tenri-shi, Nara Pref.

These laboratories carry out central research on precision mechanisms and ultra-precise processing for the development of "mechatronics" products such as printers, optomagnetic disks, etc. To meet various demands for manufacturing automation devices and equipments, the laboratories are committed to the systematizing of components technologies and to the development of automation systems and intelligent robots employing advanced technologies for "mechatronics" and visual recognition devices.

5) **Computer Systems Laboratories** - Tenri-shi, Nara Pref.

These laboratories carry out reseach to establish basic technology for computer software development and stress artificial intelligence and multi-media information processing technologies as well as interoperability of computers and productivity improvement for software development. A specific focus is on the development of CAD (Computer-Aided Design). CAM (Computer-Aided Manufacturing), and CAE (Computer-Aided Engineering) systems for designing LSI and electric appliances.

6) **Liquid Crystal Laboratories** - Tenri-shi, Nara Pref.

These laboratories carry out research and development of diverse liquid crystal display (LCD) solid-state technology toward the ultimate realization of large-scale flat-panel, high-definition and performance color displays for use as monitors for television, personal computers, and interactive workstations.

There are also 5 product development groups. Each group focusses on a specific product area and has its own laboratories:

1) Television Video Systems Group - in Yaita-shi, Tochigi Pref.
2) Audio Systems Group - Higashi-Hiroshima-shi, Hiroshima Pref.
3) Appliance Systems Group - Yao-shi, Osaka
4) Information Systems Group* - Yamato-Koriyama-shi, Nara Pref.
5) Integrated Circuits Group - Tenri-shi, Nara Pref.

*Stressing Office Automation (OA)

R&D Topics Discussed

The R&D topics discussed below were selected by the company and conform to those of the survey topic list.

1) Voice & Visual Pattern Recognition

There is good emphasis on both visual and voice areas:

- In Visual Pattern Recognition, Sharp is working on specific applications to production processes and product testing. A high priority is detecting LCD faults. Interest is strong also in the recognizing of handwritten script and in image compression for storage and transmission. They are interested in cooperative development of applications of the latter to home appliances and office automation.

- In Voice Recognition and Synthesis, Sharp is working on the recognition of voice commands for the remote control of TV sets (eg, channel changing). They are almost ready with a speaker-dependent system for telephone voice dialing (including car phone for navigation applications) and for pilot's cockpit checklist execution using "voice in - voice out". They are developing a voice clock where you can record and playback (up to 3.0 seconds' worth on 1 chip so far). They are also working on a speaker-independent voice recognition system.

2) Ceramics

- Sharp's is emphasizing applications, not basic materials, research. LCD is no longer a high priority as it already has momentum but would still be receptive to Canadian initiatives anyway because of the importance of the technology, SHARP would prefer cooperative activities instead in thin film ceramic and superconducting materials. Superconductive ceramics are of much interest. Thin film technology with respect to these ceramics is highly relevant to their ultrasensitive magnetic sensor project which they believe will be a world first. The area of device technology involved is known a SQUIDs (Superconducting Quantum Interference Devices). So far they do not have a commercial application. Elsewhere scientists have used SQUIDs to study brain waves, explore geological formations, and do fundamental physics research. The technology is "difficult" and SHARP is "open to ideas and initiatives" from Canada.

3) Parallel Processing Systems

The software group is working on parallel processing software, especially for home appliances (eg. picture processing). Also, in combining videodisk and the personal computer, they aim to develop a control to speed up computing. Though a software development now, the goal is a 1-chip firmware design. SHARP is a member of ICOT.

4) Display Systems

Basically an LCD lab, it now includes LED and EL displays. While LCD is now low priority, emphasis is on the large scale matrix, eg., 5-inch TFT display (one in Osaka). The difficulty is achieving size and bandwidth. A research goal is to increase size enough to apply to HDTV. A 3-inch color TV is commercially available. There is also aggressive R&D in EL technology. So far, Luthia (Finnish) and SHARP are the only 2 companies which have commercialized EL. SHARP ships 2000 units/month for Office Automation applications, mainly for word processors used in personal computers (640 x 400 pixels). In display drive and control software development, SHARP is open to cooperation.

5) Light Sources

The research is focussed on developing a blue laser of high intensity. An important R&D topic in Japan, SHARP is not so much interested in lasers for film recorders but for applications with much broader potential.

6) Artificial Intelligence (AI)/ Expert Systems (ES)

Notwithstanding an emphasis on using AI to support R&D in general throughout the corporation, SHARP is working on Expert Systems software for commercial applications such as:

- recipe-based cooking control and direction of a microwave oven and similar appliance generated from a recipe selected by reading bar-codes

- "intelligent" air conditioners that adjust to presence and location of persons. So far one processer application.

- a wordprocessor system in Japanese to input kanji and kana character combinations from voice input and distinguish between homonyms. The system is now available.

Electronic translation systems are one of the more practical forms of Artificial Intelligence. Sharp has one English-Japanese automatic translation system which provides wordprocessing in a desktop form. They are now developing unique software that will increase of electronic translation accuracy by a sizable margin.

7) Printed Circuit (PC) Boards

SHARP is good at this and uses an electrified camera and direct writing techniques, but SHARP is not in this as a business which usually requires large volume and direct writing is only good in small volumes. It is mainly for lab and prototype use.

8) Radar

SHARP has no interest here.

9) Videotex/teletex

Sharp's interest is in NAPLPS related to the CAPTAIN system (experimental at present).

10) Application Specific Integrated Circuits (ASIC's)

ASIC's are a priority for cooperative work. The VLSI group has to determine what to implement in IC's and then do it. This is difficult and the risk is in choosing badly. It is important to grasp clearly what needs to be implemented. Future IC-related production at SHARP will be ASIC's. SHARP stresses that any item or topic that could be jointly studied for ASIC implementation is a possible cooperative area. In ASIC's, their priority is mainly home appliances but they also stressed the communications aspect. In Irvine, California, its research base, Hycom Incorporated, is developing modem technology for use in LAN'S and peripherals.

11) Satellite-based Sensors

Interested in general, it is "open to cooperative proposals to adapt applications in space to the home appliances area". It makes a charge-coupled device (CCD) for a 640x400 pixel camera.

12) Fiberoptics

SHARP has components, not systems, technologies to build optical LAN systems for "intelligent" buildings. SHARP makes lasers, especially for CD-laser application, and has a long history of work in lasers, EL, LCD and IC'S. After 15 years, SHARP has developed a prototype of a first read/write optical magnetic disk available in 540 MB.

Observations:

Open for cooperation are ASIC's and sensors for home appliances.

SHARP stressed that contact be via Canadian government and/or university research groups. They have such contacts with U.S. and European groups already.

Omron Tateisi Electronics Co.

A leader for over 50 years in advanced automation research, development, manufacture and implementation of systems for factory automation, electronic funds transfer, advanced credit/debit cards, automated shopping (videotex), public service automation, electronic traffic regulation, office automation, CAD/CAM, mechanical diagnosis and treatment, home health care. Particular focus on making machines more intelligent and on fuzzy control for positioning. Involved in Sigma project. Very receptive to international cooperation in IT R&D. Research staff being joined shortly by Mr. Diamond, a Canadian researcher.

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Omron Tateisi Discussion

Company Profile

Omron Tateisi Electronics Co. began in 1933 as Tateisi Elecric Manufacturing Co. to make control components. Today, Omron is very applications oriented covering many areas involving the technologies of computers, communications, and control. The products and systems are tailored to fit the application, and are generally reproducible or adaptable to comparable applications.

In 1986, on paid-in capital of C$ 86 M, it grossed sales of C$ 2.5 B. It has 6,447 employees. Head office is in Kyoto.

With the vision: "To the machine, the work of the machine; to man, the thrill of further creation", Omron pursues "Advanced Automation" blending the most advanced aspects of the core technologies of computers, communications and control to make machines work more intelligently and free human energies for more creative endeavours. By constantly researching new technologies, Omron develops new products and systems for emerging applications in in factory, laboratory, bank, retail, medical and implicitly home automation. And, as an increasingly international company, Omron has been seeking to strengthen its business activities in response to regional markets, particularly in North America.

The key technical elements in its organization are:

Research and Technology Assessment H.Q.
- Central R&D Laboratory
- Production Engineering Laboratory
- Research & Technology Assessment Div. Software Lab.
- Tateisi Tokyo Telecommunication Laboratory

Control Components H.Q.
- Product Development & Engineering Center
- Tsukuba R&D Lab.
- Production Engineering Center H.Q.
- Industrial Division H.Q.
- Consumers & Commercial Div. H.Q.
- Factory Automation (FA) Device Div. H.Q.
- Automobile Electronics Components Div.

Electronic Fund Transfer Systems H.Q.
- Product Development Center
- Banking Systems & Equipment Div.
- Retail Information Products & Systems Div.
- Public Systems Div.
- Special Electronic Systems Div.

Information Systems H.Q.
Product Development Center
Traffic Control Systems Div.
Inductrial Control Systems Div.

Health & Medical Equipment H.Q.
Health Care Equipment Div.
Medical Equipment Div.

Office Automation System & Equipment Division.

Activities and achievements range widely and include:
- unmanned automated railway station systems
- computers, communications and control systems
- thin Angstrom-order membranes
- original LSI design
- laser applications
- communications
- mechatronics (including computer vision)
- life sciences, bionics, related image processing
- advanced automation involving sensors, timers, temperature controllers for mills, bottling plants, and autobody assembly.
- traffic control systems such as city traffic lights - bus location systems
- credit card vending machines (a 1965 first)
- Electronic Fund Transfer (EFT) Systems, Point of Sale (POS) Systems, Automated Teller (AT) systems including terminals and credit/debit card readers
- Electronic Item Purchase (EIP) System (eg,Securities)
- advanced automation in Office Automation (OA)
- health care products: thermometers, Microx blood cell measurements systems, sphygmanometers, hyper-thermic treatment systems to kill cancer tissue
- Material Requirement Processing (MRP) System involving nationwide network of offices, factories and laboratories
- Flexible Intelligent Manufacturing (FIM) Systems for efficient small parts manufacture
- Factory Automation (FA) products

Specific global product development includes:
- programmable controllers for production sites
- cash dispensers
- terminals such as the cash registers used by Druxy's et al

Technology knowhow, as well as products, is also marketed.

Research and Development

Technological advances depend in large part on timely innovation of the research structure itself. To ensure this, Omron continually evolves its well-equipped laboratories so as to foster the support of free-wheeling activities in many fields.

The Central R&D Laboratory in Kyoto is the core. Associated with it is a comprehensive series of specialized development centers. For example, Tateisi Tokyo Telecommunication Laboratory focusses on developing the nervous systems of tomorrow's production and service sectors while Omron Tateisi Software Co. focusses on infusing Omron products with human-oriented intelligence and flexibility. Omron has also set up "mini-labs" at several of Japan's nationally sponsored Technopolis sites. This flexible and multi-dimensional R&D structure breaks down barriers from many angles to accelerate breakthroughs and strengthen Omron's technomix.

The Research and Technology Assessment H.Q. at Nagaoka with 2000 persons comprises:

- a Central R&D Laboratory with 200 persons
- a Production Engineering Laboratory with 650 persons - a Production Engineering Center in Kyoto with another 2000 persons
- a Technology planning & Promotion Dept., including patent development and standardization
- a Research & Technology Assessment Div. Software Lab which includes the AI project
- a Tokyo Technological Liaison Department.

The Product Development & Engineering Center at Nagaoka with 300 persons specifically deals with:

- electronic control components
- factory automation (FA) systems
- information systems.

Related labs include:

- Tsukuba R&D
- Tateisi Tokyo Telecommunications Laboratory
- Tateisi Institute of Life Science
- Tateisi Software Company Ltd.
- Omron Research Institute (Calif), Los Altos, Calif.

Current projects at various sites are as follows:

Central R&D Lab

1) Computer technology: work stations (W/S), operating systems (O/S), software (S/W) development tools, Artificial Intelligence (AI), and Computer-Aided Engineering (CAE)

2) Mechanical and Electronic Technologies

Production Engineering Lab

1) CAD/CAM, notably CAM, as in tape automated bonding for base chips using involving photopolymer for electron-beam lithograph

2) Ultrafine processes & mechanisms

Software Lab

1) AI projects

2) Enhancement of S/W development productivity

3) Expert Systems (ES) for hospitals using fuzzy logic theory

4) Expert Systems for fuzzy controller

R&D Topics Discussed

Omron is noted for its many diversified products and many ongoing projects in R&D. However, given its priorities of interest and time, Omron selected and focussed the topics as follows:

1) Artificial Intelligence (AI) such as:

a) Applications of the fuzzy controller developed and patented jointly with Dr. Yamakawa (Kumamoto University). The example they have so far is an easy-to-understand small fast 1M FIPS (Fuzzy Inferences Per Second) controller to balance a rod vertically. The fuzzy control algorithm has only 7 lines of program code and need not change if rod is changed.

b) Expert system tools to diagnose: (1) ATM malfunctions in EFT systems and (2) diseases through system "interviews" of the adult patient (jointly with Keio University).

c) Computer-Aided Software Engineering (CASE) participating in Sigma involving 1000 programmers.

2) Printed Circuit Board Production Techniques aimed at total electronic digital circuit design support from PCB design to manufacturing data.

3) Visual Pattern Recognition such as real-time dynamic robotic recognition of patterns in moving objects to identify moving licence plates, inspect soldering in Surface Mount Technology (SMT), and measure tennis ball speed. In related work, Omron developed technology to read printed or handwritten alphabets and symbols, including Japanese characters with English.

4) Sensors and instruments such as:

a) a fluorometer which converts light to temperature by photoluminescence for use with optical datalink.
b) a laser-based displacement sensor.
c) a ultrafine positioner providing non-contact to within 0.1 um using air-bearing technology.

5) Light sources, namely, a high power solid state coherent laser-diode light source emitting in 780-850 umrange with low threshold and 1.5 W power output.

6) In fiberoptics, Omron develops a wide range of devices to optically transmit data in industrial environments.

7) In optoelectronics, Omron developed Fresnel diffraction grating lenses but does not yet have a specific application.

Observations:

A flexible, applications-oriented company, Omron is very open to new areas, ideas and approaches. It is especially open to the idea of cooperative R&D and enterprise on an international basis. Foreign scientists and engineers have worked at the Central R&D Laboratory for 3 to 6 months at a time. Currently, there are 4. By the time this report is issued, a Mr. Diamond from Northern Telecom will have joined Mr. Ichihara in the System Development department at the Central R&D Laboratory.

Omron was curious to know how it came to be chosen for the survey being somewhat small and not well known in Canada. It was simply selected by the Embassy because of its medium size, Kansei area location, and availability for the survey.

Omron has done good work in fuzzy logic control but has yet to find a good application. Omron will make 5 more, but smaller, machines. Omron will send a detailed logic description via the embassy when available. Omron very much wants to find good applications for their fuzzy controller. There are value-added opportunities here for dynamic realtime applications such as:

- camera platform stabilization for mapping
- tool bit control for tunnel boring
- satellite attitude control
- oil/gas drilling rig platform stabilization

Their present fuzzy controller is analog and small scale. A logical next step would be to develop a digitally programmed and larger version to handle more variables and massive situations.

Another area of fuzzy logic development to think about is the application of fuzzy logic concepts to the handling of fuzzy linguistic information such to recognize its visual/aural forms and to interpret its content and meaning.

Omron would like to hear from those who could really help out in developing this technology and its application. However, it is important to note that the information is unique and proprietary to only a few. Anyone interested should to talk only with Omron.

In optoelectronics, Omron would like applications support for its diffraction grating or Fresnel lens technology where they have a lot of strength.

In summary, Omron is very flexible and open to cooperating with any company (domestic or foreign) in any application as long as the company can be a good partner.

Matsushita Electric Industrial Co.

A major diversified maker of high technology consumer electronic products for home appliance, audio, and video applications under the brand names of Panasonic, National, Technics, and Quasar. Also, a large supplier of passive components.

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Matsushita Discussion

Company Profile

A major diversified maker of high technology consumer electronic products for home appliance, audio, and video applications under the brand names of Panasonic, National, Technics, and Quasar. Also, a large supplier of passive components.

A brand transition is in progress from National to Panasonic in Japan and Worldwide. The Technics brand is only for hi-fi audio equipment while the Quasar brand is for products made in Chicago.

Corporate Engineering Division

- Form of technical museum.

R&D Topics Discussed:

The R&D topics discussed were selected by the company.

1) Fiber Optics - Topic 12

LED's, lasers, and passive components for analog transmission in CATV systems (12-channel single fiber analog) and for digital transmission to GHz in data and HDTV transmission. Applications include:

- 100 Mbps LAN developed 17 years ago for NTT, also a special IC for LAN
- CATV systems (12-channel single fiber analog)
- monitoring system with metro
- not yet into switching systems
- NTT compatible data transmission
- PLZT - Lead Lanten Zirconate Titanate-for experimental optical switch

2) Display Systems - Topic 4

Flat color display technologies are a priority for development:

a) Flat color CRT - for HDTV use.

They have developed a 10-inch, 480 x 400 pixel unit with a contrast ratio of 50, a brightness of 70 foot-candles. Pixel pitch is 2 lines per mm. Flat CRT uses a concept of multiple screens. Power consumption is 70 W.

b) Color LCD panel display - for portable PC and TV use.

Studying both active and passive matrix drives, they developed:

- a 3-inch 240 x 126 pixel active matrix with contrast ratio of 90, brightness of 20 ft-candles, and 30 degree view angle.
- a 12-inch 200 x 320 pixel passive matrix with contrast ratio of 8, brightness of 20 ft-candles and 30-degree view angle.

and are now aiming for a larger size in each.

3) EL panel display - for desktop personal computer and color EL They are developing a 9-inch diagonal, 2 x 8.3 inch, 256 x 1024 pixel unit with a pixel pitch of 5 lines/mm, contrast ratio of more than 15, a brightness of 20 ft-candles. Pixel pitch is 5 lines/mm. Under study are:

- the use of different dielectrics to reduce drive voltage.
- the problem of achieving an adequate blue color (perhaps through an information exchange with Canada).

Note: No work is going on in high energy light sources.

3) Dielectric Ceramic Materials - Topic 2

Still in the experimental stage, an optical switch based on Lead Lanten Zirconate Titanate (PLZT) is exhibiting high electro-optic effect 2 to 9 times better than any existing materials.

They are also developing superconducting thin planar film by sputtering in an O_2 and Ag atmosphere with different materials.

Observations:

Mr. Moriyama said Matsushita was not interested at this time in cooperation but still wants to follow up on topics 2, 4 and 12.

Sumitomo Electric Industries, Ltd.

A major maker of electrical and fiberoptic cables; materials technology such as zinc-selenide, gallium arsenide, thin film coating, solar cells, LED's, PIN photo diodes, carbon fiber reinforced plastics and ceramics, and elecrical power systems. Now moving into information technology including information systems, optical character readers (OCR's), LAN's and videotex.

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Kazuaki Chiba, Chief Research Associate

Sumitomo Discussion

Company Profile

Sumitomo Electric, founded 90 years ago to make copper wire and cable, has since diversified into many fields. Copper wire drawing technology grew into steel wire drawing technology. Die-making technology for wire drawing developed into the technology of hard materials/artificial diamonds. Insulation technology for cable expanded into plastics technology. Systems were integrated to become electronic systems. Thus, it developed its current interests in

- Videotex
- Superconductors
- Artificial Intelligence
- Graphic Displays

Sumitomo has 6 plants, all involved in R&D, except the Kanto. It has over 150 OEM customers and sells its workstations to computer service companies (Univac) who then sell the system with software to end-users (Toyota).

SUN has 30% of the market; Sumitomo, 10%; the competitors (DEC, Apollo, etc.), the rest.

Following an overview presentation, demos were given of videotex, superconductors, and a series of AI workstations.

R&D Topics Discussed:

The R&D topics discussed below were selected by the company:

2) Superconducting ceramics
   - about 60 persons work in this area
   - Y-Ba-Cu-O ceramics, 1000 A/sq.cm.
   - Nb-T (metal) best record is 10^{-6} A/cm

4) Graphics Displays
   - monochrome display system for Sigma project workstation.

6) Artificial Intelligence
   - 1500 AI electronic workstations (EWS) shipped. Current versions are E5 and E15 (both 16-bit versions). The new ones are E20 (a 32-bit version) and E30 (an E20 with FPP) based on the Motorola 68020 chip are a first in Japan.

9) Videotex
   - JNAPLPS-based Cantex system with 30 terminals to go into operation in Yokohama in Feb '88.

Observations:

Sumitomo is not really a display manufacturer but a workstation developer. It develops the terminal systems but does not make the electronic display. Hitachi does that.

Sumitomo is quite interested in cooperative development of PROLOG based Systems. Those interested should contact Dr. Matsuo or Dr. Ikami of the Torrance Office in Los Angeles, Calif.

Fujitsu, Limited

A major maker of office and personal typewriters, laser and inkjet printers, copiers, fax machines, desktop publishing, and language translators.

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Electron Devices Division
Dr. Yoshikazu Toyama, Deputy General Manager

Fujitsu Discussion

Company Profile

A major maker of office and personal typewriters, copiers, fax machines, laser and inkjet printers, desktop publishing, and language translators.

Increasing telecommunication sales are countering the decline in semiconductor sales, but profit is down. '88 overall sales will increase a further 17%. About 10% of net sales or 1.3% of total sales goes to R&D.

Fujitsu's advanced technology originates from two R&D labs at Kawasaki and Atsugi. At Kawasaki, the focus is on information processing and telecommunications systems (including space). At Atsugi, the focus is on microelectronics-semiconductor devices and components; peripheral and terminal equipment; and materials. Total complement is about 1400 persons. Kawasaki has some 600 persons or about 43% of the science and engineering work force. The R&D staff comprises about 46% Masters, 11% Doctorates, 31% Bachelors, and 12% administrative and support.

Fujitsu is strongly oriented toward international cooperation.

R&D Topics Discussed

The R&D topics discussed were selected by the company:

1) High Speed Image Processing

Fujitsu is developing high speed image processing aimed at increasing productivity in manufacturing...
...Binary image processing - logic circuit diagrams
- mechanical parts diagrams
...Gray level image processing - visual inspection of parts

Fujitsu prototyped a ultra high speed image processor, IDATEN. This is a reconfigurable image processor of time-varying color image data at video rate. Treating basic arithmetic and logical operations as single instructions, it can process at speeds up to 500 MIPS using a new "variable structured pipeline architecture" which combines multiprocessing (medium fast but flexible) and pipeline processing (fast but inflexible) to create a machine that is both flexible and fast. It is based on the pipelining and multiple feedback via specialized processing machines (PMs) driven by a ring network. Edge detection at video rates for both still and time-varying images is a major goal. Main application is to moving object situations. Fujitsu developed a color video chip for this which processes an image matrix of 512 by 512 by 8 (RGB) at a speed of 100 ns. IDATEN is expected to be ready in about one year.

2) Software Engineering - Expert Systems

Working long term toward the goal of developing a knowledge-based development environment, Fujitsu is developing a Programming Consultant System based on LISP - PAL so as to...

...acquire programming knowledge from skilled use by programmers

...provide a natural language interface for the Japanese user

...enable a user to add knowledge in Japanese.

The knowledge base is set up as a "frame" structure with Verb, Term, Purpose, and Function to define a Skill. As a member of Sigma, Fujitsu is also working on a PROLOG version. LISP is seen as product-oriented and popular in industrial applications in the USA while PROLOG is seen as being more R&D-oriented.

3) Fiberoptics

- In LANS, they feel that R&D cooperation is not needed because existing products are already adequately developed. For example:

...Token Ring	10 MBps
...CSMA/CD	10 MBps

- In new media, especially mixed media at 205-410 Mbps, single mode at 410 Mbps, multi-mode at 205 Mbps for straight connection, PBX and CPU extension, they noted there are reasons to cooperate, namely...

...high-speed user-independent systems
...intelligent building systems
...composite visual networks,

and reasons not to cooperate, namely...

...standards are almost there in some cases.

In composite visual networks, Fujitsu stressed the need to be able to transfer data at very high speed. While there is no need for cooperation at the low end as standards now exist, there may be at the high end such as in 410 Mbps integrated service modules and in packetized methods to fax video (high speed, high capacity signals) to various sources.

Some fiberoptics (F/O) systems currently under development are:

a) High speed systems...

...1.6 GHz system* in production for NTT use in '88
...next goal is 6.4 GHz
...then coherent optical transmission

* using silicon IC for repeaters.

b) Subscriber systems...

...video transmission systems
...digital CATV systems

c) Optical CATV systems...

...a 3-level single-mode fiber (SMF), hub-based, bus-star digital all-optical fiber cable system with both uplink channel selection and downlink channel routing but with provision for a planned evolution to full viewer interaction. It uses modified time polarity control (M-TPC) and line code time division multiplexing LSI processors with edge-emitting LED and high-speed serial video data bus technology. The use of M-TPC...

...requires only half the trunkline's operating speed
...provides a built-in high-speed 4-channel MUX/DEMUX
...imposes a power penalty of only 3-5 dB

The edge-emitting LED's output is 18 dBm and the newly-developed optical sender laser feeds data up to 900 Mbps using 3-level SMF transmission over a trunkline up to 20 km with 4 optical taps without a repeater.

An experimental CATV system now being developed has 8 channels of NTSC-standard video plus 16 channels of PCM audio. Head-end to first-drop distance can be to 5 km away with each drop serving up to 8 hubs and each hub serving up to 32 subscribers. With this system, a subscriber can tune into 2 video channels each with 2 audio channels allowing sound for each. Requests are made uplink at 64 Kbps to the hub controller which then selects and routes the requested channel to the viewer at 200 Mbps. Expansion is easy and extensive viewer interaction in the future is possible.

4) Display Systems

In computer and related display technology, Fujitsu is working intently on flat panel displays as follows...

...a 6-inch diagonal active-matrix aximatic LCD color display of 960 x 960 pixels with:

- pixel area of 375 sq.mm.
- pixel size of .125 x .375 mm. for color picture
- contrast ratio of 25:1
- viewing angles of:

  50 deg horizontally
  40 deg vertically

...a new architecture using dual thin-film transistor (dual TFT) where each pixel has its own color memory and gate and built-in added redundancy for a greater yield design. A prototype 6-inch diagonal 120 x 90 sq.mm. TFT-LCD display panel has been developed featuring a 320 x 240 array of trio color dots (960 x 240 pixels of size .375 sq.mm.), contrast ratio of 35, 50-degree horizontal and 40-degree vertical viewing angles.

...a phase change LCD display of 640 x 400 pixels in which each pixel can be switched between a cholesteric (twisted) state and a nematic (straight) state to give a low or high transmittance.

...an EL display of 640 x 400 pixels with 4 lines per millimeter in yellow, green and red, but not blue yet.

...a monochrome plasma display showing a dark image on an amber background is now in production in 12 x 9 inch version. Fujitsu is now concentrating on expanding to very large-size displays.

Observations:

Fujitsu is greatly interested in exploring cooperative R&D with Canadian firms.

In optical digital CATV, three phases of development are planned:

In 1988, the current Phase 1 will move to 16-channel, then to 32-channel video, then possibly to still larger n-channel video. Planned progression is from bus-star in Phase 1 to bus-star with polling in Phase 2 and to overlaid double-star in Phase 3.

Phase 2 will develop a broadband ISDN subscriber system which will incorporate the sending of burst data uplink in response to periodic polling (eg, electric, gas, water, oil and other meter readings).

Phase 3 will introduce full interactive services such as 2-way video, voice and data between subscriber and the CATV center, or among subscribers themselves. There can be no doubt that this system will evolve to form a very effective core of a broadband integrated services digital netwoork or B-ISDN. Cooperative R&D at this early stage would seem most opportune.

Note: Fujitsu is not working on high intensity low energy light sources, but suggested looking at LED or capacitive discharge tubes and perhaps contact their electromechanical subsidiary-Fujitsu Kiden.

Hitachi, Limited

A leading diversified manufacturer of a wide array of electrical and electronic products.

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Met With:

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David Cohn, Visiting Researcher from Univ. of Washington
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Hitachi Discussion

Company Profile

Hitachi, founded in 1934, is a leading diversified maker of a wide array of products:

Information and Communications Products	38%
Consumer Products	20%
Power Systems and Equipment	23%
Industrial Machines	9%
Other	1%

Hitachi Ltd. (excluding affiliates):

Net sales '86	U$ 21,000 M
Capital	U$ 1,000 M
Net income	U$ 380 M
Employees	79,000
Expended for R&D	U$ 1.8 B or about 9% of sales

R&D policy aims are to:

- develop new "technology pillars" for 21st century
- feed new seedlings through creative research
- promote openness in world academic societies
- intensify systems orientation and software

There are 11,800 personnel doing R&D (3,650 at labs and 8,150 at work divisions). Dr. Watanabe is Head of R&D. The 8 Corporate R&D labs with the year founded and current personnel are:

- Central R&D Laboratory (1942/1300)
  - microelectronics
  - information technology
  - fundamentals
- Hitachi (1934/1300)
  - energy systems
  - control systems
  - electronics
- Mechanical Engineering (1966/650)
- Energy Research (1971/300)
  - nuclear
- Production Engineering (1971/540)
  - improvement of production facilities
- System Engineering (1973/400)
- Microelectronics (1983/140)
- Advanced Research (1985/80)
  - biotechnology
  - software
  - material science

The Central R&D Lab was founded to create new industry and business through:

1) Systems research - to capture latent social needs to create actual business

2) Materials and Device research - to achieve technological breakthroughs for "a jump" in quantity and quality

in the areas of:

- Fundamental R&D
- Information Technology R&D
- Microelectronics R&D

In Information Technology R&D in particular, they have priorities in many areas relating to:

a) in Computers:

- architecture and language
- artificial intelligence
- file storage

b) in Communications:

- new broadcasting media and networks
- advanced communication network

R&D Topics Discussed

1) Electroluminescence, EL

Though concentrated in phosphors, Hitachi is close behind SHARP et al, and catching up. Several problems remain:

- achieving adequate brightness for blue (Hitachi now has suitable materials for all colors except blue)

- eliminating hydrospectrocity (ie., permeability to moisture or deterioration over time from moisture penetration)

- high driving voltage and material cost

They noted their materials production method uses gas sources, not chemical "sputtering", ie., Metal Organics Chemical Vapor Deposition (MOCYD) and separate sources (ie., not combined).

They also noted that achieving a certain color is making a right selection of the manganese source

$ZnS.Mn$	$ZnS.TbF_3$
yellow	green

2) Drawing Recognition

Applications in map data acquisition, manipulation and display are of primary interest. To this end, they are working on:

- high-capacity color contour-map reading, vectorization and display
- computation and display of perspective from any vantage point.

3) Optical Image Filing

Many applications involve classifying, filing, finding and correlating information. Present methods are inefficient and ineffective. Sophisticated approaches based on Artificial Intelligence technology appear promising. A major effort is on intelligent filing and retrieval of information from a 2 Gbyte optical disk complete with knowledge data base, simple inference engine, and a natural language interface. User instruction is based on a "concept network" or "semantic query using inference", an approach which permits intelligent browsing. Libraries might find network interaction via a "Concept Browsing System" useful.

4) Large Display Gas Discharge Tube

- 100 mm x 125 mm pitch, small pixel or tube size is a problem because it will consume the same amount of power as a big one, thus for 2X the resolution, power is 4X
- gas discharge voltage is 300 V
- price is about C$100 (10,000 Yen) per inch
- power consumption for 8 in parallel is about 10 W
- viewing angle is about the same as a CRT

Observations:

Hitachi favors cooperative development, especially the direct participation of foreign scientists at their labs where a 15-20% English-speaking environment makes it easier to work.

Hitachi has a most constructive attitude whose aims are to:

- respect creativity
- eliminate the NIH (or " Not Invented Here") syndrome
- activate international collaboration by reciprocity

International activities encompass:

1) Promotion of research cooperation

   - collaborative research with foreign institutes (one in Ottawa)
   - accepting foreign scientists at Hitachi lab

2) Direct support to international symposia

3) Contributions to conferences including:

   - the sending of 200 persons per year

   - a Hitachi satellite seminar (Stanford & MIT)

Longer term cooperative R&D in Drawing Recognition and Optical Image Filing may appeal particularly to systems-oriented firms.

Oki Electric Industries Ltd

A leader in telecommunications and information processing systems and electronic devices. A participant in national projects in leading-edge technologies including: FGCS, high-speed logic, 3D integrated circuits, operation-specific robots, databases having versatile access from different computers and devices, digital signal processing, high capacity DRAM's, AI, machine translation, ultrathin high capacity graphic plasma display, high output semiconductor lasers for optical communications, digital information networks, intelligent building systems, and speaker independent voice recognition using "fuzzy set" theory.

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Oki Discussion

Company Profile:

Oki Electric Industry Company, Limited, founded 1881 by Kibataro Oki, pioneered the introduction of communications technologies in Japan. Now, Oki is a leading manufacturer of telecommunications systems, data processing systems, and electronic devices involved in specialized areas like optical communications systems, office automation, and digital electronics. Oki is thus well-positioned to capture a large share of the growing market for Information Technology based products.

Oki is an international company with state-of-the-art products in digital communications, office automation, optoelectronics and other applications in more than 100 countries worldwide. Oki's reputation for innovation and reliability is the result of its commitment to large-scale research and development and an ability to assess customer needs accurately.

Of all OKI labs, the R&D Group and Research Laboratory here has the newest technology. There are 4 labs and 1 technology center with 450 persons total; 400 are in R&D. Lab space here and in central Tokyo is 25,000 and 4,000 square meters respectively. The Research and Development Group comprises:

- an administration
- a research lab (200 PY)
- a systems lab
- a semiconductor technology lab
- a digital communications lab
- a compound semiconductor device center

1) **Research Lab** (Dr. Nihei in charge of 6 departments and 200 persons)

Information Processing Dept.
- speech processing section
- pattern recognition section

Information Terminals Dept.
- printing process section
- image processing section
- electromagnetic control section

Optical Technology Dept.
- display devices section
- optical function devices section

Hybrid Microelectronics Dept.
- printing devices section
- superconducting (SAW) devices section

Optoelectronics Dept.
- semiconductor lasers section
- optical circuits section
- optoelectronics devices section

Materials Dept.
- electronic materials section
- bioelectronic materials section

2) **Systems Lab (in Tokyo)**

R&D Planning Office
Knowledge Information Processing Dept.
- architecture section
- parallel processing section
- knowledge base section
- computer vision section

Office Systems Dept.
- AI workstation section I
- AI workstation section II
- Natural Language section
- AI section

Sonar Systems Dept. (for Department of Defence)
- signal processing session

Dr. Kobayashi's Special Office

3) **Semiconductor Technology Lab**

ULSI Technology Dept.
- lithography section
- fund processing section
- total processing section

Electronic Components Dept.
- high speed integrated devices
- high speed devices
- GaAs devices, digital and analog

Dr. Ishi's Special Office

4) **Digital Communication Lab (in Central Tokyo)**

Digital Communication Dept.
- digital coding, signal processing circuits, subscriber loop circuits, transmission circuits

Data Communications Dept.
- radar signal processing, signal processing architecture

Digital Signal Processing (DSP) Dept.
- signal processing, high performance DSP

5) **Compound Semiconductor Device Center (not a lab - started 1 year ago to boost business cash flow)**

Market Research
GaAs IC Development Dept.
- devices
- circuits

GaAs IC Process Dept.
- processing
- fabrication

Optoelectronic Device Development Dept.
- laser diodes
- optical devices

R&D Topics Discussed

OKI stressed they are working on all topics. The focus selected was because of limited time. They have over 100 papers. Mr. Sawaguchi can provide the names of the authors.

1) Man-machine interface

Input - output technologies are many and varied...

Input Technology	Output Technology
OCR: Alphanumeric Japanese Kana, Kanji - written - printed	Hardcopy: Impact printer Non-impact printer - thermal - optical (LED)****
Speech Recognition: Speaker-dependent* Speaker-independent**	Softcopy: Flat Panel Display (PDP, EL, LCD)
Image Reader: Image sensor (contact type CCD or a-Si***)	Speech Synthesis Speech coding (10-32 Kbps) Rule synthesis - in Japanese

File Memory
Storage is 3 MByte magneto-optic disk

* about 100 Japanese words
** about 32 Japanese words
*** a-Si used mainly for x-ray
**** LED-drum distance of 20 mm (cf. Laser-drum at 300 mm, same cost but LED more compact - may use for hi-speed G4 FAX

2) Speech Recognition and Systems (Morito)

OKI is working hard on speech processing ...

In Development:

- highly accurate recognition of speech input in "noisy" environments.
- a new method yielding accuracies to 97% in a computer-simulated noisy environment at a signal-to-noise (SN) ratio of 10dB to be prototyped next in portable hardware to carry out experiments in real noisy environments. The method uses -
  - spectral subtraction for noise reduction
  - local peak vectors for voice pattern expression
  - endpoints free local peak dynamic programming matching

  An '87 Paper in English by Morito and Tabe is available.
  - synthesis of natural speech at low bit rates using subband frequency encoding with 1:6 compression ratio. Subband voice sythesis utilizes Block Coding PCM (BCPCM) to record any kind of sound (music, speech, etc.) and can be applied to realtime analysis. Its high data compression (10-16 Kbps) is especially useful in voice storage systems (eg., voice mail, toys, floppy's, talking clocks/dolls).

In Research:

- voice input/output systems
- continuous speech recognition accurate to 97%

In continuous recognition of voiced speech in voice input/output systems for telephone networks, key research areas include ...

1) Processes:

- word spotting (ie., looking for keywords in any order)
- understanding a sentence
- answering structures and sequences

2) Applications:

- bank answering services
- operatorfree switching services
- reservation systems

3) Flat Panel Displays

a) Plasma Display Panels (PDP)

- Direct Current (DC) driven
- easy fabrication of large scale unit
- easy to get gray scale
- applicable to:
  Point-of-Sale (POS) equipment
  telecommunications terminals computers (including personal computers and bank terminals)

b) Electroluminescent Panels (ELP)

- thin film
- fine resolution
- high readibility (no flicker)
- wide viewing angle
- applicable to:
  automobile information displays
  aircraft cockpit displays

c) Liquid Crystal Display (LCD) Panels

- a-Si TFT Active Matrix Color LCD
- good color presentation
- low power consumption drive
- applicable to:
  portable office automation (OA) equipment
  portable home automation (HA) equipment
  automobile dashboard instruments
  industrial control instruments

Technical features of each Flat Panel Display:

Display	PDP	ELP	LCD
Width x Height (mm)	211 x 132	179.2 x108	192 x 120
Resolution (lines/mm)	3	3.7	3.33
Mode	emissive	emissive	transmissive
Color	neon-orange	orange-yellow	multicolor
Drive voltage	200	200	10

Their R&D target for flat panel displays over next 5 years is:

1024 x 1024 pixels, 6-10 dots/mm resolution, and full color.

4) Dielectric Filters

- Oki proposes to develop a microwave dielective ceramic which they believe is a most suitable composition, viz.,

$$(BaO)[(Sm_2O_3).742-(CeO_2).158-(La_2O_3).100](TiO_2)_4$$

Preparation Process:

weigh (starting materials)
•
mix (20-24 hours)
•
calcinate at 1080^0C for 2.5 hours
•
crush
•
granulate (adding binder)
•
form
•
fire
•
measure

Note: OKI is good at rare earth ceramic materials. Those with interests in microwave components may wish to follow this area closely and participate in the development of new materials and microwave components.

The proposed ceramic has temperature - independent resonant frequency (typically 835 MHz for a transmitting filter; 880 MHz for a receiving filter) and its Qu is very linear with respect to temperature. A small-size duplexer using it would be about 11 cu. cm. Typical resonant frequencies for transmitting and receiving would be 835 MHz and 880 MHz respectively in a filter application.

Observations:

The potential and environment for cooperative R&D is high in the topics discussed.

Their work in speech recognition is most advanced. Adaptation to English, French and other languages holds great promise for achieving cost-effective translation services for example.

Toshiba Corporation

Major maker of computer/communications systems and equipment. Products include: color television, business and personal computers, printers and displays. Research interests include: office automation, automated data acquisition, relational databases, machine translation, fiberoptic transmission, laser lithography, high resolution and flat panel color LCD display, high definition video and television, and robotics.

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Shun-ichi Sano, Senior Manager

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Dr. Taro Shibagaki, Research Scientist

Toshiba Discussion

Company Profile

Dr. Nagai spent a year at NRC as a Post Doctorate Fellow PDF

Total Employed PY = 70,000
Total Sales = 2,000,000 M Yen (C$ 20B)
Total R&D Budget = 6 - 7% of Total Sales (C$1.2B - 1.4B)
R&D Center Budget = about 1% of Total Sales (S$200 M+)

R&D Centre - Komukai Area of Kawasaki-shi

1800 persons total, 1100 in R&D

R&D Topics Discussed ...

1) Sensors, Lasers, Displays, Printers and Light Sources

Sensors
- a high performance CCD solid state image sensor with high sensitivity and high density aimed at HDTV - 640 x 480 pixels (each pixel 300 um square)
- a matrix-driven amorphous silicon contact image sensor that reads an A4 size document with 8 pixels/mm resolution and an optical path 1/10th that of a CCD image sensor
- linear sensors for humidity, temperature, electric power/ gas/water
- linear Ion Sensitive Field Effect Transistor (ISFET) pH sensors (48mV/pH over pH 4 - 10)
- ISFET-based flowrate sensors

Lasers
- communications (solid state types)
- industrial use (gas types)
- consumer use (solid state types) at 0.85, 1.3, 1.5, and 1.55 micron for optical disk use (30 mW)

Displays
- LCD only, no PDP or EL
- an amorphous silicon thin film transistor driven active matrix liquid crystal color flat panel (FP) display with large area (10 inch diagonal) and high definition (640 x 480 pixels)
- started work on larger size LCD but noted lack of machinery and glass substrate in large size
- aiming at horizontal resolution in EDTV much greater than 400 pixel

Printers/Copiers
- laser printers with organic drums for photocopiers
- no LED printer system but Toshiba as the largest Japanese maker, can readily supply OEM LED printer heads

Light Sources
- a 20 W fluorescent lamp with 60 - 70 W light output

Optical Disk
- a magneto-optic erasable disc using a highly reliable TbCo film with user capacity of 200 MBytes per side of a 13-cm diameter disk. TbCo is preferred for hard disk. CoCr is a topic of R&D for 2.5 inch diskette use.

2) Fiber Optic Systems

Fiberoptic star LAN -

- a single-mode optical fiber 1.6 Gbps digital lightwave transmission system for 50 KM and 23,000 phone channels
- a multimode fiber - optical coupler, an optical repeater and an optical transceiver for 33 Km
- a 400 Mbps IC for light transmission at 1.39 or 1.55 um wave length (repeater uses 4 chips)
- a low noise wideband front-end detector using InGaAs for high speed digital transmission optical LAN and CATV use
- a high speed, long wavelength avalanche GaAs-based photodiode for ultra-low threshold MQW laser. Threshold current versus stripe width is 1.1 mA/um
- an InGaP-based emitter diode for visible light laser pointers

Except for the 400 Mbps IC-based repeater, the transceivers et al. are still experimental and use discrete components.

3) Image Pattern Recognition Machine

Toshiba is working on a machine to recognize thin lines and identify symbols from a library of 200 symbols of Kanji, Kana, alphanumeric and other sets of characters.

In detail, it will...

...input and store an image by scanning with a TOSGRAPH digital high-speed high-resolution (8 pixel/mm) fax.
...store and vectorize entire image following the same scan order to get thin line vectors.
...regularize and catalog the thin line vectors.
...box in each symbol or character in turn and compare it with each symbol library repertoire.

A pipeline drawing with lines, alphanumeric, Kanji, Kana and other symbols was processed as an example. Used also for circuit recognition and circuit simulation.

Observations:

Dr. Nagai spent a year in Canada at the NRC as a Post Doctorate Fellow.

Toshiba is very receptive to cooperative R&D. All topics above are still largely experimental and thus open to cooperative R&D.

Firms involved in geomatics or in CAD/CAM may have an interest in the work in image pattern recognition.

There may be potential for cooperative R&D in high output low energy lighting for warning purposes.

APPENDIX B

OTHER PROSPECTIVE JAPANESE ORGANIZATIONS

APPENDIX B

OTHER PROSPECTIVE JAPANESE ORGANIZATIONS

This appendix identifies prospective Japanese organizations to consider for visits on any subsequent or follow-up survey for ITRD database development. Many are affiliates of the larger and more familiar companies of Japan. These are typical of "small to medium size" companies of Japan and may be a more fertile ground for cooperative R&D.

Anritsu Electric

Medium-size telecommunications maker. An affiliate of NEC. Taking to information and labor-saving equipment to reduce heavy reliance on NTT. Leader in measuring instruments for optical communications.

5-10-27, Minami-Azabu, Minato-ku, Tokyo 106
Phone: (03) 446-1111 Telex: 02422353

Asahi Chemical Industry

Integrated maker of synthetics. Largest maker of acrylic fibers. Aggressively diversifying into housing, pharmaceutical, new ceramic and optics related fields.

1-1-2, Yuraku-cho, Chiyoda-ku, Tokyo 100
Phone: (03) 507-2730 Telex: 02223518

Fuji Electric

Boasts world's largest market share in high-voltage silicon diodes and power transistors for switching power sources. Makes electronic parts, thick-film based IC's and information equipment.

1-1, Tanabe-Shinden, Kawasaki-ku, Kawasaki 210
Phone: (044) 333-7111 Telex: 382461

Fuji Photo Film

Has 70% of domestic film market. Putting extra emphasis on R&D. Stepping up development of electronic still cameras to bring up electronic image business.

2-26-30, Nishi-Azabu, Minato-ku, Tokyo 106
Phone: (03) 406-2111 Telex: 24306

Furukawa Electric

Among the top in electric wires and cables. Teaming up with Fujitsu in fiberoptic communications. Developing memory alloys at a subsidiary.

2-6-1, Marunouchi, Chiyoda-ku, Tokyo 100
Phone: (03) 216-1738 Telex: 02222365

Ikegami Tsushinki

Leading comprehensive maker of broadcasting equipment. Developing new media technology, including TV and video processing.

5-5-16, Ikegami, Ohta-ku, Tokyo 146
Phone: (03) 754-2121 Telex: 2466738

Japan Aviation Electronics Industry

A NEC subsidiary specialized in connectors and aerospace electronics. Biggest maker of industrial use connectors. Strong in inertial navigation equipment and advancing into applied products. Expanding in Office Automation (OA) equipment.

1-21-6, Dogenzaka, Shibuya-ku, Tokyo 150
Phone: (03) 463-3111 Telex: 2423345

Kyocera

Pioneer in ceramic packages. Also engaged in electronic products including Office Automation (OA) equipment. Active in technical development. Inaugurated telecommunications equipment joint venture with Philips of the Netherlands.

5-22, Kita-Inouecho, Higashino, Yamashina-ku, Kyoto 607
Phone: (075) 592-3851 Telex: 05422479

Matsushita Communication Industrial

A subsidiary of Matsushita Electrical Industrial and leading maker of communications equipment technology for industry.

4-3-1, Tsunashima-Higashi, Kohoku-ku, Yokohama 223
Phone: (045) 531-1231 Telex: 3822671

Sanyo Electric

Major integrated maker of home electric and electronic appliances. Planning broad range of cooperation with Kodansha group in the new media field.

2-18, Keihan-Hondori, Moriguchi City, Osaka Pref. 570
Phone: (06) 991-1181 Telex: 63363

Sony Corporation

Worldwide maker of audio equipment, TVs and VTRs. Has started own production of optical video discs.

6-7-35, Kita-Shinagawa, Shinagawa-ku, Tokyo 141
Phone: (03) 448-2111 Telex: 2424218

Tamura Electric Works

Medium-size telecommunications equipment maker. Moving into data communications equipment.

2-2-3, Shimo-Meguro-ku, Tokyo 1523
Phone: (03) 493-5111 Telex: 2466218

Toyo Communication Equipment

Medium-size telecommunications equipment maker. A NEC affiliate. Strengthening in the information related field.

3-20-4, Nishi- Shinbashi, Minato-ku, Tokyo 105
Phone: (03) 436-1300 Telex: 03842185

Victor Company of Japan

A subsidiary of Matsushita Electric Industrial and leading maker of audio equipment and VTRs. Stressing information equipment.

4-1, Nihonbashi-Honcho, Chuo-ku, Tokyo 103
Phone: (03) 241-7811 Telex: 26222

APPENDIX C

SURVEY TOPICS

INTERNATIONAL COOPERATION IN INFORMATION TECHNOLOGY R & D

R&D SURVEY TOPICS

(08-14-1987)

1. Image & Voice Synthesis

    1. visual pattern recognition
    2. voice recognition

2. Dielectric Ceramic Materials

    1. sensors
    2. heat and corrosion resistant ceramics
    3. superconductive ceramics
    4. transmission (e.g. microwave 5-channel combiner)

3. Parallel Processing Systems

    1. operating systems
    2. software modules & tools

4. Display Systems

    1. high efficiency, high intensity displays
    2. electroluminescent, electrochromic displays
    3. high resolution graphics display systems
    4. wide band variable scanning colour display
    5. flat panel display

5. Light Sources

    1. solid state light sources for film recorders
    2. blue lasers with frequency doubling for film recorders
    3. high power ultraviolet sources for printed circuit board production, (direct-read-after-write) (DRAW) films

6. Expert Systems/Artificial Intelligence

   1. intelligent databases
   2. tools & techniques for software engineering
   3 diagnostic expert system shell

7. Printed Circuit Board Production Techniques

   1. direct writing on PC laminates

8. Radar

   1. radar chromograph, millimeter wave guide - 60 GHz range
   2. sidelooking airborne radar, resolution improvement, frequency stability
   3. high power coherent power sources

9. Videotex/Teletext

   1. NAPLPS videotex in Korean, Chinese, Japanese & Thai languages

10. Application Specific Integrated Circuits Development (ASIC VLSI Circuits)

   1. transmission systems T1, T2 & T3 carrier systems
   2. ISDN devices & components
   3. automated design techniques of system level ASIC's
   4. RF synthesizers to 400 MHz

11. Satellite Based Sensors

   1. sensors for topographic & planimetric mapping

12. Fiber Optics

   1. intelligent buildings system design techniques
   2. small-scale fibre optic telephone-transmission system for use between and with large buildings (direct and/or packet switched)
   3. integrated voice/data/video/power/control services
   4. integrated interfaces (radio/telephone)
   5. 100 Mb/s fibre optics LAN
   6. optical fibre couplers (active & passive)

ITRD DATABASE CATEGORY/TOPIC LIST

(08-14-1987)

1 - Communications Technology
- 1 - Telecommunications Networking
- 2 - Transmission Media
- 3 - Modulation and Encoding
- 4 - Switching and Multiplexing
- 99 - Other

2 - Communications Systems
- 1 - Radio and Television Broadcast System
- 2 - Communications Satellite System
- 3 - Mobile Communications System
- 99 - Other

3 - Communications Networks
- 1 - Computer Communications Protocols
- 2 - ISDN
- 3 - Local Area Networks
- 4 - Value Added Networks
- 5 - Broadband Networks for Video, FAX, Etc.,
- 6 - Communications Network Mgmt.
- 99 - Other

4 - Office Automation Systems
- 1 - Text and Graphics Creation, Manipulation, etc
- 2 - Database Management
- 3 - Electronic Mail and Messaging
- 4 - Electronic File Transfer and Decision Support
- 99 - Other

5 - Computer Systems and Applications
- 1 - Image Recognition and Processing
- 2 - Voice Recognition
- 3 - Distributed and Parallel Processing Systems
- 4 - Supercomputers
- 5 - 5th and 6th Generation Computers
- 99 - Other

6 - Software Automation
- 1 - Relational Database Storage and Retrieval
- 2 - Computer Aided Education and Instruction (CAE/CAI)
- 3 - Computer Aided Design and Manufacturing
- 4 - Computer Integrated Manufacturing
- 5 - Computer Aided Translation
- 6 - Computer Aided Animation
- 7 - Electronic publishing
- 99 - Other

7 - Human-Machine Interface
- 1 - Intelligent Input/Output
- 2 - Speech Recognition
- 3 - Voice Recognition
- 4 - Visual Pattern Recognition
- 5 - Visual Display and Printing
- 6 - High Definition Television
- 7 - Flat Panel Display
- 8 - Three Dimensional Display
- 9 - Laser Printing
- 10 - Image and Sound Synthesis
- 99 - Other

8 - Components, Devices & materials
- 1 - Microelectronics
- 2 - Optical and Optoelectronic Devices
- 3 - Sensors and Transducers
- 99 - Other

R&D SURVEY - ITRD DATABASE TOPICS CROSS-REFERENCE

(08-14-1987)

SURVEY	DATABASE
1.1	7.4
1.2	7.2 7.3 7.10 5.2
2.1	8.3
2.2	8.99
2.3	8.99
2.4	8.99 1.4 1.3
3.1	5.3
3.2	5.3
4.1	7.5
4.2	7.5
4.3	7.5 4.1
4.4	7.5
4.5	7.7
5.1	8.99 8.2
5.2	8.99 8.2
5.3	8.99 8.2
6.1	4.2 6.1 7.1
6.2	6.1 6.3
6.3	6.1 6.3 6.1 6.3
7.1	8.99
8.1	1.99
8.2	1.99
8.3	1.99
9.1	3.1 4.1 7.5
10.1	8.1 1.1 2.99 3.2 3.3
10.2	8.1 1.1 3.2
10.3	6.3 8.1
10.4	8.1 1.99
11.1	8.3
12.1	6.3 3.3 3.4 3.5 4.3 7.1
12.2	1.1 1.4 3.3 3.4 3.5 4.3
12.3	3.5 3.3 3.4 4.3
12.4	1.1 3.1
12.5	1.1 3.3
12.6	8.2

APPENDIX D

ABBREVIATIONS

ABBREVIATIONS

3D = three-dimensional, as in 3D pictures

5GCS = see FGCS

Ag = silver

AI = Artificial Intelligence

ASIC = Application Specific Integrated Circuits

ATM = Automated Teller Machine, as in banking

ATR = Advanced Technology Research Corp.

B = Billion (1,000,000,000)

BTSP = Binary Time Spectrum Pattern

CAD = Computer-Aided Design

CAE = Computer-Aided Engineering

CAM = Computer-Aided Manufacturing

CAPTAIN = Character And Pattern Telephone Access Information Network, Japan's videotex system

CASE = Computer-Aided Software Engineering

CATV = Community Antenna Television, typical cable TV system

CCD = Charge-Coupled Device or image sensor for video cameras

CD = Compact Disk

CEPT = Conference of European Post and Telecommunications

CHI = Cooperative Hierarchical Inference

CoCr = Cobalt Chromium

CPU = Central Processing Unit

CRT = Cathode Ray Tube

CS = Communications Satellite

CTV = Color Television

DAT = Digital Audio Tape-recorder

DEMUX = Demultiplex, as in reassembling time sequence of signal samples to their proper channel as result of previously having been Multiplexed (see MUX)

DRAM = Dynamic Random Access Memory

DSP = Digital Signal Processing

EB = Electron Beam, as in EB lithography

EDTV = Extended Definition Television

EFT = Electronic Funds Transfer

EIP = Electronic Item Purchase

EL = Electroluminescent, as in EL display

EWS = Electronic Work Station

FA = Factory Automation

FP = Flat Panel, as in FP Display

FAX = Facsimile

FGCS = Fifth Generation Computing System

G3 = Group 3 Facsimile

G4 = Group 4 Facsimile

GaAs = Gallium Arsenide

Gbps = Gigabits per second, or 1,000 Mbps

GKS = Graphical Kernel System

HDTV = High Definition Television

HFP = Human Frontier Program

HFSRP = Human Frontier Science Research Program

IC = Integrated Circuit (see also LSI, VLSI, ULSI)

ICOT = Institute for New Generation COmputer Technology, estab. April '82 to promote the FGCS project

IDATEN = Fujitsu's ultra-fast color image processor

INS = Information Network System (see also ISDN, ISN)

IPA = Information Technology Promotion Agency, estab. '86 to oversee the Sigma software project to rationalize and automate the production of software generation systems for greater productivity

ISDN = Integrated Services Digital Network (see also INS, ISN)

ISN = Japan's ISDN which includes, inter alia, the CAPTAIN Videotex/Teletext System (see also ISDN, INS)

ISP = International Standard Profile, relating to OSI

JNAPLPS = NAPLPS with Japanese Kana and Kanji added

Kana = Japanese phonetic characters: Hirigana for words of Japanese origin; Katagana for words of foreign origin

Kanji = Chinese ideographs used in Japanese

KDD = Kokusai Denshin Denwa Co., Ltd., providing all international telecommunications services including telephone, telegraph and data communications

KTR = Key Technology Center, estab. October '85 by MPT to address issues of rapid change and rising impact of other nations on electronics and telecommunications and to fund relevant research via organizations such as ATR in Osaka

Lan = Local Area Network

LC = Liquid Crystal

LCD = Liquid Crystal Display

LED = Light Emitting Diode

LSI = Large Scale Integration, referring to ICs incorporating electronic circuitry on a large scale

MB = Megabytes (1,000,000 bytes)

Mbps = Megabits per second (1,000,000 bits per second)

MITI = Ministry of International Trade and Industry

MPT = Ministry of Posts and Telecommunications

MT = Machine Translation, as in Natuiral Language Processing

M-TPC = Modified Time Polarity Control

MUX = Multiplex, as in dissassembling signals on multiple channels as a predetermined time sequence of signal samples (see DEMUX)

NAPLPS = North American Presentation Level Protocol Syntax, a joint USA/Canada standard for videotex/teletext displays

NHK = Nippon Hoso Kyokai, or Japan Broadcasting Corporation, Japan's only government-operated broadcaster

NL = Natural Language, as in Japanese, English, and French

NLP = Natural Language Processing, translating from one NL to another or using NL for a user-friendly input/output

NTSC = National Television Standards Committee, referring to the television broadcasting standard used by USA/Canada

NTT = Nippon Telephone and Telegraph Corp., Japan's provider of all domestic telecommunications services, including telephone, telegraph and data communications

OA = Office Automation

AOSYS = Office Automation System

OCR = Optical Character Recognition

OSI = Open Systems Interconnection

PBX = Private Branch Exchange, a unit for local switching of calls by a telephone operator in a large office

PC = Personal Computer or Printed Circuit depending on the context

PCM = Pulse Code Modulation

PHIGS = Programmer's Hierarchical Interactive Graphics Standard

PHIGS+ = PHIGS extended to three-dimensional graphics

PIN = refers to PIN diode, a power diode where a silicon wafer of nearly equal p-type and n-type impurities is infused with extra p-type impurities from one side and extra n-type from the other to yield a lightly-doped intrinsic layer in the middle

Pixel = Picture Element

PLZT = Lead Lanten Zirconate Titanate, for optical switching

POS = Point Of Sale

PSI = Personal Sequential Interference, as in PSI Machine

ROM = Read Only Memory

RRL = Radio Research Laboratory, the sole research institute attached to MPT

SAW = Software Analysis Workstation or Surface Acoustic Wave depending on context

SID = Society for Information Display

SMF = Single Mode Fiber, as in fiberoptics

SQUID = Superconducting Quantum Interference Device, usually a superconducting ring with 1 or 2 Josephson junctions

SrS = Strontium Sulphur, as in bright EL Flat Panel displays

SrSe = Strontium Selenium

TbCo = Tibium Cobalt

TFEL = Thin Film Electroluminescent, as in TFEL FP displays

TFT = Thin Film Transistor

TFT-LCD = TFT-addressed Liquid Crystal Display

TRON = The Real-time Operating Nucleus, a 32-bit architecture digital computer as proposed by Prof. Ken Sakamura, of the Information Science Department, Faculty of Physical Science, University of Tokyo

ULSI = Ultra Large Scale Integration (see IC, LSI, VLSI)

um = micrometer, one millionth of a meter

VLSI = Very Large Scale Integration (see IC, LSI, ULSI)

VRS = Video Response System

W = Watts

KWAN, A.
--Potential for international cooperation in information technology R & D in Japan