THE JAPANESE SPACE AND REMOTE SENSING PROGRAMS

A REPORT OF A VISIT TO JAPAN, 5 - 13 MAY, 1975

UNDERTAKEN ON BEHALF OF EMR BY

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CONTENTS

		PAGE
1.0	Introduction	1
2.0	Discussions with Agencies	2
2.1	Ministry of Posts and Telecommunications	2
2.2	Science & Technology Agency	2
2.3	National Space Development Agency	3
2.4	NAC Incorporated	3
2.5	Mitsubishi Research Institute Inc.	3
2.6	The Keidanren	4
2.7	University of Tokyo, Research Institute of Productivity	4
2.8	The National Research Institute of Resources (NRIR)	4
2.9	Japan Meteorological Agency and Institute	5
2.10	Asia Air Survey Company Ltd.	6
2.11	Kimoto and Company Limited	7
2.12	Toshiba Research Laboratories	7
2.13	Maritime Safety Agency	8
3.0	Tanegashima Space Centre	8
4.0	Conclusions, Tentative Ideas and Recommendation	10
4.1	Conclusions	10
4.2	Tentative Ideas for Discussion	11
4.2.1	Introduction	11
4.2.2	Meetings of Experts	11
4.2.3	Studies of Satellite Systems	12
4.3	Recommendation	13

LIST OF APPENDICES

1	Names of Persons met by J. MacDowall	15
2	Japanese Addresses	17
3	US/Japan Technology Exchange Agreement	20
4	Presentation to Keidanren of Japan	22
5	Space Program Summary and Budget	39
6	National Institute of Resources (STA)	42
7	Publications Collected in Japan	45

VISIT REPORT

JAPAN 5-13 MAY 1975

TOKYO AND TANEGASHIMA SPACE CENTRE

1.0 INTRODUCTION

In November, 1974, the Canada Centre for Remote Sensing (CCRS) of DEMR started a joint project with the Japanese Science and Technology Agency (STA) when Mr. Hiromasa Suzuka of STA commenced a three-year period of work in the CCRS facilities. The CCRS liaison officer was Mr. Joseph MacDowall. The resulting increased exposure to the Japanese space programs, particularly their remote sensing activity, indicated the need for CCRS to obtain first hand knowledge of Japanese work. The Canadian Department of External Affairs (EA), Scientific Relations and Environmental Problems Division confirmed that such a visit to Japan was timely from their point of view.

On April 2, 1975, it was decided by DEMR, Science and Technology Sector, that the nature of remote sensing, and related developments in Japan should be studied at first hand. Detailed arrangements for the visit were made by Mr. Suzuka with assistance from the Science Officer at the Canadian Embassy in Tokyo, Dr. R.H.J. Bower. The visit was co-ordinated with a similar mission undertaken by Dr. C.A. Franklin, Department of Communications. The DEMR was represented in Japan by Mr. J. MacDowall from the Canada Centre for Remote Sensing.

1.1 ITINERARY

The itinerary followed by Mr. MacDowall is given below:

May 5 - Discussions with Canadian Science Officer*

May 6 - Ministry of Post and Telecommunications*
- Science and Technology Agency*
- National Space Development Agency*
- Newspaper Interview

May 7 - NAC Incorporated (Remote Sensing Equipment and Instrument Development Company)
- Mitsubishi Research Institute Inc.
- Address to Keidanren (Federation of Economic Organizations)* on the Canadian Remote Sensing Program

May 8 - Tokyo University Research Institute of Productivity (Land Use Maps by Computer Analyzer of ERTS)
- National Research Institute of Resources
- Japan Meteorological Agency

May 9 - Asia Air Survey Co. Ltd.
- Kimoto and Co. Ltd. (Developers of Meteorological Satellite Reception Stations and Remote Sensing Analysis Equipment)
- Toshiba Research and Development Centre

May 10 - Maritime Safety Agency and Hydrological Service

May 11 & May 12 - Tanegashima Satellite Launching Facilities of NASDA*

May 13 - Prepared report for Canadian Science Officer for consideration by Canadian Official Delegation to Japan

For the items marked with an *, Mr. MacDowall was accompanied by Dr. C. Franklin, who will be preparing a separate trip report. Mr. Suzuka accompanied Mr. MacDowall on all the visits to Japanese agencies.

2.0 DISCUSSIONS WITH AGENCIES

On each visit the procedures followed were similar. The Canadians were met by about five Japanese from the highest level. A summary of the agency program was given followed by details of the Canadian program. Four packages of publications on the activities of CCRS were taken to Japan, two sets were left with the Canadian Embassy, Science Officer, one set given to STA and another to the National Space Development Agency, NSDA. Literature in English, of Japanese activity was collected and shipped back to Canada after it was scanned by the Embassy. Publications are listed in Appendix 7.

After the mutual exchange of information, several questions were asked by both sides. It was recommended by the Embassy that key questions be asked at each visit to government agencies since the Japanese decision-making process involves wide consultation. The following key questions were asked:

- What would be the conditions attached to Canadian use of Japanese launch facilities?

- Can Canada read out the Japanese ISS satellite?

- In which government facilities could Canadian scientists or engineers work for periods of up to three years?

- How can we increase the flow of detailed information from Japan to even up the technical information exchange between the two countries?

When visiting a government or industrial laboratory, the meeting included a tour of relevant facilities. The tours were thorough and included an opportunity to talk to the technical people at the working level. Answers to technical questions, at this level, were direct and included detailed technical information.

In almost all cases, the visit proved to be the first Canadian visit. The evidence of visitors from the United States was extensive. Strong links exist between Japan and the USA at all levels.

A complete list of all persons met, together with addresses and phone numbers is given in Appendix I.

2.1 MINISTRY OF POSTS AND TELECOMMUNICATIONS

As a prime user of space technology, this Ministry was considered to have an important influence on any Japan-Canada relations.

In reply to our questions, MPT said they agree to the principle of Canada reading out from the ISS satellite. The details could be arranged by the Japanese Radio Research Laboratories (RRL). RRL have a microwave program and have some interest in remote sensing. MPT did not anticipate any major problems in hosting a Canadian at RRL for a two-year period. Details would have to be worked out with RRL.

An important point was raised by Mr. Sonoyama regarding a USA-Japan agreement which prohibits the leakage of certain technological information to third countries. (See Appendix 3) This point was also addressed during visits to STA and NASDA. The United States maintain a liaison officer in Japan to look after this agreement. It was felt by the Japanese that this would need careful handling and they did not have much experience in dealing with this kind of situation.

MPT said that they had an interest in the Space Shuttle as a means to test out microwave devices. They are interested in satellite to satellite communication.

2.2 SCIENCE AND TECHNOLOGY AGENCY

This agency, as an agency of the Prime Minister's office, is considered to be the lead agency for all experimental projects.

The key questions were asked again and the problem of the US-Japan agreement was raised. In addition, many Japanese companies have very close working arrangements with US companies.

Oceanographic work, the possibility of co-operation on the Japanese CS, BS, or ETS 3 satellites was mentioned. Japan has only just heard of SEASAT. The idea

2.2 CON'T

of co-operation on presently defined satellites is difficult for a number of reasons, including the "technological leak" problem referred to above.

The Canadian capability for ERTS ground station construction was emphasized. No Japanese funds have yet been identified, but they are optimistic for next year.

The idea of "no funds across the border" joint programs was raised. STA agreed to look at this idea.

The possibility of holding regular meetings of experts was raised.

2.3 NATIONAL SPACE DEVELOPMENT AGENCY

It was made clear that NASDA was too concerned with making a success of their on-going program to spend much time on international programs. They defer to STA in this regard. The budget and capability of NASDA was reviewed.

The total Japanese space budget was increased by about 34% in 1975 to 77.039 billion yen (270 million). A larger launch vehicle program was started to give 350 kg in synchronous orbit by 1980 and 500 kg in the mid 1980's. some new spacecraft were added to the program.

The key questions were asked again adding some detail. Mme Sauve's statement of 16 July 1974 was referred to regarding Canada's reliance on others for launch facilities. NASDA have no policy on this matter and agreed to consider it.

With regard to any such possible joint programs, NASDA considered the most appropriate first agency to undertake negotiations would be STA.

The possibility of holding regular meetings of experts was mentioned, as a means of evening up the information exchange.

2.4 NAC INCORPORATED

NAC Incorporated is a small but dynamic private company concerned with the development of remote sensing hardware. Equipment is developed by NAC for the acquisition and analysis of remotely sensed data. The emphasis is on airborne multispectral scanner and multispectral photography.

Toured were the electro-optical development laboratory, the camera workshop and the production assembly shop.

Some time ago, NAC acquired a Bendix MSS and have now developed both ground and airborne analysis and quicklook systems to go with the Bendix. This includes an interactive colour display with a facility for plotting out spectral signatures. NAC plan to do the marketing of the airborne quicklook system for the Bendix MSS.

NAC already have a colour density slicer on the market - the model 1200. This is being developed further through models 4200 and 5200, into a complete analysis system connected to an IBM minicomputer and having a plumbicon reader and a laser recorder output. One input to this system will be provided by a multispectral camera they have developed which uses a f2.0, 150mm lens having no vignetting for f numbers greater than 2.8. The camera has four lenses for the four bands so that four images fit on one 9 x 9-inch film. It is equipped with a LED annotation system, a grey scale, and independent automatic exposure control on each waveband. Interest was expressed in the NRC/FMI radar with a view to integrating the altitude outputs and tree heights into this system.

The Company was asked if they planned to exhibit at the 3rd Canadian Symposium on Remote Sensing. Later in the week they called to say that they did plan to exhibit in Edmonton.

2.5 MITSUBISHI RESEARCH INSTITUTE INC.

Interest in remote sensing by Mitsubishi commenced in 1973 as a research activity. Support comes out of a $300 million allocation set aside for social development. Co-ordination of the work is arranged through STA.

In June 1975 an industrial seven-company grouping of air survey companies and Mitsubishi will be set up. It will be called the Japan Remote Sensing

2.5 CON'T

Centre (JRSC). MRI will look after software development, possibly in collaboration with Earthsat Corporation of Washington, D.C. The JRSC will have twenty to thirty persons in it at first, plus some outside specialists from the seven component companies. They will aim to do research which will lead to the development of new services that can be sold by the air survey companies.

Two years' work on the digital analysis of ERTS tapes has been done by MRI. To date twenty million yen ($70,000) has been spent. The rate of spending will increase. The analyzed output was displayed as a dot printer and as a colour output using the Tokyo University electron beam recorder. The ultimate applications include land use, updating maps, population density maps. The land use work was being sponsored by a new Japanses agency for land use.

Mitsubishi are considering the purchase of a GE Image 100.

MRI has a large IBM computer set up. Included was an automatic magnetic tape store and dispenser, manufactured by Itoki. It holds 6000 magnetic tapes and automatically delivers your tape under push button control.

2.6 THE KEIDANREN

The Keidanren is a federation of economic organizations in Japan. The presidents of most major Japanese companies are members, together with an upper crust of the government agencies. They have a palatial building in Tokyo complete with a large lecture hall and multi language simultaneous translation facilities.

A lecture on the Canadian national program on remote sensing was invited by the Keidanren. About two hundred persons attended, including the highest level of representation from most of the agencies visited by the CCRS-EMR representative. The forty-five minute presentation was well received and the question period was an active one.

The lecture avoided repetitious presentations during the visits and greatly facilitated the discussions. A quarter-page newspaper article on the visit was also published during the week.

The presentation was tape recorded, transcribed and returned to the author with a view to publication in the Keidanren monthly magazine. A transcript of the presentation is given in Appendix 4.

2.7 UNIVERSITY OF TOKYO, RESEARCH INSTITUTE OF PRODUCTIVITY

Professor Murai is a member of the STA digital processing committee. They have developed software to analyze an ERTS CCT of the Tokyo area. The aim is to produce colour maps at 1:50,000 scale with shades of colours related to land use. These maps are intended for strategic land use planning purposes and do not replace conventional land use maps. A rather simple colour presentation is used which allows one to appreciate the relative magnitude of two bands of ERTS. Considerable attention has been paid to the problems of image rectific-ation with a view to improving mapping accuracy. Up to 35 ground correction points have been used. The relative accuracy of polynomial correction programs up to the 5th power were tested.

2.8 THE NATIONAL RESEARCH INSTITUTE OF RESOURCES (NRIR)

The meeting was held at STA. The participants in this meeting came from several locations. Each person looks after a different facet of the remote sensing of resources. Japan does not have a government agency equivalent to the CCRS but STA co-ordinate the work. The industrial group referred to in 2.5, which will call itself the Japan Remote Sensing Centre, will be guided by STA. The Director of the National Institute of Resources, N. Makimura, is located at the Science and Technology Agency, Tokyo. (See also Appendix 6)

In the introduction, it was explained that Japan did not have a government National remote sensing centre. However, work was being fostered in each appropr-iate area through NRIR and STA. In addition, non-government agencies are doing work. An example was quoted as

2.8 CON'T

the Blue Sea and Green Land Foundation (BSGF) sponsored by the speedboat operators. The BSGF gets its funds from the government, however, to do remote sensing from a YS-11 aircraft for coastal zone studies.

Japan is keeping her options open on the development of a centralized government remote sensing centre, because a number of factors need to be considered and some important decisions have not yet been made. NSDA have a proposal to set up an ERTS reception station. Although this was not approved for 1975, it may be in the 1976 program. The location for the reception station would probably be at the NSDA Tsukaba Centre. Japan does not have an ERTS agreement with NASA. A factor in the delay of the ground reception station may have been the relatively low resolution of ERTS by comparison with the size of Japanese fields, the scale on which land use changes and the range of detail with which the country is normally mapped. With regard to airborne services for any remote sensing centre, these would be provided by private industry.

Chiba University, Institute of Colour Technology looks after the NRIR program for the development of photographic techniques. Included are camera development, photographic analysis, and image production and analysis methods. Dr. Genda, who is in charge of the work at Chiba, has compiled a file of ERTS images of Japan. Fifty ERTS images cover the whole country. A collection of these images was presented to CCRS. Japan does not copy and distribute ERTS images. When asked why, Dr. Genda said, "Because US NASA does not allow this." The team at Chiba have used a Daedalus Multispectral Scanner for coastal water depths. The two bands centered at 530 and 750 nm were used for this work. A compact two-band camera has been developed at Chiba working at 530 and 750 nm. This utilizes a dichroic mirror to separate out the wavebands so that only one lens is required. Examples of the products from the two-band camera were examed together with photographically produced colour density slices of the images.

Mr. M. Onoue is responsible for the work in the field of digital data analysis. The work is done in cooperation with Professor Murai (see para 2.7) and the Tokyo University Institute of Industrial Science. Software has been developed for image rectification, ERTS CCT reformatting, cluster analysis, and two-band colour presentation for land use analysis. Hardware systems, like Image 100 and MMIP (Man-Machine Interactive Processor for satellite weather data), are developed by the Institute of Industrial Science.

The application of remote sensing techniques to Japanese forest problems is the concern of Mr. Nakajima. They have worked to speed up and reduce the cost of interpretation for forest wind damage and disease survey. They find that seasonal change is very important. They are also concerned with crop estimation and environmental problems. A forest survey of Japan is done every five years. Considerable interest was expressed in the forest tree height radar developed in Canada by NRC in collaboration with FMI.

2.9 JAPAN METEOROLOGICAL AGENCY AND INSTITUTE

The JMA has 110 persons working on satellite meteorology and plans to have 300 by 1977. Their budget for ground stations is 13 million yen ($45 million). The satellite activities are concerned with the receipt, analysis and use of the polar orbiting and synchronous orbit meteorological satellites. Japan is having constructed one of the five synchronous orbit satellites for GARP. The Japanese satellite will be at 140°E longitude. NSDA are in charge of the satellite development work up until it is proved out as operating. The planned launch date for GMS (Geostationary Meteorological Satellite) is 1977. Dr. Kodaira looks after the GMS project. Mr. Terauchi gave the report on the project.

The South Kanto Plains Project of JMI was reviewed by Dr. Takeuchi. This is a meso-meteorological project with the aim of providing information pertinent to pollution dispersion and distribution. Lidars and non-lifting balloons will be used in addition to the usual range of conventional meteorological instrumentation.

2.9 CON'T

The agrometeorological effort was described by Mr. Yasuda. Long range weather forecasts for national planning purposes are prepared for 3 months ahead, and for one month ahead. The Ministry of Agriculture also have an agrometeorological activity at their institute.

During a tour of the facilities examined was the Satellite Data Production System (SDPS) of JMA. All the reception, analysis and display system is made in Japan by the Kimoto Company. The receiver is located 20 km away and reads out the NOAA series of polar orbiting satellites. Just before the readout time, an automated system does a check out of the equipment. The image is rectified in real time. The image is created on film by means of an argon laser. The complete system was handled by one person. A Kimoto colour density slicer was available for image analysis.

The team was asked if they had any regular contact with the Canadian AES. They replied, "No, we have no contact with AES; however, one of our junior staff members has an NRC PDF in the AES laboratory and will be there for one year".

JMA and JMI would be prepared to consider hosting suitably qualified Canadians for a period of 2-3 years.

2.10 ASIA AIR SURVEY COMPANY LIMITED

Asia Air is a well established air survey company which has been able to add remote sensing capabilities to conventional air photo activity. The company operate five aircraft and has a staff of 400 persons. Their airborne equipment includes a Fujitsu far infrared line scanner, a PRT-5 radiometer, a Daedalus 11 channel multispectral scanner, an I^2S multispectral camera, and the usual survey cameras for conventional photogrammetric work. The ground analysis equipment includes a NAC colour density slicer, microdensitometers, Toshiba/Ampex recorders for handling CCT's, the Gestalt automatic stereo plotting system, and manual stereo plotters.

The Company has been active in a number of fields. Examples were compiled in a well prepared sales brochure. (See Appendix 7, Item 25). They do not normally acquire data for user evaluation and interpretation, but undertake the complete task including interpretation. A typical charge for a small project would be $8,000. The following examples of recent projects were given:

- survey of vegetation in urban areas;
- environmental surveys before and after civil engineering works;
- study of green belts around cities;
- forest inventory, particularly in SE Asia and Indonesia;
- thermal pollution studies;
- lake water quality survey;
- agricultural land use and crop estimation;
- stereo plots of Siguka 7th century wooden masks so that they could be replaced and repaired if damaged;
- stereo plots of female figures for the purposes of improving foundation garment manufacture;
- archeological site survey;
- mosaic production.

The well-qualified staff were familiar with the advantages, and limitations of modern remote sensing techniques, and the developments in North America.

The Daedalus 11 channel MSS had been given 20 hours of flight testing to December 1974. It was considered to be an experimental system still under test with problems still to be ironed out. They would probably use the NAC ground data analysis system when finally developed.

Asia Air and Gestalt International of Vancouver have formed a joint, 50-50 company in Tokyo to exploit the automatic stereo plotter. Another joint company called Mitsu/Asia was referred to which was set up for the purpose of expanding

2.10 CON'T

activities in SE Asia.

Keen interest was expressed by the President of Asia Air in the Canadian radar for tree heights (NRC-FMI development). To protect Canadian investment it was suggested that a joint company could be set up in the same way the Asia Gestalt Company was established. This suggestion was brought to the attention of the ITC representative at the Canadian Embassy, Mr. D.J.T. Winfield.

With regard to their future development, the executives of Asia Air said that they were seeking answers to the following questions:

- What is the capability of sideways looking Airborne Radar (SLAR) for map making?
- What are the limits of vegetation recognition?
- What advantage does the multispectral scanner offer over the multispectral camera?
- How do you keep costs down?

2.11 KIMOTO AND COMPANY LIMITED

Kimoto design and manufacture ground reception and data production facilities for meteorological satellite systems. The Japanese Navy and the Meteorological Agency use Kimoto equipment (see para. 2.9). The cost of a system, excluding the antenna is 100 million yen. An APT system costs 20 million yen ($70,000).

The Company is associated with Eltec who produce the laser beam printer, and with Totsu who do the computer processing for image rectification, etc.

Cannon have developed a carefully engineered colour additive viewer. An example was seen at Kimoto. The cost is 5.5 million yen, FOB Yokohama.

Kimoto presented CCRS Library with a copy of the textbook, "Remote Sensing" published by the technical staff of the Canon Camera Corporation (in Japanese).

2.12 TOSHIBA RESEARCH LABORATORIES

Toshiba are in charge of a program of research, funded by the Ministry of Industry since about 1970. The following targets were set for the research by the Ministry:

(1) character recognition;

(2) picture processing;

(3) speech recognition;

(4) three dimensional recognition;

(5) computer understanding and translation.

Toshiba won the industrial response competition to these objectives. The project will run for eight years with a $100 million budget. Objectives 1 and 2 are being realized by Toshiba with the TOSPICS system. Targets 3 and 4 are subcontracted by Toshiba to Nippon Electric. Item 5 is subcontracted to Hitachi. Toshiba are responsible for the whole project.

The progress with TOSPICS was described by Mr. H. Ogoshi, Dr. D-I Mori, and Dr. H. Genchi. Later, during a laboratory visit, the development prototype was demonstrated. In 1973 airborne remote sensing photographs, and other types of input data were collected. The concepts for the hardware design were developed in 1973-74. The design of the production unit will be accomplished during 1975/76. For picture analysis, the resolution is 4096 by 4096 resolution elements per picture. Each resolution element can take 64 grey levels. For multispectral recognition, four spectral bands can be studied by the existing hardware. The input to TOSPICS may be on magnetic tape (CCT), TV, graph pen, microscope slide, drum scanner, the 7 in. diameter Double Deflection Flying Spot Scanner (DDT), or magnetic disc. Ultimately stereo pairs will be inputted for both contour production and cluster analysis of multispectral signatures. TOSPICS employs a Distributed Special Purpose Processing Unit. During the tour, the prototype model was operated. A demonstration was given of computer crop recognition using four band multispectral data. Various recognition methods can be used including the minimum distance approach. The method most favoured by the Toshiba team was the Multiple Similarity Technique of cluster

2.12 CON'T

analysis. A high quality colour TV display of crop recognition was demonstrated. Histograms of spectral response, etc., could also be printed out. The DDT input/output tube was studied. It was originally developed by Tokyo University. (See Appendix 7, Item 14) To date there are 100 command programs available for TOSPICS. For character recognition, the initial thrust was to achieve recognition of the 70,000 Kanji characters compiled from a study of Japanese scientific and patent literature.

Toshiba are doing microwave development work, and they make a detector suitable for use in meteorological satellites.

It was understood by the Toshiba team that the Japanese Ministry of Industry is considering a new program to support remote sensing development. No details were available.

2.13 MARITIME SAFETY AGENCY

Discussions were held with Dr. D. Shoji of the Hydrogtaphic Department of MSA. The agency is equipped for photographic processing, photogrammetry, and for the analysis of oil content and mercury content of water. Three sets of Fujitsu for infra-red scanners are operated for the detection of oil dumping at night. The agency has YS-11, Beachcraft and Skyvan aircraft. In general they have had success with the detection and prosecution of oil pollution violations, but acknowledged that sometimes the oil does not show up.

Sea ice north of Japan is studied in a joint program with the Low Temperature Institute on Hokaido using a chain of radar stations. A new phase of this program will start next year.

The agency is responsible for plotting the data from a large number of MSA, Fishery and Meteorological Ships. Charts showing all cruises around Japan from April to June 1974 were studied. Information was also gathered on the foreign fishing vessels off Japan's coast. In 1974, for the first time, 100 Russian fishing boats came to fish in the waters near Japan.

A new volcanic island which was created on November 20, 1973 was under regular study. ERTS and airborne remote sensing data was used to support the program.

Dr. Shoji was asked whether Canadian scientists could participate in the work of his agency. He said, "Yes, they can by arrangements with the Tokyo University Ocean Research Institute".

The importance of meetings of experts was recognized by Dr. Shoji as an important complement to symposia. Reference was made to a symposium on tides to be held in Tokyo in 1976.

3.0 TANEGASHIMA SPACE CENTRE

The NASDA Tanegashima Space Centre is located on the south-eastern coast of the island of Tanegashima, about 1200 km south of Tokyo at 30° 23' 45.″0 N, 130° 58' 21.″8 E and 29.4 m above sea level. The island has an area of 500 km^2 and a population of 50,000. The airport is near the main town of Nakatane. There is a regular air service between Osaka and Nakatane. The total transit time between Tokyo and Nakatane airports is about 4 hours. Hotel accommodation is available at Kaminaka, 15 km south of the airport.

The gently rolling topography of the island is largely devoted to agriculture. The fields are small and terraced with substantial bamboo hedging to give some protection from the annual typhoons and to reduce soil erosion. In the lower parts, rice is cultivated yielding two crops a year. A wide variety of fruit and vegetable crops are grown on higher ground. The second main activity is fishing. The NASDA budget includes an allowance to compensate fishermen for the restrictions now imposed on their activity in the ocean adjacent to the launch area.

In reply to a question regarding earthquake activity the answer given was: "No, Tanegeshima is not subject to significant earthquakes, that is one reason it was chosen as launch site." The facilities have shown they are capable of withstanding the regular typhoon season. The advantage that would have been offered by a site on Okinawa,

3.0 CON'T

due to its lower latitude, was discussed. When the decision to construct complete launching facilities was made nine years ago, Okinawa was still under United States occupation. The Tanegeshima location was decided on in 1969.

Tanegashima is well known in Japan as the place where firearms were introduced to the nation. The occasion is commenorated by a monument and plaque in a park at the southern tip of the island about 150 m from the place where a Portugese ship was wrecked in 1543. The firearms from the wreck were studied by the local population and an abortive attempt was made to construct copies. Apparently the local craftsmen had difficulty in making the trigger work. Subsequently, a shipwrecked Portugese sailor assisted in overcoming this difficulty. One of the five NASDA optical tracking sites is located near this commemorative park on Cape Kadokura.

The question was asked as to which other Canadians had already visited the NASDA Tanegeshima Launch Site. The answer given was, "No others have visited the site, C.A. Franklin and J. MacDowall are the first Canadians to visit NASDA in Tanegeshima." The visit was recorded in a visiting book using the traditional Japanese "paint brush" method. The Canadian visitors were accompanied by Dr. H. Uda, Dr. Y.Takenaka, and H.H. Suzuka through the visit on 11/12 May 1975.

The construction of the site is now almost complete. The launcher for small rockets has already been used. The main launch site for the N vehicles will be used for the first time on September 9, 1975. The N rocket will have the capability to put 350 kg into synchronous orbit before 1980. That means 350 kg after apogee burn-out but including the motor case. The planned launch rate is two per year at first. After 1980, 500 kg will be their launch capability. NASDA have a staff of 200 persons at Tanegeshima.

On the evening of 11 May 1975, there was a general exchange of information between Uda, Takenaka, Suzuka, Franklin and MacDowall. A number of questions were asked regarding the precise Canadian role in the launching, etc. of the Canadian satellites and Anik. The Japanese had the impression that, "The USA handle the whole job for Canada." Franklin was aware of the situation and clarified the considerable extent of Canadian input and expertise in this activity. Also discussed were the tentative plans of NASDA, the impact of the space shuttle, and Canadian programs in remote sensing and communications satellites. To date details are published on Japan's ETS-1 and -2 satellites. Planning is almost complete for ETS-3, which has gone too far down the road to be available for any joint program. It is possible that ETS-5 may be an earth resource satellite for launch after 1978.

To do full justice to the extent of NASDA Tanegeshima two days are required. There are two launch platforms. The small, proven out southern one, Takesaki, is for launching small rockets. The large platform is called Ohsaki and has the capability of putting 130 kg into synchronous orbit. It will be used for the first time on September 9, 1975. Ohsaki is equipped with a Moving Service Tower (MST), and launch control blockhouse. For rocket assembly there is a 40 x 20 m assembly building equipped with two, 10-ton hoists up to 15 m. This is for the assembly and check-out for the first two stages. Two floors of electronics and gyroscope laboratories surround the assembly shed. An 80 m high meteorological mast measures wind, temperature and humidity at 4 levels. A meteorological office is located in the central Range Control Centre (RCC). Hazardous activities or stores, and vital facilities are cleverly placed in folds of the hills. These include, a spin test facility, storage of motors and other explosives, and the power plant. A reservoir is included within the site for all water supplies and to flood launch areas during motor firing. A Satellite Test Facility has been constructed for the testing of the satellite before it goes to the satellite installation laboratory in the Moving Service Tower. The whole launch activity is controlled by the Range Control Centre. This is equipped with large visual status display boards. Meteorological and radar surveillance data is collected together with tracking data and other pieces of information needed by the Mission Director. After successful injection into orbit, the control of the satellite is handled by NASDA Tsukuba near Tokyo. The location in rolling hills near golden Pacific beaches is scenic. Though relatively small in area, the hills conceal one location from the other to give an uncluttered appearance. The press viewing grandstand was located on a promentary overlooking both the launch site and the beaches. It is equipped to accommodate about 50 persons, a conference room with a dozen or so telephones, and a VIP lounge on the very top. At each location visited the question was asked about the extent of US technology employed. In each case the answer given was: "No US technology was used to construct the Tanegeshima facilities." All significant areas were visited and appeared to be staffed and operational.

The Ohsaki launch area blockhouse accommodates about 50 persons at consoles facing TV screens and status boards. Several TV systems monitor the launch area and various points in the rocket and tower. A telemetry control room surrounds the central area in the house.

Mr. Yoshimyama is in charge of the Moving Service Tower. During the visit, six young engineers were working to install the ETS-1 satellite on the rocket in preparation for September 1975 launch. The satellite laboratory in the MST was well equipped. This laboratory was fitted with walls transparent to microwave radiation. The MST has already shown that it can withstand the 60 M/S winds which accompany the typhoons. Tanegeshima is in the normal typhoon path. Their season extends from the end of August to the beginning of November each year. The MST is 55 m high and weighs 2700 tons.

The Satellite Test Facilities (STF) comprise a clean room and the associated electronic laboratories needed to support satellite check-out. The satellites are shipped by sea to the STF in a special container which is filled with dry nitrogen. One of these was inspected at the STF. In the base of the container are shock, temperature and humidity recorders. Transit time to the STF is four days. Large double doors with laminar air flow control give access to the clean room. Automatic check-out equipment is in the clean room to test the satellite. Programs for ETS-1 check-out took one year to write. If anything is under or over the set limit, this is displayed in red. During the visit a construction test model of ETS-1 was in the STF for a test of fitting and handling gear.

The Range Control Centre (RCC) is the nerve and control centre during any launch mission. Status information from the whole complex is collected and displayed. This includes status of the optical and radar tracking network, together with rocket and satellite status. Ship and aircraft movement is also monitored. A conference room is set up just outside the operations room with a window looking into the room and at all the status display boards and the trajectory display board. The centre is serviced by an NEAC 2200/575 computer which has a 384 k bit core memory. An NEAC 3200 computer is used for communication and control. NEAC computers are a product of the NEC Company of Japan.

The formal opening of the facilities were set for May 22, 1975. The visit confirmed that the staff of NASDA were well prepared for that event.

4.0 CONCLUSIONS, TENTATIVE IDEAS AND RECOMMENDATION

4.1 CONCLUSIONS

It was concluded that the objectives of the visit were achieved in the following respects:

(1) First hand knowledge of the Japanese Space and Remote Sensing Program was obtained in meetings with over fifty individuals and over ten different government and industrial agencies.

(2) A greater awareness was created in the extent of the native Canadian contributions and capabilities in the field of remote sensing.

(3) A favourable atmosphere for further cooperation was found, both in areas where national skills or facilities complement each other, and also on space system projects whose objective would be to obtain information required by both countries, such as information

4.1 CON'T

(3) on the oceans of the world.

(4) That the need exists for a mechanism to improve the information flow between the two countries, complementing symposia and conferences with meetings of experts.

(5) That NASDA have been too busy with their program to consider international programs; however, early discussions on joint work needs to be started if Canada is to take advantage of the launch capability facilities constructed on Tanegeshima.

(6) That the earliest possible start on joint space programs would be in the post ETS-3 phase.

(7) That a joint Japanese-Canadian company approach has been adopted to protect the Canadian investment in new technology.

4.2 TENTATIVE IDEAS FOR DISCUSSION

4.2.1 Introduction

The visit provided an opportunity for officials from three Canadian agencies (EA, DOC, & DEMR) to spend some hours together with Japanese officials. It is not surprising, therefore, that ideas were discussed for increasing national capabilities through cooperation between Canada and Japan. Ways came to mind where both countries could have more effective and complete programs without increasing expenditures in a "no funds across the border" manner. Ideas were mooted for protecting Canadian inovative skills whilst exploiting them cooperatively, for satisfying concerns of both countries by space programs aimed at obtaining resource and environmental information both countries need.

4.2.2 Meetings of Experts

These meetings are suggested in order to even up the flow of information between the two countries and to consolidate and deepen the relations at the working level. It is recommended that each country identify an individual, plus an alternate, in each of several areas and give them the following tasks to accomplish:

1. Review work in both countries;
2. Exchange written reports and have in-depth discussions on the reports;
3. Visit appropriate government, industry and university laboratories in each country;
4. Review any joint projects and prepare a written advisory report on past work and future direction;
5. Give an open lecture on the speciality to the technical public having an interest in the particular speciality;
6. Write a joint annual report for the CACRS;
7. For the first year two meetings are recommended, then annual meetings could be held. It is suggested that the first meeting be in Tokyo followed, in six months by one in Ottawa.

In the case of remote sensing, it is suggested that the following seven areas be covered:

AREA	CANADA	JAPAN	SUBJECTS
1.	CCRS ITC	1. Minist. of Indust. and Trade 2. Science and Technology Agency	Remote Sensing instruments for Aircraft and Spacecraft and Systems.
2.	CCRS DOE	1. NASDA (STA) 2. Minist. of Communication 3. Minist of Transport. Meteorological Agency	Ground Stations and Data Processing for Remote Sensing and Meteorology
3.	CCRS DOC	1. Minist. of Communication 2. STA 3. Minist. of Indust. and Trade	Microwaves for Remote Sensing

4.2.2 Con't

AREA	CANADA	JAPAN	SUBJECTS
4.	CCRS	1. STA 2. Minist. of Indust. and Trade 3. Minist. of Agriculture 4. Minist. of Transport 5. Minist. of Construction	Data analysis, interpretation and computer processing
5.	DOE	1. Minist. of Agriculture, Forestry Agency	Remote Sensing for Forestry
6.	DOE	1. Minist. of Transport a) Marine Safety Agency b) Meteorological Agency 2. STA 3. Minist. of Agriculture	Remote Sensing for Oceanography
7.	DOE	1. Minist of Transport Meteorological Agency 2. NASDA (STA)	Satellite Meteorology

With regard to timing, it is recommended that meetings of experts commence in 1976.

4.2.3 Studies of Satellite Systems

The cost of implementing satellite systems is so high that international cooperation is becoming more common. At the same time, the capability and coverage of satellite systems is great enough to cross national boundaries.

It may be advantageous for Canada and Japan to cooperatively construct satellite observing systems, particularly if this can be done without significant funds crossing the border.

Both Canada and Japan share a need for ocean data and this may prove to be an area for future cooperation. Canadian industry is concerned about its activity in the period after the Communications Technology Satellite (CTS). The Department of Communications have considered various ideas for the eventual construction of an Ultra High Frequency Satellite and a three axis stabilized user "bus" which could be applied to a wide range of user requirements for resource meteorological or communications purposes.

Japan has constructed a complete facility for the launching of satellites, together with reasonably firm plans for a series of experimental satellites. In a few years time, in the post-ETS-3 phase, informal discussions suggest that Japan would be in a position to launch any such cooperative satellite.

In order to clarify thinking, the above tentative ideas were crystalized into the following suggestion for a study of experimental resource applications satellite systems.

Following the 1975 May 4-13 visit of C.A. Franklin and J. MacDowall to Japan, it is considered that a basis exists for a Canada-Japan study of Joint Satellite Information Systems in the following areas of application:

Ocean Surface Temperatures Through Cloud;

Ocean Colour;

Ice Observations Through Cloud;

Ultra High Frequency Systems for Resource Data Collection and Distribution.

It is considered that the satellite vehicle in the System could provide a basis for a three axis stabilized user "Bus" applied here to experimental ocean-earth resource and communications missions during the post-ETS-3 period.

It is recommended that the study commence with the establishment of a project definition task force to study and report on the following aspects:

4.2.3 Con't

1. Orbit and Payload Capability (Japan)
2. User Needs (Canada and Japan)
3. Payload State of the Art and Orbit Selections (Canada and Japan)
4. Ways and Means to Support the Program (Canada and Japan)
5. Data Reception and Distribution (Canada and Japan)
6. International and United Nations Aspects (Canada and Japan)

It is recommended that the terms of reference include:

A. The definition of the project
B. Program timing
C. The division of tasks and responsibilities
D. The presentation and distribution of data to the users.

4.3 RECOMMENDATION

Recognising that a basis may exist for the serious consideration of joint Canadian-Japanese programs applying aerospace technology to the fields of remote sensing for resource management and environmental monitoring;

It is recommended:

That consideration be given to the establishment of a task force to follow up on the EMR visit and consider tentative ideas for future joint activities between Canada and Japan.

LIST OF APPENDICES

	PAGE
1. Names of Persons Met by J. MacDowall	15
2. Japanese Addresses	17
3. US/Japan Technology Exchange Agreement	20
4. Presentation to Keidanren of Japan	22
5. Space Development Program and Budget	39
6. National Institute of Resources	42
7. Publications Collected in Japan	45

APPENDIX 1

NAMES OF PERSONS MET BY J. MACDOWALL
IN
JAPAN, 4-13 MAY, 1975

NAME	AGENCY
Dr. R.H.J. Bower	CE
Mr. Yoshiyuka Endo	AG
Mr. J.S. Farroll	GI
Mr. Masataka Fuchimoto	AA
Mr. Fuji	MPT
Mr. Junji Fujii	MRI
Mr. Hisashi Genchi	TOS
Dr. Prof. Hidesabro Genda	CU
Mr. R.W. Gorham	CE
Mr. Hasegawa	MPT
Dr. Masaichi Hirai	NSDA
Mr. Yoshihide Hiraiwa	MEC
Prof. Kumio Hirao	UT
Mr. Hiroshi Inamura	STA
Mr. Mitsuo Iwasaki	JMA
Mr. Masahiro Kadoi	NSDA
Mr. Kaneda	MPT
Mr. Kikuchi	JMA
Mr. Fuyihiko Kitazawa	JMA
Mr. N. Makimura	STA
Mr. Kazutoshi Maruyama	MPT
Mr. T. Maruyasu	STA
Mr. Shinichi Matsubara	STA
Mr. Matsuma	MPT
Mr. Tsuneto Matsuzawa	MPT
Mr. Toshi Michino	NAC
Mr. Tukuyi Mina	CU
Mr. C. Miyakozawa	KIM
Dr. Ken-Ichi Mori	TOS
Mr. Mori	MPT
Mr. H. Motojima	AA
Dr. Shunji Murai	UT
Dr. T. Murao	NSDA
Mr. Murayma	JMA
Mr. K. Nagai	NAC
Mr. Youichi Nakagawa	TOT (KIM)
Dr. Iwao Nakajima	MAF
Mr. Nakajima	STA
Mr. K. Nakajima	NAC
Mr. Kiyoshi Nishikori	NSDA
Mr. Nisimura	MPT
Mr. Masayoshi Nojima	NSDA

NAME	AGENCY
Mr. Hideo Ogoshi	TOS
Mr. Oida	MPT
Mr. Shigeru Omori	AA
Mr. Koichi Onoe	MPT
Mr. M. Onoue	STA
Mr. H. Osawa	STA
Mr. Hiroshi Saito	MPT
Mr. Tetsuya Senga	KEI
Mr. Sakio Shiina	AA
Dr. Daitaro Shoji	MSA
Mr. J.S. Simpson	GI
Mr. Soyanama	MPT
Dr. Noroboni Sugino	MRI
Mr. H. Suzuka	STA (CCRS)
Mr. Akira Takahashi	STA
Mr. M. Takahashi	NAC
Mr. K. Takeda	STA
Dr. Y. Takenaka	NSDA
Dr. Tadao Takenouchi	NSDA
Dr. K. Takeuchi	JMI
Mr. E. Terauchi	JMA
Mr. Masaru Toshioka	AA
Mr. K. Tsuba	ELT (KIM)
Mr. Tsujiuchi	MRI
Dr. Hiroshi Uda	NSDA
Mr. Atsuo Ueda	KEI
Mr. Watanabe	MPT
Dr. David J.T. Winfield	CE
Mr. Yasuda	JMA
Mr. Mitsuzo Yokota	NTT
Dr. S. Yoshida	TOS
Mr. Yoshimyama	NSDA

APPENDIX 2

JAPANESE AGENCY

	ADDRESS	TELEPHONE NUMBER
AA	Asia Air Survey Co. Ltd., 2-16 Tsurumaki-5, Setagaya-Ku, Tokyo 154.	03 429-2151
AG	Asia Gestalt Co. Ltd., 2-16 Tsurumaki-5, Setagaya-Ku, Tokyo 154.	03 425-1597
CE	Canadian Embassy, 3-38 7-Chrome, Akasaka, Minato-Ku, Tokyo 107.	408-2101
CU	Chiba University, Institute of Colour Technology Yayoi-Cho, Chiba	
ELT	Eltec Company Limited, Tokyo.	
GI	Gestalt International Ltd., 58 West 6th Avenue, Vancouver, B.C. V5Y 1Kl. Canada.	604 872-0111
JMA	Japan Meteorological Agency, 1-3-4 Otemachi, Chiyoda-Ku, Tokyo.	212-8341
JMI	Japan Meteorological Institute, Koenji-Kita, Suginami-Ku, Tokyo.	337-1111
KEI	Keidanren, Keidanren Kaikan, Otemachi, Chiyoda-Ku, Tokyo.	279-1411
KIM	Kimoto and Company Ltd., 1-7-2 Chrome Shinjuka, Shinjuku-Ku, Tokyo 160.	03 354-0361 356-7645

ADDRESS		TELEPHONE NUMBER
MAF	Ministry of Agriculture and Forestry, Forest Experimental Station, Meguro, Shimomeguro 5-37, Tokyo.	03 711-5171
MEC	Mitsubishi Electric Corp., 2-3 Marunouchi, 2-Chrome, Chiyoda-Ku, Tokyo.	218-8490
MPT	Ministry of Posts and Telecommunications, 1-3-2 Kasumigaski, Chiyoda-Ku, Tokyo.	504-4894 504-4914 504-4827 504-4850
MRI	Mitsubishi Research Institute Inc., 1-6-1 Ohte Machi, Chiyoda-Ku, Tokyo 100.	03 214-5531
MSA	Maritime Safety Agency, 5-3-1 Tsukiju, Chuo-Ku, Tokyo.	541-3811
NAC	NAC Incorporated, 17 Kowa Building, 2-7 Nishiazaku, 1-Chrome Minato-Ku, Tokyo.	404-2321 045 591-3711
NSDA	National Space Development Agency, World Trade Center Building, 2-4-1 Hamamatscho, Minato-Ku, Tokyo 105.	03 435-6201 435-6105 435-6241 435-6165 (Tanegeshima Space Centre 09973 6-1240)
NTT	Nippon Telegraph and Telephone, Public Corporation (NTT), 1-6 Uchisaiwai-Cho, 1-Chrome, Chiyoda-Ku, Tokyo 100.	509-5423
NRIR	National Research Institute for Resources, 2-2-1 Kasumigashi, Chiyoda-Ku, Tokyo.	03 581-5271

ADDRESS		TELEPHONE NUMBER
STA	Science and Technology Agency, 2-2-1 Kasumigashi, Chiyoda-Ku, Tokyo.	03 581-5271
TOS	Toshiba Shibaura Electric Ltd., 1 Toshiba-Cho, Komubai, Saiwai-Ku, Kawasaki-City 210, Japan.	044 511-1111
TOT	Totsu Engineering Co. Ltd., 118 Miyuki-Machi, Kodaira, Tokyo.	0423 23-6622
UT	University of Tokyo, Roppongi, 7-22-1 Minato-Ku.	03 402-6231

TRANSLATION

(Japanese Note)

Excellency,

I have the honour to refer to recent conversations between the representatives of the Government of Japan and the Government of the United States of America concerning cooperation between the two countries in space activities for peaceful purposes. The understanding of my Government of the results of these conversations is as follows:

(1) The United States Government undertakes, in accordance with United States laws and administrative procedures, to permit United States industry to provide to the Japanese Government or to Japanese industry under contract with the Japanese Government, unclassified technology and equipment listed in the attachment to this Note for the development of Japanese Q and N launch vehicles and communications and other satellites for peaceful applications.

(2) The Japanese Government undertakes (a) to ensure that any technology or equipment transferred to Japan under paragraph (1) above will be used soley for peaceful purposes; (b) to take all available steps in accordance with Japanese laws, regulations and administrative procedures to prevent transfer to third countries of such technology and equipment, and any launch vehicles and communications or other satellites, and components, parts, accessories and attachments thereof manufactured by use of such technology or equipment except by mutual agreement between the two Governments; and (c) to use communication satellites developed or launched with United States cooperation compatibly with the objectives and purposes of INTELSAT arrangements as they exist or evolve.

I have the honour to propose that the present Note and your Note in reply confirming the foregoing understandings on behalf of the Government of the United States shall constitute an Agreement which shall enter into force on the date of your Note.

I avail myself of this opportunity to renew to your Excellency the assurance of my highest consideration.

ATTACHMENT TO U.S./JAPANESE AGREEMENT CONCERNING THE PROVISION BY U.S. INDUSTRY OF CERTAIN CATEGORIES OF UNCLASSIFIED TECHNOLOGY AND EQUIPMENT FOR THE DEVELOPMENT OF JAPANESE Q AND N LAUNCH VEHICLES AND COMMUNICATIONS AND OTHER SATELLITES FOR PEACEFUL APPLICATIONS

A. The technology and equipment referred to in this agreement includes that software and hardware pertaining to communications and other satellites for peaceful applications, and to Q and N launch vehicles technology, and to associated ground support technology related directly to, and necessary for, placing satellites in geo-stationary orbit.

Software is understood to comprise information concerning program management, systems engineering and design, testing and manufacture. Hardware is understood to comprise components, parts, accessories, attachments and associated equipment.

B. This Agreement will cover unclassified technology and equipment up to the level of the Thor-Delta vehicle systems, exclusive of reentry and related technology.

C. In exceptional cases, the United States may license the export of hardware rather than export of design, development or production information.

D. United States supplying companies will be responsible for filing application for all United States export licenses required. To facilitate the provision of United States technology and equipment, it is understood that each export license application under this program will include a statement by the Japanese Government as to whether the technology or equipment requested is (i) directly for a specified

Japanese Government agency or (ii) for a Japanese company which is acting pursuant to a Japanese Government contract.

E. The Japanese Government, as referred to in paragraph (1) of the Agreement and in subparagraphs D (i) and (ii) of the Attachment, is understood to include the Space Development Corporation, a public corporation which will come into operation in October, 1969.

(U.S. Note)

Excellency,

I have the honour to acknowledge receipt of Your Excellency's Note of today's date reading as follows:

"(Japanese Note)"

In reply, I have the honour to confirm on behalf of the United States Government that the foregoing also represents the understanding of my Government. It is the understanding of the United States Government that this Agreement enters into force as of the date of this Note.

I avail myself of this opportunity to renew to Your Excellency the assurance of my highest consideration.

APPENDIX 4

CANADA'S SPACE PROGRAM

THE CANADIAN NATIONAL PROGRAM
OF
REMOTE SENSING

Presented To

THE KEIDANREN OF JAPAN
(Federation of Economic Organizations)

BY

JOSEPH MACDOWALL
CANADA CENTRE FOR REMOTE SENSING
DEPARTMENT OF ENERGY, MINES AND RESOURCES
OTTAWA, Canada.

TOKYO, Japan 7 May 1975.

MR. CHAIRMAN, GENTLEMEN, I'd like to thank you very much for the honour of addressing such a distinguished and talented audience today, and also for the personal pleasure of being in Tokyo. The visit is proving to be a delightful experience. The City has already made a great impression on me and your thoughtful hospitality has relaxed me after the sixteen-hour journey from Ottawa. Thank you very much for your interest in the Canadian experience in remote sensing.

I bring you warm greetings from Dr. L.W. Morley, Director of the Canada Centre for Remote Sensing. Dr. Morley spent a happy period working in Japan during 1962. It might indeed be said that his interest in remote sensing commenced at that time. During his visit to Japan, Dr. Morley was accompanied by Mr. William Fisher, of the United States Geological Survey who is one of the originators of the EROS system, the predecessor of ERTS. Together they spent many hours talking about the newly-emerging technique of remote sensing. When Dr. Morley returned to Canada, he started to develop the Canadian interest in remote sensing.

When the ERTS program started, Dr. Morley explained the potential of remote sensing to the Canadian Government, pointing out that ERTS would pass over Canada four times a day, forming 80 images a day of Canadian territory. Canada had to decide whether she was prepared to set up ground reception facilities so that she could obtain this data of her own terrain at least as soon as anybody else in the world. Well, we all know the answer now - Canada decided to build her own reception and processing facilities for the ERTS system. To undertake this work, Canada set up a national centre for remote sensing, The Canada Centre for Remote Sensing (CCRS) in the Department of Energy, Mines and Resources. Satellite remote sensing was complemented by an airborne program. Studies were initiated of the value of remote sensing to various user groups, such as agriculturalists, foresters, oceanographers, etc.

The challenge of remote sensing is many faceted because it is not just a matter of technology, it's also a matter of organization to apply remote sensing to assist a wide range of activities. Diplomacy is important too, because, by utilizing remote sensing the countries of the world who have invested in advanced technology have acquired the ability to obtain from spacecraft, national resource information about other countries, without breaking any existing laws. They can obtain information which, before the advent of artificial earth satellites, was private information. We are therefore concerned that no nation is unnecessarily disadvantaged by this new situation. The information gathering power of remote sensing has the potential of improving the data base on world resources. Canada plays a part assisting the world to benefit from this technology, by working with the UN Peaceful Uses of Outer Space Committee, and other international fora.

In Canada, we have a federal system of government so we have to meet the challenge of making sure that the resource information gets into the hands of those lower levels of government who have the responsibility for the details of resource management. When necessary, we assist with the analysis, interpretation, and presentation of the data. It is therefore very important to have an organization that can meet many challenges.

The main elements of the Canadian national remote sensing program are:

1. the ERTS receiving station at Prince Albert, Saskatchewan (a second Canadian-built station will operate in Newfoundland in 1976);

2. the airborne and ERTS data processing reproduction facility in Ottawa;

3. the photographic reproduction facility in Ottawa;

4. the airborne program;

5. the remote sensing test sites;

6. the sensor development program;

7. regional (provincial) and speciality interpretation centres;

8. the Canadian Remote Sensing Society of the Canadian Aeronautics and Space Institute;

9. the necessary national organization to manage the national program and meet international needs.

Canada designed and constructed her own reception station for ERTS. She utilized existing facilities at Prince Alberta, a little to the west of the centre of Canada (see Fig. 1). It is equpped with a 85-foot diameter receiving antenna. A "Quicklook" facility at Prince Albert allows for the immediate distribution of less-than-full resolution, black and white data, (see Fig. 2), mailed out to users within hours of the satellite's overpass. Individual ERTS frames and microfiche copies of the 80 daily scenes are produced at Prince Albert. Quicklook and ERTSfiche (see Fig. 3) data are distributed by an industrial contractor, Donald Fisher and Associates Limited. Canada is still the only ERTS reception system which has this operational Quicklook capability and which offers the ERTSfiche service to the users. The prime industrial contractor involved with the construction of Prince Albert was SED Systems Limited, Saskatoon. A second new Canadian station for receiving and ground data handling of very low cost is being built by MDA Limited of Vancouver for installation on the East Coast in Newfoundland.

The tape recorded data from ERTS is air-freighted to the data processing facility set up by CCRS in Ottawa. This facility has the capability of producing, by means of an electron beam recorder, photographic negatives of ERTS data. Computer compatible tapes (CCT's) are also produced in Ottawa. The computers in the processing facility are used to maintain the ERTS image inventory, process and analyze ERTS and airborne data, handle the CCRS financial information system, and handle the CCRS computer-based information retrieval system, RESORS. Computing Devices of Canada Limited was the industry concerned with the establishment of the data processing facility. Photographic reproduction and distribution of ERTS and airborne data is handled by the National Air Photographic Reproduction Laboratory (NAPL). NAPL is co-located with CCRS at Sheffield Road, Ottawa. Examples of Canadian imagery are given in Figures 4, 7 and 8.

CCRS established a national program of airborne remote sensing as an essential complement to the ERTS program. A twin-jet Falcon (Fig. 5) aircraft was purchased by CCRS, and two DC-3's and a CF-100 were obtained from the Canadian Forces. Recently a Convair aircraft was purchased to replace the pensioned-off CF-100 and to enhance the capability for work in the Arctic. Aircraft operations are provided by the Canadian Forces Airborne Sensing Unit (CFASU). From May 1975 the services of the Air Force will be replaced by services from Innotech Aviation Limited of Montreal, in co-operation with Intera Environmental Consultants Limited of Calgary.

Airborne imagery from the ultra-violet to far infra-red is acquired by CCRS aircraft. Figure 9 shows an example of ultra-violet photography (300-400nm). The pelts of the white seals have a much lower reflectance in the ultra-violet than in the visible and so they show up as quite black in the uv photography. Water is at its most transparent in the blue-green part of the spectrum. Figure 10 shows how this was applied by the use of conventional colour photography to define the beds of aquatic vegetation in the Kawartha Lakes region of Ontario. In Balsam Lake, plant growth 10M beneath the surface was detected. An example of false colour, near infra-red photography is given in Figure 11. This colour infra-red photograph was assessed as "very good", or "excellent" for land use classification purposes at a scale of 1:137,000 or larger. Far infra-red scanning data is acquired with a Daedalus 8-14 micron scanner, an example of the imagery is given in Fig. 12. This was taken from 2500 feet altitude over Cowansville Prison at 0400 hours (pre-dawn). The high temperatures are indicated by black, lower temperature by grey. In Figure 13, the large circle is the power plant and the small circles show buildings with excessive heat loss. The route of the leaking underground heating pipes can be detected even though they are eight feet below ground surface.

Test sites were selected across the country so that users could examine the utility of remote sensing for various purposes. For example, in forestry, to answer questions such as, "Can you recognize and map various types of forest from ERTS or can you see insect damage?" Agriculturalists wanted to know the extent to which crops could be recognized. Environmentalists needed to establish whether or not the productivity of water, or its sediment content could be established with useful precision. Every user needed to study ERTS and airborne images, to test sophisticated methods of image analysis, and establish the role of remote sensing in their operations.

To enable Canada to contribute to the development of remote sensing technology, a sensor development program was set up. Contracts were let to industry and universities to build new instruments with the potential of meeting the needs of the user. One of CCRS's DC-3 aircraft was set aside for the purpose of flight testing this new equipment. Some devices have now had two years of flight testing. An example of one of these devices is a blue-green laser for airborne bathymetry. The system can be fitted with an ultra-violet laser to map oil pollution by exciting fluorescence. The airborne laser fluorosensor may ultimately have the capability of identifying the tanker from which the oil was split. An instrument was developed which will measure the colour of the water and this can be related to the productivity of the water. There are several such new devices under development.

In order to bring remote sensing to the attention of the provinces of Canada and also to the many different users, we encouraged the setting up of Regional and Speciality interpretation centres. There is a speciality centre for agriculture in Ottawa, for lake and inland water studies in Burlington, Ontario. There is a forestry centre in Ottawa, and there is an oceanography centre in Victoria, B.C. Provincial centres are now being set up by the various provincial governments. We have encouraged the ten provincial governments of Canada to set up their own centres, staffed with civil servants from the provincial level of government. The province of Ontario has one, so have British Columbia, Manitoba and Alberta. The other provinces have co-ordinators, and they are examining the possibility of setting up a permanent organization.

One of the challenges in remote sensing is that the problems are not confined to the technology of inventing new instruments and flying them, of analyzing tapes and so on. It is also a matter of applying technology to the various tasks. You also have to have good communications with persons knowledgeable in agriculture, forestry, oceanography, etc. It would be extravagent to set up a centre that has all the necessary disciplines on staff. What was done, therefore, was to set up two advisory committees. The first was called the Canadian Advisory Committee on Remote Sensing (CACRS). CACRS has 14 Working Groups in various areas of remote sensing, as shown in Fig. 6. Now each one of these working groups is staffed by, not by members of Canada Centre for Remote Sensing, but by those departments concerned with the user disciplines. For example, the Committee on Agriculture is chaired by Dr. Mack who is a scientist in the Department of Agriculture. The Oceanography Committee is chaired by Dr. Gower, who is an oceanographer from the Department of Environment. Now these 200 individuals act as a user arm to help us foster and develop the applications of remote sensing in all user areas. The second committee, the Inter-Agency Committee on Remote Sensing (IACRS) is rather like a Board of Directors sitting over the Centre. Dr. Morley reports to the Committee which comprises high-level civil servants from 10 other federal departments. Now the reason for this is that remote sensing is a technology which can be applied to the jobs of many other departments. It is very important that our work should be overseen by a number of other federal departments. These are some of the ways in which we have tried to meet the organizational challenges of remote sensing. CCRS is, of course, the focus for international co-operation.

CCRS has three line divisions - the Data Acquisition Division is concerned with the acquisition of airborne data. They have four aircraft at their disposal. The Data Processing Division receives the data from the earth resource technology satellite and turns it into usable imagery, and computer compatible tapes. The Applications Division is concerned with the fostering and development of applications of remote sensing and is staffed with people who develop new methods of analysis and who do demonstration projects, to demonstrate or examine the feasibility of doing certain tasks by means of remote sensing. For example, over the past two years, there was a project called the Spring Wheat Project, co-operatively done by CCRS and the Department of Agriculture, and working jointly with the United States Department of Agriculture and NASA. The aim was to examine the feasibility of doing crop recognition from space, and to measure the total area of wheat growing. Having demonstrated applications and examined the limitations and advantages, CCRS works with user departments to foster applications.

Although each type of remotely sensed information tends to have its own sphere of application, aircraft and satellite data can complement each other. Canada is now experienced in the use of satellite data for crop recognition, for mapping forests and so on. In order to do this job, it is essential, in our experience, to have aircraft data from a lower level and also to have ground observations. If you go into the laboratory where computers are used for crop recognition, and you look over the shoulder of the expert doing it, you will find that he has the computer in front of him with the colour display, but on his left hand he will have an aircraft picture, and on his right hand, he will have a field notebook from someone who worked at ground level. If you take any one of those three pieces of information away from him, he cannot do his job properly. So it should never be forgotten when one talks about using satellite imagery, that ground level observations and aircraft observations are indispensable adjuncts to the satellite observations.

Figure 7 is an example of the image from space which was made in Canada. It shows the region around Zama Lake, Alberta. The picture is a hundred miles wide (185 km). Now there is a wealth of information in this picture. One could talk for half an hour and not exhaust the subject. You can see all the major transportation routes, you can see the areas of occupation, you can see the forest areas that have been cut, and the areas under urban development. You can see, of course, all the lakes and rivers, but you can also make statements about the quality. You can see a lake which is green. This indicates that it's a lake with a lot of sediment in it: the dark lake shows that it is a lake with relatively clear water: the red in the lake shows algae on it - and so on. In other words, there is a tremendous amount of information in this picture. A great deal of it, in fact almost all of the information on it can be extracted by eye. It's our experience that an effective way to interpret remotely sensed data is by eye, the eye and mind combination of a person who knows the subject that is being studied. In other words, if you wish to extract information about this lake or marsh, you need to have a wild land biologist, and if he has some instruction in the physics of the interaction and is familiar with the technical characteristics of the ERTS system, he will extract a great deal of useful information about that marsh. It is exactly the same with a forest, if you get a forester looking at the image, he can interpret it extremely well. This is one way of extracting the information. It is a relatively cheap way, but an effective way. Figure 8 shows you a Canadian image of Winnipeg and the surrounding area. In Lake Winnipeg, you can see the delta area. The valley is occupied by farms. This is the Red River Valley - an extremely fertile area of Canada. In the lower left hand corner note the marked change in colour. What you are looking at there is a major pedological boundary. The soil on one side of the line is highly productive and the soil on the other side has a lower productivity. We have found in both Manitoba and Ontario that pedological boundaries can be mapped by eye, using spacecraft imagery. Now in Canada, this isn't very much help perhaps, because most of our soil zones have already been mapped. In other parts of the world the pedological mapping capability of space photography may be more useful.

Another example of the eye interpretation technique is in routine use in Canada now for updating our northern maps. The band 5, or the red band image from ERTS satellite, shows the roads very clearly. The red band shows most clearly the effects of man. The first operational use for the ERTS satellite in Canada was for updating the maps of Canada's north. We have found some "islands" in the Arctic Archipellago, which are presently marked on our maps did not exist. They were, in fact, ice islands and the ERTS satellites have shown us this. We found other areas which were out-ot-date due to the rapid pace of northern development. We are now up-dating the maps of our Northern Territories using the information from ERTS. What is the accuracy of the mapping? One can located an object with ERTS within the accuracy of about 1-2 kilometres, on the basis of the ERTS information alone. That is not quite as accurate as we would normally expect at mapping at 1:250,000 scale. However, it is an amazingly high degree of accuracy bearing in mind that it can be achieved without the use of normal ground control. The biggest application in this area is the up-dating of 1:250,000 scale topographic maps.

An important step taken in Canada was too look at the crop recognition process. A relatively direct approach was taken at first without the aid of computers, because the scientists doing it felt that they didn't want to get bogged down in computer hardware and programming. ERTS and airborne images were used, black and white photographs in the infrared and in the red. The test site was studied on a scale of 1:36,000. The grayness of the individual fields was measured by eye-matching on a scale of 10. This was done by eye. It was shown that for both ERTS and for airborne data, reasonably accurate results were obtained. For airborne data, cereals, rapeseed, grassland and fallow land were identified. In the case of the rapeseed, of the seven fields that were rapeseed, all of them were correctly identified. In the case of cereals, out of the 12 fields that were studied, 10 were correctly identified and there were two errors. Now this was done with a very simple grey scale matching technique. The same has been done using rocket photographs in the Argentine. Bare soil, pasture, forest, grain and alfalfa were recognized. The number of errors was approximately 10 to 15%, provided, of course, that the crops were studied at an appropriate time so they were reasonably well developed and they hadn't been cut. The same can be done from satellite altitude. The accuracy in this case was approximately 93%. Having come to the conclusion that a range of crops can be identified using manual techniques, the development of computer techniques was commenced with a view to automatic crop recognition.

The results of computer classification were shown on a colour television display. In one particular study in Manitoba, fields shown blue were fallow fields, the red ones were wheat, light blue was corn, pink was rapeseed and the green was other grains except corn and wheat. CCRS can do this automatically using two machines. There is a Bendix Multispectral Analyzer System which is connected to the CCRS PDP-10 computer. CCRS also has a General Electric Image 100 machine which is a stand alone piece of hardware. There are, of course, difficulties. In the case of crop recognition, for example, it is clear that you can't recognize a crop until it grows - it has to develop before you can recognize it, and the crops has to be observed before harvest. This sounds obvious, but what it really means is that you have a period of about twenty to forty days in which crop recognition is possible. If you try too early, you can't recognize the crops, and if you do it too late, the crops have been cut. In the case of ERTS, the fields must be greater than about 1-2 hectars in size.

A lot of information can be extracted from the ERTS images by using the eye-brain combination. Figures 14 and 15 show you geological information which has been extracted from the ERTS images. Clearly shown are bedding trends, geological and glacial features which show up on the ERTS imagery, some of which were not mapped before. Now none of the geologists from the oil and mining companies are going to come along and tell us what they have found as a result of looking at an ERTS picture, not until they have safely got the mine into operation. However, there is no doubt that new geological information is being mapped, not only in the areas of Canada, but also in other well mapped parts of the world. The French tell us that in parts of their country, they found new geological features. This is obviously useful. We now know that in Canada any geologist going to work, either in Canada or abroad, scrutinizes all the ERTS imagery that is available for that area before he goes on his expedition.

Figure 16 gives the results of an investigation by our Forest Management Institute. It is an assessment of whether or not you can see pest damage in an ERTS image. You can see that in about 30-40% of the areas they looked at, they could, in fact, see these insect infestations and map the area by satellite. Again, this can be done quite easily by hand and eye.

Looking for more subtle features in the ERTS data such as the quality of lakes, it is necessary to look at two bands. The return on band 5 (the red band) and in band 4 (the green band) of the ERTS satellite, can be related to the lake productivity. Lakes like Lake Ontario which are somewhat polluted are observed in one part of the graph, and waters like Georgian Bay are in another part of the graph. So we've found that by doing some very simple computations on the numbers that come down from the satellite, we can grade our lakes on a eutrophic scale - that is, a scale that is related to the productivity of the water. If the waters are too productive, then of course, this amounts to pollution. Similarly, we can classify land use. Figure 17 shows you the reflection from an area on the ground in the infra-red band, between 0.8 and 1.1 micron (band 7) plotted against the reflection in band 5 (the red band). Similarly Figure 18 illustrates how the reflectance in bands 5 and 7 are affected by land use.

An example of CCRS work in supervised computer analysis of ERTS data is shown in Figure 19. Each colour represents the following feature:

Yellow	water
Dark Blue	sand and rocks
Brown	conifers with shadow influence
Pink	heath
Light Beige	deciduous trees
Purple	mixed wood
Azur	conifers
Orange	grass

Some of the examples discussed delete above were taken from the Proceedings of the Second Canadian Symposium on Remote Sensing, organized in collaboration with the Canadian Remote Sensing Society of the Canadian Aeronautics and Space Institute, Ottawa. This newly established learned society is an element of our national program. Time does not allow for a full review of all Canadian work. Further details can be found in the Symposium Proceedings and in the Society Journal. The examples were intended to illustrate some of the proven applications, the techniques used, and some of the limitations.

The technical literature of the world now abounds with examples of the utility, productivity, and cost effectiveness of remote sensing methods. If Canada is to benefit from her investment, however, it is necessary to follow up such technical studies with the incorporation of remotely sensed information into operational systems. Remotely sensed information must be pressed into normal, rountine use for geological mapping, forest mapping, map revision, environmental monitoring, land use recognition, crop recognition, snow and flood mapping, fire mapping, ice reconnaissance, ocean resource exploitation and management, etc. We see this as a big challenge in Canada, the challenge of putting proven techniques of remote sensing into operational use.

The Canadian program has also developed Canadian industrial skills in ground station construction and innovative instrument development which can serve wider market needs.

Many consider that the world has a need for improved data on resources and the environment. Remote sensing has the potential of contributing to the improvement of world food, resource, and ocean data systems. A present international challenge is the construction or improvement of such data systems.

LIST OF FIGURES AND LEGENDS

1. A photograph of the Canadian ERTS reception station located at Prince Albert, Saskatchewan.

2. An example of Canadian Quicklook imagery available within hours of the satellite's pass.

3. A sample of ERTSFICHE.

4 ERTS image of Vancouver and Victoria, B.C.

5. The CCRS Falcon Aircraft.

6. Organization of the Canadian National Program on Remote Sensing.

7. ERTS image of the Zama Lake area.

8. ERTS image of the Winnipeg area. Note the pedological boundary marked in the lower left hand corner.

9. An ultra-violet image used for counting white seals.

10. A normal colour photograph used to plan control measures for underwater weeds.

11. False colour photograph of the St. Catherines area, Ontario, used to map land use.

12. (No overlay) Far infra-red (8-14 micron) image showing heat losses from old pipes eight feet underground.

13. (With overlay) The route of the underground pipes and location of major heat loss sites.

14. Geological information taken from ERTS images.

15. Glacial information taken from ERTS images.

16. Status of pest damage on ERTS imagery.

17. Classification of lakes on ERTS images.

18. Cluster analysis of ERTS data.

19. An example of CCRS work in supervised computer analysis of ERTS data.

LECTURE MEETING

ON

COMMUNICATIONS SATELLITES PROGRAMS

AND

REMOTE SENSING PROGRAMS IN CANADA

ON MAY 7, 1975

LIST OF PARTICIPANTS

(Service Institutions)

* * * * * * * * * * * * * * * * *

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	Shigehiro Hamada	Deputy Head Coordination Division
	Yoshihiro Ogura	Deputy Head Coordination Division
Masato Yamano	Counsellor	
	Hiroshi Imamura	Director Space Development Division
Shin-ichi Matsubara	Head, Space International Affairs Division	
	Kazuo Suzuki	Deputy Director Space Development Division
Akira Takahashi	Officer	
	Masakatsu Nakamichi	Research Officer Space Development Division
National Aerospace Laboratory	Masao Yamanouchi	Director
	Hajime Koshiishi	Chief of Instrumentation Section, Instrumentation & Control Division
	Tomifumi Godai	Space Technology Research Group No. 3 Group Leader
	Koju Otsubo	Principal Research Officer

National Institute of Resources	Yojiro Imamura	Science Research Officer
	Kaname Takeda	Leader of Research Group
	Toshitaka Seki	Research Officer
	Masahiko Katakura	Research Officer
	Yuji Yajima	Research Officer
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	Ryojiro Akiba	Professor
	Haruto Hirosawa	Associate Professor
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	Masakazu Tsuchide	Photogrammetry Section, Surveying Division
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	Minoru Sasaki	Astronomer
	Akira Yamazaki	Chief of Marine Research Laboratory
	Masataka Hishida	Researching Staff of Marine Research Laboratory

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	Keikichi Naito	Chief, The 3rd Office Meteorological Satellite Lab.
	Kyo Sekihara	Head, Upper Atmosphere Physics Lab.
	Yozo Takayama	Researcher, Upper Atmosphere Physics Lab.
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	Kazutoshi Maruyama	Special Assistant, " "
	Susumu Sato	Deputy Director " "
	Kiyoshi Oh-ida	Deputy Director " "
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	Yoshitaka Kurihara	Director, Technical Consulting Division
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	Nobuyoshi Fugono	Senior Research Officer " " "

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	Tadao Hoya	Chief, Photomap Subsection
	Masakatsu Horino	
	Masanori Sugiyama	
	Seiichi Tanioka	
National Space Development Agency of Japan	Hideo Shima	President
	Tatsumi Kitaoka	Executive Director
	Rinnosuke Nishihara	Executive Director
	Haruhisa Suzuki	General Auditor
	Tadafumi Sakai	General Auditor
	Tadao Takenouchi	Special Assistant to the President
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	Sadahiro Ishizawa	Senior Engineer, "
	Susumu Nishida	Senior Engineer, "
	Yoshimori Minowa	Senior Engineer,
	Fumio Imai	Assistant Senior Engineer, "
	Tateo Goka	Engineer, "
	Hisakazu Shirai	Engineer, "
	Kazuo Watanabe	Senior Engineer (Deputy Director), Application Satellite Design Group
	Yoshihisa Kido	Senior Engineer, "
	Masahiko Kudoh	Senior Engineer, "
	Shohji Sonoda	Senior Engineer, "
	Jun Shimaoka	Senior Engineer, "
	Aogu Matsumae	Senior Engineer, "
	Yasushi Horikawa	Engineer, "
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	Shoichi Kubo	Assistant Senior Engineer, "
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	Nobuhisa Matsutomoto	Director Environmental Test Group

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LECTURE MEETING

ON

COMMUNICATIONS SATELLITES PROGRAMS

AND

REMOTE SENSING PROGRAMS IN CANADA

ON MAY 7, 1975

LIST OF PARTICIPANTS
(Business Enterprises)

* * * * * * * * * * * * * * * * *

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Mitsubishi TRW Co., Ltd.	Takeshi Hagiwara	Managing Director
Mitsui Shipbuilding & Engineering Co., Ltd.	Shogo Saeki	Deputy General Manager, Systems Headquarters
	Kohei Okinaka	Assistant Manager Projects Development Headquarters
Nippon Electric Co., Ltd.	Yoshihiro Irie	Vice President
	Toshihiko Saijo	General Manager, Space Development Division
	Kimiatsu Tanaka	General Manager, Space Developments Sales Div.
	Yoshiro Takeuchi	Manager, Engineering Dept.
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Nissan Motor Co., Ltd.	Shinji Tamura	Manager, Planning & Marketing Section Aeronautical & Space Div.
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	Shinichiro Yoshida	Senior Speciliast on Space Engineering
	Hiroyuki Uyeda	Consultant
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Kokusai Denshin Denwa Co.	Masayoshi Tomita	Manager, Transmission System Department
Space Activities Promotion Council, Keidanren	Koji Kobayashi	Chairman
	Tetsuya Senga	Permanent Director and Secretary General
	Hiroshi Morikawa	Deputy Director
	Atsuo Ueda	Staff
	Tetsuji Suematsu	Staff

* * * * * * * * * * * * * *

APPENDIX 5

SPACE DEVELOPMENT PROGRAM

("Space Development Program Decision for FY 1971", authorized by the Space Activities Commission on 7th of March, 1975)

FY	1975	1976	1977	1978	1979
Scientific Satellites					
Designation	No. 4 (CORSA)		No. 5 (EXOS-A)	No. 6 (EXOS-B)	No. 7 (ASTRO-A)
Launch vehicle	M-3C		M-3H	M-3S	M-3S
Perigee/Apogee	350/600		350/4500	300/30000	350/600
Applications Satellites					
Designation	ETS-I ISS	ETS-II	GMS CS BS	ECS	
Launch vehicle	N N	N	U.S. vehicles	N	
Orbit alt.	1000 circular 1000 circular	36000 synchronous	36000 geo-synchronous	36000 geo-sunchronous	

ETS: Engineering Test Satellite
ISS: Inosphere Sounding Satellite
ECS: Experimental Communications Satellite
GMS: Geostationary Meteorological Satellite
CS: Medium-Capacity Communications Satellite for Experimental Purpose
BS: Medium-Scale Broadcasting Satellite for Experimental Purpose

STUDIES OR THE DEVELOPMENT OF LARGER LAUNCH VEHICLES

	Available by:	Launch Capability (to geostationary orbit)	Improvements
(1)	Around 1980	330 kg	Augmented solid rocket motors, improved first stage propellant tank, improved second stage engine, higher-precision guidance system.
(2)	Mid 1980's	More than 500 kg	Based upon technologies acquired by the development of the above-mentioned vehicle, cryogenic second stage engine.

New Spacecraft

Scientific Satellite No. 7

The Scientific Satellite No. 7 (ASTRO-A) is to observe solar soft X-ray flares, solar particles, X-ray bursts, etc. It will be launched by an M-3S launch vehicles in FY 1979 into an elliptical orbit with a perigee and an apogee of 350 and 600 km respectively.

FY 1973 JAPAN'S SPACE BUDGET

(Government estimate subject to diet deliberation)

Millions of yens

AGENCIES	FY 1974	FY 1975 (estimate)
Science and Technology Agency	48,613	62,697
Ministry of Education	5,084	6,538
Ministry of International Trade and Industry	75	79
Ministry of Transport	2,454	4,164
Ministry of Posts and Telecommunications	1,236	3,550
Ministry of Construction	3	10
TOTAL	57,465	77,039

THE OPERATIONAL UTILIZATION OF REMOTE SENSING IN JAPAN

-National Institute of Resources,
Science and Technology Agency-

1. Research Title:

   General Research on the Application and Utilization Techniques of Remote Sensing Information Data

2. Research Term:

   1973-1974-1975

3. Research Extra-budget:

   Each Year's $400,000
   Science and Technology Agency
   "Special Research Fund".

4. Associated Office and Research Group

   (1) Science and Technology Agency

   *Research Coordination Bureau

   *National Institute of Resources

   (2) Ministry of Transportation

   *Meteorological Institute

   (3) Ministry of Agriculture and Forestry

   *Regional Agriculture Experiment Stations

   *Forestry Experiment Station, Forestry Agency

   (4) Ministry of Construction

   *Geographical Survey Institute

   Associated Group

   Institute of Industrial Science, University of Tokyo

   Institute of Color Technology, Faculty of Engineering, Chiba University

RESEARCH CONTENTS

(1) Computer Aided Image Analysis: Digital Analysis of Imaging Interpretation for Multi-spectral Scanner and Camera (NIR, University of Tokyo)

(2) The Basic Study on Photographic Analysis for using an Optical Instrument (NIR, Chiba University)

(3) The Basic Study of Advanced Technique of Photographic Processing (NIR, Chiba University)

(4) The Application Study for the Interpretation of Spectral Data as following Problems (Associated Group and Member)

Problems: (a) Atmospheric Phenomena

(meso-scale disturbance, snow cover and distribution, etc.)
MI, JMA

(b) Ocean Phenomena

(soil erosion, seaside phenomena, tide, rip current, surface water pollution, water depth analysis, etc.)
NIR, IGS

(c) Ground Surface Phenomena

(study of crops, vegetation, damage by blight and insects, forest and soil, land use mapping, cartographic application of ERTS 1 images).

Organization for Remote Sensing Project

Remote Sensing
Research Coordinating Group

Technology		
Digital	Analog	Application
NIR	NIR	Atmospheric Phenomena MI, JMA
University of Tokyo	Chiba University	Ground Surface Phenomena GSI, FES, REAS
		Oceanic Phenomena NIR, GSI

1. Research Coordinating Group:

Project Leader Dr. Takakazu	Professor, Faculty of Engineering, University of Tokyo
Project Members Mr. Kaname Takeda	Leader of Research Group, National Institute of Resources, Science and Technology Agency
Dr. Kantaro Watanabe	Professor, Faculty of Marine Science and Technology, Tokai University
Dr. Hidesaburo Genta	Professor, Institute of Colour Technology, Faculty of Engineering, Chiba University
Dr. Morio Onoue	Professor, Institute of Industrial Science, University of Tokyo
Dr. Tatsuo Izawa	Chief, Typhoon Research Division, Meteorological Research Institute, Japan Meteorological Agency
Mr. Kiyoo Sasanami	Geographical Survey Institute, Ministry of Construction
Mr. Hiroaki Ochiai	Assistant Professor, Toba Merchant Marine College
Dr. Kiyoshi Tsuchiya	Chief Engineer, Application Satellite Design Group, National Space Development Agency of Japan
Dr. Iwao Nakajima	Chief of Photogrammetry Laboratory, Government Forest Experiment Station, Ministry of Agriculture and Forestry
Mr. Seishu Hayashi	Hokkaido National Agricultural Experiment Station

2. Digital Research Group:

   Dr. Morio Onoue

3. Analog Research Group:

   Dr. Hidesaburo Genta

4. Application Group:

   (a) Atmospheric Phenomena

       Dr. Tasuo Izawa
       Dr. Iwao Tsuchiya

   (b) Ground Surface Phenomena

       Dr. Iwao Nakajima
       Mr. Seishu Hayashi

   (c) Oceanic Phenomena

       Dr. Takakazu Maruyasu
       Mr. Kazuhiko Ootake

PUBLICATIONS COLLECTED IN JAPAN

The following material was collected by the EMR-CCRS representative during his visit to Japan. Items can be borrowed from the Technical Information Service of the Canada Centre for Remote Sensing. Most of the information is in English, but a few well-illustrated publications in Japanese are included.

1. Japan-Canada Relations
2. Some Data about the Japanese Economy in Comparison with Foreign Countries
3. Space in Japan 1974-75 (a well presented, attractively illustrated overview of the Japanese Space Program).
4. Science and Technology Agency - an Outline 1975
5. NASDA, the National Space Development Agency of Japan
6. Tanegashima Space Centre (in Japanese)
7. Tsukuba Space Centre (in Japanese)
8. Brief Aspect of the Hydrographic Department of Japan (of MSA)
9. As item 8, well illustrated, but in Japanese.
10. Medium Capacity Communications Satellite for Experimental Purposes (NASDA,May 1975 Provisional Draft)
11. Medium Scale Broadcasting Satellite for Experimental Purposes (NASDA, May 1975 Provisional Draft)
12. Geostationary Meteorological Satellite (NASDA, May 1975 Provisional Draft)
13. GMS Program of Japan (JMA April 1975)
14. High Precision Cathode Ray Tubes for Computer Graphics (DDT Tube) by E. Goto and T. Soma
15. Digital Correction of ERTS MSS Bulk Data for High Resolution Image Data Base by S. Murai
16. Summary of Prof. S. Murai's Research Interests
17. South Kanto Plain Project - Meteorological Aspect by K. Takeuchi
18. Products of NAC Incorporate giving details on:
    - NAC Image Processing System
    - Laser Beam Image Recorder
    - Photo Digitizing System
    - NAC Total Image Processing System for Remote Sensing
    - Model 1200 Colour Data System
    - Mini Addcol Viewer
    - Graph per Sonic Digitizer
    - Multispectral Camera
19. Products of Kimoto Company Limited
20. Canon Multispectral Viewer MSV-300, High Performance Aerial Photograph Analyzer
21. Toshiba Research and Development Centre
22. TOSPICS of Toshiba
23. Mitsubishi Research Institute Inc. (MRI)
24. Better Information, Brighter Future (Information on MRI in Japanese)

25. Asia Air Survey Company Limited

A very well prepared document giving details on organizations, staff, past projects and customers, major equipment and facilities of Asia Air. Examples of applications are given in photogrammetry, city planning, highway planning, geological surveying, ocean development, environmental surveying, agriculture, archeology, forestry, etc.

26. Remote Sensing, a comprehensive textbook on the subject prepared by the staff of Canon Camera (in Japanese)

27. File of ERTS images of Japan compiled by Dr. Genda, Chiba University (colour and black & white).