conference on

RESEARCH and DEVELOPMENT REQUIREMENTS in

SM

Surveys & Mapping

Sponsored by the:

National Advisory Committee on
Control Surveys and Mapping

1979

Conference On

RESEARCH AND DEVELOPMENT REQUIREMENTS IN SURVEYS AND MAPPING

Record of Proceedings

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FOREWORD

The Task Force on National Surveying and Mapping pointed out the need for the application of more research and development to surveying and mapping in Canada. The Task Force Report was reviewed by the National Advisory Committee on Control Surveys and Mapping and as part of their follow-up, the NACCSM sponsored this conference on the need for research and development.

The response to the conference was most encouraging. Many prominent researchers from across Canada gathered with those who would be potential users of R & D.

These proceedings contain the papers presented at the conference, the discussions that followed the papers, and the conclusions and recommendations resulting from the discussions. The conclusions and recommendations represent the consensus of the participants.

It is hoped that this report will provide impetus and guidance for future R & D work in surveying and mapping.

D.N. Kendall,
Conference Chairman and Member,
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on Control Surveys and Mapping

CONTENTS

LIST OF DELEGATES

Conference on Research and Development Requirements in Surveys and Mapping

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CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The purpose of the Conference was to determine the needs for applied research and development in surveying and mapping, and to respond to the recommendation of the "Task Force on National Surveying and Mapping" that more emphasis be placed on applied R & D.

The Conference endorsed the general concept that more funding should be directed to research. Specific areas were identified, some of which were relatively short term, while others were directed to what would be the technical needs five or ten years from now. The feeling overall was that money spent in research pays off in five to eight years, provided that it is well directed.

The Conference was told that the survey business in Canada, including engineering and property surveys, amounts to $500 million annually and provides employment for some 22 000 people. Of this large sum, however, less than 10 per cent is spent for hardware, the balance being consumed in the gathering, assessing, manipulation and display of data. It would appear obvious therefore, that the first target for the research has to be improving the productivity in the area of data acquisition, management and display, where 90 per cent of the expenditure occurs.

The Conference discussed the question of the split of the R & D effort between government (in house), industry and the universities. It was not found practical to arbitrarily split the funds available between the three. Rather, the needs must first be determined and then these tasks assigned to the most qualified group.

The Conference agreed that research for research's sake must be avoided. It did, however, endorse overall the aim of reaching an expenditure on R & D of 5 per cent of the Surveys and Mapping Branch's budget without specifying either how it should be split and by when the target should be reached. It was further recognized that the federal Surveys and Mapping Branch by itself could not or should not fund the full R & D effort. Other levels of government should accept a similar challenge. As well, industry should contribute funds to R & D sponsored by the public sector.

The Conference spent some time discussing the sharing of the cost of R & D, particularly where industry was involved. It was pointed out that where research was conducted by a profitable Canadian-based company, tax write-offs could absorb 75 per cent of the cost of R & D and, under ideal conditions, even more. If in addition, some funding was provided by government, the cost to the company could be very low indeed, making Canada an attractive country in which to conduct research.

The Conference felt that where research was conducted in a corporation, the best chances for success lie in having the corporation use some of its own funds rather than providing 100 per cent funding from the public purse.

SUMMARY OF RECOMMENDATIONS

1. Research funds should be directed to improve geodetic instrumentation and methods, specifically on developing a new technique for high precision levelling and on improvements in ISS and Doppler methods of positioning and heighting.

2. Development work should be directed toward the design and production of comprehensive land information systems.

3. Funds should be made available to do the necessary research and to publish a reference book on Canadian Survey Law. This is recognized as an urgent need by all surveying jurisdictions.

4. A short term research project is required to develop a series of standard survey monuments which fit the various field conditions to be found in Canada.

5. Improved instrumentation is required for hydrographic data collection in bathymetry.

6. Improved navigation and positioning systems are required in the Arctic.

7. Digitized information systems require R & D for development of standards, compatibility between systems, transfer of georeferenced data, improvements in digitizing and editing, and general digital data management.

8. Research projects should be set up to develop the most cost-effective method for carrying out map revision, including an examination of the use of digital cartographic data banks as the driving force.

9. R & D should be directed toward the development of fully integrated aircraft guidance and aerial photo acquisition systems.

10. There is a need for improved aerial photography specifications for photography intended for orthophoto production, and for R & D into photomap reproduction processes.

11. R & D is required for the application of improved remote sensing data to land-use and resource inventories.

12. There is a need for better coordination and communication of R & D projects throughout the surveying and mapping community.

RESEARCH AND DEVELOPMENT REQUIREMENTS IN SURVEYS AND MAPPING

1. WELCOMING REMARKS AND OUTLINE OF CONFERENCE OBJECTIVES

R.E. MOORE - CHAIRMAN, NACCSM

Ladies and gentlemen, thank you for coming and for participating in the conference at this very short notice. I am here as Chairman of the National Advisory Committee on Control Surveys and Mapping. In a moment, I will be introducing the Chairman of the conference, Mr. Douglas Kendall. Before doing that, I would like to thank our Conference Advisory Group: Ted Blachut of the National Research Council;Don McLarty, President of the Association of Aerial Surveyors; Maurice Gaudreault, Chairman of the Canadian Council of Land Surveyors; Les O'Brien, Director of Geodetic Survey and George Zarzycki, Director of Topographical Survey. I would also like to thank Al Stewart, who is the main push behind this conference, and Jill Swords, who did much to organize this meeting.

I would like to speak for a moment about the National Advisory Committee and tell you how these conferences come about. The committee operates under an Order-in-Council and is made up of three representatives from federal departments, two from provincial governments, two from universities and two from industry. The Committee advises the Minister of Energy, Mines and Resources on the coordination of federal surveying and mapping programs and secondly, on the promotion and coordination of related research and education programs, including the sponsoring of worthwhile research projects.

The results of this conference will be published and will be available to you all. I will ensure that the proceedings and the results of the conference reach the federal government. At the last meeting of the Committee, held last fall, we considered the Task Force Report on National Surveying and Mapping, or, as we like to call it, the Lapp Report. This is a report commissioned by the Department of Energy, Mines and Resources to examine and report on the long-term needs of surveying and mapping in Canada. One of the recommendations was a re-emphasis of the need for research and development and a greater participation by industry and universities in the research.

As many of you know, the National Advisory Committee under the chairmanship of the late Dr. Sam Gamble, has held a number of conferences on many important topics since its formation in 1964. Some of the changes for the better in our surveying and mapping community can be traced to these conferences; for instance, the First Symposium on Survey Education.

It is our view that research and development in surveying and mapping warranted a national conference, and we are delighted that Mr. Douglas Kendall, a member of the National Advisory Committee, agreed to chair the conference. It is now my pleasure to introduce our Chairman.

Douglas Kendall was born in Portugal of British parents and was educated in England at Oxford University. In 1939, while he was at Oxford taking a course in

forestry, the war broke out and he joined the R.A.F. Being an expert in aerial photography, he was assigned to the Photographic Interpretation Group and became a Squadron Leader, in charge of the Allies' Central Interpretation Unit. As many of you know, the most publicized activity of the unit was its discovery of the German V-weapons and the subsequent counter-measures. This resulted in a film being made called "Operation Cross-Bow", and the part of Wing Commander Kendall was played by Richard Todd.

In 1946, Douglas Kendall moved to Toronto, set up the Photographic Survey Corporation Ltd. and became a Canadian citizen. This company is still active today under the name of Northway Survey Corporation. The next year he established Kenting Aviation Ltd., which diversified into oil drilling, seismic surveying and pipeline construction. The following year, he established Field Aviation Company Ltd., and in 1948 he established Aeromagnetic Survey Ltd., which developed a high sensitivity airborne magnetometer. In 1949, he established Canadian Applied Research Ltd., which eventually, through Hawker-Siddley, became a partner in Spar Aerospace. Doug Kendall then spent most of his time managing these businesses and establishing foreign contacts. The results of his activities were surveys and explorations in more than 60 countries.

More directly related to the activities of today, Doug Kendall established a new company in 1967, Hobrough Ltd., later named Gestalt International, to design and build a revolutionary new instrument for automation in mapping. Later, of course, he became involved in oceanography, in Hermes Electronics Ltd., today one of the largest employers in Dartmouth, Nova Scoita. On taking up his duties as Chairman of the Enterprise Development Board for the Department of Industry, Trade and Commerce, Doug Kendall relinquished his direct involvement in his surveying and mapping-related companies. He now devotes about 50 per cent of his time to his duties as Chairman of the Enterprise Development Board, and the balance is taken up by directorships in a dozen or so companies, including the Chairman of the Board of de havilland Aircraft of Canada, the Canadian Development Corporation, Connaught Laboratories and the Fisheries Research Board. As you can see, Doug Kendall is a man who has not only carried out mapping and surveys in all parts of the globe, but has had direct involvement in organizing and carrying out successful research and development projects. We could not have a more fitting Chairman today. So Douglas, we are delighted to have you, and the chair is yours, sir.

2. OPENING ADDRESS

D.N. KENDALL - CHAIRMAN OF THE CONFERENCE

I thank you very much for the very flattering introduction.

Last year, the three wise men, Phil Lapp, Les O'Brien and André Marsan, submitted their report, entitled "Task Force on National Surveying and Mapping" to the Department of Energy, Mines and Resources. Personally, I thought it was an excellent report, although I am hardly entitled to an opinion, as I have now been out of the mapping business for nearly ten years. One of the most surprising, and perhaps most controversial recommendations was that five per cent of the mapping budget of government, specifically, that of Energy, Mines and Resour-

ces, should be diverted to research. There was a further implication that this should be divided more or less equally among government in-house, industry, and the universities. What was not said was how, and for what activities, this was to be spent.

A few months ago, Ray Moore decided that a conference on research and development in surveying and mapping might be useful in helping to determine this unresolved question. He very kindly asked me if I would chair it. Having long had an interest in, indeed a fascination with R&D, I was most honoured to accept, and I hope the agenda we produce will bring forth some of the answers.

In drawing up the format for the conference, it was decided to keep it small, preferably under 100 people, largely so that it could remain informal. When conferences are too large, discussion is more inhibited. We certainly hope that all of you will participate, make suggestions and ask any questions you want. To keep the conference small, we had to keep it on an invitational basis, which always brings with it the danger that people who should have been invited inadvertently get left out. To such people I apologize. I do think, however, that we have a sufficient cross-section of well-known people here today from all aspects of the mapping business that we should have all aspects of the field well covered.

I don't know if Ray Moore had a private pipeline into the PMO, because the fact is, his timing was perfect. The one thing that all three major parties are agreed upon in this election is that there has to be more R&D, and that this, God willing, is one of the major keys to solving the unemployment problem. I wish it were as simple as that. I happen to be Chairman of the Enterprise Development Board, which administers a number of programs. These include the old P.A.I.T. program, now called Innovation Support, plus the new 50 million dollar fund that has just been announced, for stimulating development in high-technology electronics. Certainly, some aspects of surveying should qualify under these programs.

I would like to discuss for a moment the question of whether support of R&D really does create new jobs and at what cost. Under E.D.P., Enterprise Development Program, over the last five years, we have supported just over 1500 companies. The total cost has been about $110 million. Since this was on a 50/50 sharing basis with the companies concerned, it means that about $200 million was spent under the program. What has gone right and what has gone wrong with the program? Let's look at the cause of the failures first.

They include, 1) the fact that the project had technical merit but that there was no market requirement; 2) that the project has good technical merit but the company was under-capitalized and thus had no ability to exploit; 3) the company was not technically competent enough to meet the technical objectives; 4) and very commonly, the company was poorly managed. In other words, it's not good enough to have a good idea. The company sponsoring the development must have the stability and ability to attract good people and, if the development is successful, must be able to finance its production and marketing.

Let's look at some of the successes. These are not in the mapping field, I might

say. Company A produces processing equipment in the banking field. Between 1972 and 1977, E.D.B. supported it to develop a whole family of systems, to the tune of 7 million dollars. Company A agreed that if the development was successful, the product would be produced in Canada exclusively for their world-wide market. They turned out to meet their full expectations. As a consequence, they have now built a new plant, creating 650 new jobs. In two years, their exports have reached the level of 90 million dollars per annum, and by the end of 1979, they will have paid to the government 13 million dollars in income taxes as a consequence of this development. That was a pretty good return on an investment of 7 million dollars.

The story of A.S. Data is even more extraordinary. This company is in the field of word processing. The original development was financed by E.D.B. under the P.A.I.T. program. Subsequently, and prior to exploitation, the company got into financial difficulties, in other words, it went into receivership. However, a new shareholder was found and E.D.B. provided a one million dollar loan to help it get into production. Today, all loans have been repaid (this is over a period of about two years), the company employs over 1000 people and has sales in excess of $150 million per annum. The conclusion is that R&D can pay off handsomely if the right product is selected, but it takes time. From original support to exploitation will normally be from five to eight years. As a matter of interest, averaging out the successes and failures, it has cost E.D.B. about 16 thousand dollars in R&D support for each permanent job created, so it costs money to create employment.

Now let me turn to R&D in the mapping field. As Chairman, I will try to have no biases when we come to the end of the conference and will try to draw some conclusions and recommendations. However, at this point I certainly have some biases, so I might as well table them, to be shot at, if you will. I'm against research for research's sake, except in universities, where research projects, however esoteric, are part of the learning process. To be flippant for a moment, I can recall, when I was at university, thinking, in my youth, that the key to academic success lay in becoming the world's leading expert on one obtuse subject. I finally dreamed up my choice for a claim, which was to be a thesis entitled "Variations in the Rate of Osmotic Absorption by The Umbelliferae Under the Influence of Lunar Gravity". Translated into English, this could be restated, "Rate of Water Absorption by Cow Parsley When the Moon is Overhead". This would have been a useless piece of research but a fascinating one to carry out.

To be serious, let me continue listing my biases. In most cases I am against duplicating research that has already been done elsewhere. There are exceptions, of course. One of the important exceptions, and this applies perhaps more to the NRC than anything else, is that you have to be engaged in an area of research if you want to have dialogue with those in the rest of the world who are in the same area. So, just to be able to have dialogue is sometimes a very good reason for doing something.

Next, I'm skeptical about supporting research unless there is a good case made that there will be exploitation, given technical success. I'm reluctant to see research in industry supported by government unless the company can demonstrate

its ability to perform technically and show how it will exploit if the project is successful. I much prefer projects that are not fully funded by the government, where a reasonable part of the cost of research is borne by the company. The question is, what is a reasonable part?

My last bias relates to the nature of the mapping business. I think I'm right in saying that the total survey business in Canada, including cadastral and land survey, is about $200 million per annum. The photogrammetric portion is about $30 million. Less than 10 per cent of this annual sum is spent on new hardware. In other words, 90 per cent is spent on carrying out the job. Surely, therefore, where we need the largest amount of research dollars spent is on methods and systems for improving and reducing the costs of compilation and mapping; in other words, on the 90 per cent, rather than on the design of new hardware. I realize that methods and hardware go hand-in-hand, but the emphasis should be on methods where we can save large sums through research. Let the hardware to do the job follow. It seems to me that we have, in the past, tended to follow the other route; in other words, someone develops new hardware, then the surveyors try to find uses for it.

The support of the government through the tax structure, apart from grants, has always been an important factor in R&D and with the latest changes in the tax structure, it is even more important. It is such an important factor, that I would like to have a few words to say about it at the end of the conference, in my summing-up.

It is now my great pleasure to turn over the meeting to Ray Moore, who will act as Chairman for the first session.

3. FIRST SESSION - MAPPING

CHAIRMAN, R.E. MOORE

Thank you, Mr. Chairman. You have ably set the stage for our conference. Ladies and gentlemen, the first part of the program is on mapping. As Mr. Kendall has said, the format of the conference is such that two authors can present their papers for about 10 minutes giving the highlights, followed by a discussion period.

The first speaker this morning is R.G. (Bob) Code, Surveyor-General of Ontario. Mr. Code was born in Essex County, as he says, a few decades ago. He obtained a B.Sc. in civil engineering from Queen's University, served in the Corps of Royal Canadian Engineers during the war, and after the war practiced municipal engineering and surveying in London, Ontario, for a period of about 10 years. He was then appointed to his present position of Surveyor-General of Ontario, and Director of the Surveys and Mapping Branch, Ministry of Natural Resources.

Mr. Code will speak on two subjects this morning, related to mapping. The subject of the first paper is the preparation and semi-automation of large-scale topographic mapping, thematic maps and associated products and reports. The second paper deals with data bases, including compatible, geographical reference data base systems and integrated digital topographic data bases. It gives me great pleasure to introduce to you Robert Code.

R.G. CODE

Mr. Code presented his paper (see Appendix A).

R.E. MOORE

Steve MacPhee is our next speaker. A native of Cape Breton, N.S. Steve graduated from St. F.X. and received a degree in electronic engineering from Nova Scotia Technical University. During the last few years, Steve has taken further degrees in engineering math and business administration. In 1960, he joined E.M.I., in designing and testing underwater sounding equipment. He joined Sperry-Rand in 1964 where he worked with sonar and other systems for the military. In 1971 he joined the Bedford Institute of Oceanography and became head of the Division of Engineering Services. Later he became the Manager of Planning and Development, Canadian Hydrographic Services. Recently, he completed a tour as Acting Dominion Hydrographer. Steve will be discussing the program of the Canadian Hydrographic Service, and the needs of that Service in the field of computer-assisted techniques in survey and chart production.

S.B. MACPHEE

Mr. MacPhee presented his paper (see Appendix B).

Discussion on Papers

R.E. MOORE

I would ask you to please identify yourself and give your affiliation, before asking your questions. We are taping the discussions and will thus have a full record of the proceedings.

C.H. WEIR

My question is directed towards Steve. Unknown to him, in my paper this afternoon I support the use of some R&D funds to look into the needs of the development of our offshore resources. So my question is directed along those lines. What do you know about the needs of the oil industry regarding their requirements for information systems, both topographical and geological?

Has research been done in that area or have studies been made of that area?

S.B. MACPHEE

I guess that we could look at the oil industry as a fairly well-to-do industry, and, because government has not been active in some of these research areas, the private sector has done a fair bit of work. However, there has not been much collaboration between the private sector and the operating agencies, and I see a need by government for more collaboration. We, as a government agency, on a day-to-day basis get requests from the oil companies for information, especially on bathymetry, on what positioning system may be available in different areas, on what control is there if they put in positioning systems, etc. There is just

a lot of work to be done in this area. I don't know if that answer is specific enough or not.

R.E. MOORE

In your discussion of automation, you indicated that you had made a certain amount of progress. My question is in two parts, one, is your system economic at this stage in time or are you producing a product that is different, and therefore does the cost or the gain really lie in the compatibility of the systems? The second question is: are you in a position at this time to write specifications and to go to industry for the development of the system.

S.B. MACPHEE

Our computer-assisted system is now used to routinely produce chart bases and lattices for charts. The automated system is now 20 times faster than the manual system and the algorithms have all been developed for doing hyperbolic lattices on charts and for doing standard borders. Computer-assisted techniques are very amenable to this type of operation. If we get into interactive editing and the chart compilation process, the data will have to be digitized and, since our data is anywhere from 200 years old to two months old, some of it is in analogue form and some of it exists as graphics. There is no question that it is more expensive to produce a chart or at least it is no cheaper to produce a chart using computer-assisted techniques at this time. But we are building this parallel data base, which is a digital data base having the same information that exists on the chart. We feel that this can be used in the chart-maintenance program later on and that it can be transferred to other agencies fairly easily. Because of those factors, it is economically viable to have computer-assisted techniques in the chart production process.

Now, in answer to your second question, "are we prepared to go to industry for development"? We have a number of software contracts in operation right now and we are aware that software expertise is very strong in the private sector. This is a continuing operation, i.e., contracts to the private sector for software. For the total production of the chart, we do not have specifications, and it takes a long time to prepare such specifications.

J.C. BEATTIE

I have a question for Mr. Code. You indicated in one part of your paper that some of your senior management did not really know what they wanted. The crux of your problem was that there was an expanding need for information, which seems to be an anomaly, but my question is this; in Ontario, who, do you feel, has the responsibility or should take the responsibility for coordinating some of the various common interests in resource information?

R.G. CODE

A report of the committee on Government Productivity, which was compiled on

an all-ministry, at that time, all-department basis, was presented and endorsed by government. The report stated that the leadership for this coordination should come from the Surveyor-General. They named an official, not a group or an organization but an official, to do this.

R.E. MOORE

I would like to go back to part of Mr. Beattie's original question. You did allude to the uncertainty of senior people as to the type of information they require. I think this is common throughout the system. How do you propose to tackle this problem? Are we talking about "the chicken and the egg" here, i.e., give them the information and they like it; or how do you approach this kind of problem - from the government's point of view?

R.G. CODE

It is a long process. Within the government Ray, we are sitting down with individual managers. Over the last five years, I believe we have met with groups and individuals totalling well over 600 people. They are mostly resource-type people. Secondly, we are starting to determine the requirements of information users in other ministries through the medium of an ad-hoc committee, which is called the Inter-Ministerial Committee on Geographical Referencing. Until last September, that committee had been meeting weekly and it is now meeting every other week. The meetings are usually attended by 12 to 14 regular representatives from different ministries. It is an activity which we think will continue for at least another two years.

R.E. MOORE

Are the preliminary results of your survey available to other people? Can people write to you to get information on this, or is the information available only within the government? I am sure this kind of resumé would be useful to a lot of people who have the problem of how to communicate information.

R.G. CODE

We have the information in a variety of files and reports and we had never thought of compiling it in any sense. But we do have the information available - the kind that we have obtained from a variety of disciplines - biologists, foresters, geologists, and so on. We have statistics showing how much time would be saved by a forester or a forest manager in simply knowing that a given piece of information exists.

R.E. MOORE

May I ask a final question? You put that sketch on the board - what is it?

R.G. CODE

Well, I thought someone would ask me what I meant by a comprehensive, geographic

reference data base. I was almost certain I would have to draw a picture! The solid line is an ideal type and the concept is that you have one grid and your data base is stored by a common type of identification. These are all the various systems that now exist. We hope that within two years we will be able to find a way to bring about a comprehensive and common system.

W.V. BLACKIE

Question for Bob Code. You did indicate that one of the weaknesses in your system was the definition of what needed to be mapped, and yet most of your indication of research-need related to how it should be portrayed, how to manipulate it and deal with it. Have you, or do you think that you have solved the question of what should be mapped, how accurately it should be mapped, to what degree of resolution it should be mapped, and, related to that of course, what should be type of scale portrayal? Do you think you have a firm enough handle on this right now, Bob?

R.G. CODE

No, Bill, I believe that in many areas we are a long way off. I would be unable to say at what point in time we would cover 80 per cent of the areas - I think we are at about 30 per cent right now. But, I think in two or three years we may be up around 80 per cent.

R.E. MOORE

I'd like to take the opportunity to thank both speakers and our Chairman for a good start to the conference this morning.

Ladies and gentlemen, I would like to ask Ted Blachut to make an announcement concerning an important international symposium that will be held in Ottawa in October.

T.J. BLACHUT

Well, ladies and gentlemen, you have already heard how tremendously important is the knowledge of our land and our resources. On the suggestion of the FIG (International Federation of Surveyors), the Canadian Institute of Surveying, with the help of two of us from the Ottawa area, is organizing an international symposium from October 2-5, 1979, to be held in the Chateau Laurier Hotel. The subject of the symposium is Modern Technology for Cadastral and Land Information Systems. I do not hesitate to advertise the symposium because the organization of such an international symposium is a major effort and also very costly. The Canadian Institute of Surveying is funding it, and we would like to see a big attendance. We have managed to assemble as speakers some leading experts of international status.

R.E. MOORE

Our next speaker will be Gerald Arnold of the Directorate of Cartography, Department of National Defence. Gerry Arnold is well known to many of us. He was born and raised in Saskatchewan, and received his degree in civil engineering

from the University of Saskatchewan. Gerry did topographical surveys for EMR in 1948, transferred in 1950 to the Army Survey Establishment of the Department of National Defence, and has been involved in military surveying continuously from that time. After a number of years as Production Manager, he assumed his present duties as Head of Plans and Development, Directorate of Cartography, National Defence Headquarters.

Mr. Arnold will be speaking on applied research and development needs in the area of Canadian military mapping, by looking first at the large military R&D programs in other countries, and then at the influence that this will have on the Canadian program.

G. ARNOLD

Mr. Arnold presented his paper (see Appendix C).

R.E. MOORE

Our next speaker is George Zarzycki. George obtained his master's degree in geodesy from Warsaw University and his doctorate in photogrammetry from the Swiss Federal Institute of Technology in Zurich. After a period with the WILD Company in Heerbrugg, Switzerland, he came to Canada in 1952 as a post-doctorate fellow at N.R.C. In 1953, he joined Canadian Aero Service Ltd. as Chief Engineer. He subsequently formed Terra Surveys Ltd. and became its President. In 1974, he became Director of Topographical Survey, Surveys and Mapping Branch. George has published some 40 or so technical papers, and is recognized as a leader in digital mapping and computer-assisted cartography. He will speak to us on various projects undertaken by the Systems Engineering Group of Topographical Survey and on the auto-cartographic system.

J.M. ZARZYCKI

Dr. Zarzycki presented his paper (see Appendix D).

R.E. MOORE

I would like to introduce our next speaker, Al Daykin. Al Daykin is Vice-president, Mapping and Development for Northway-Gestalt Corporation, Toronto. We all know him as the former President and General Manager of Atlantic Air Survey in Dartmouth. Al was born in Ontario and educated in Toronto. After service in the Corps of Royal Canadian Engineers, he joined the Photographic Survey Corporation in 1946. He moved to Montreal, lectured at McGill and helped form the Montreal Branch of the Canadian Institute of Surveying. He has been very active in promoting the well-being of his fellow surveyors, and for several years served on the advisory committee of the Survey Engineering Department of U.N.B. and on the Nova Scotia Land Survey Institute Advisory Board. Last year he was elected Vice-president of the Canadian Institute of Surveying. Mr. Daykin will speak to us today on the development work associated with the extensive orthophoto-mapping project for the Council of Maritime Premiers.

S.E. DAYKIN

Mr. Daykin presented his paper (see Appendix E).

R.E. MOORE

Thank you very much. I would like to move on to the final speaker this morning, who is Brian Giles. Brian was born in London, England, studied electrical engineering at the University of London, and joined the Industrial Group of the U.K. Atomic Energy Authority in 1960. In 1966, he joined the R&D Labs of Northern Electric in Ottawa, and became involved in the ARDA Project, planning and implementing the data encoding and computer operations for the Canada Land Inventory. In 1969, he joined Softwarehouse Ltd., where he was a project manager, responsible for computer systems. He is a founding member of Systemhouse Ltd. (1974), where his present responsibilities are in computer graphics and mini-computer techniques related to mapping and graphical information systems. Presently, he is the Director of the Graphics Division of Systemhouse. Mr. Giles will speak to us this morning on R&D capabilities of the Graphics Division and the development of interactive mapping systems on analytical stereoplotters.

B.J. GILES

Mr. Giles presented his paper (see Appendix F).

R.E. MOORE

Ladies and gentlemen, we are open for questions. We have had four speakers: G. Arnold on cartography in Department of National Defence, J.M. Zarzycki on automation, S.E. Daykin on the Gestalt, and B.J. Giles on computer graphics.

S.B. MACPHEE

I have a question for Mr. Giles. I was wondering if the system that was delivered to the Australian Navy included the digitized response step, that is, digitizing from graphics documents, and, if it does, what kind of digitizing does it do?

B.J. GILES

Yes, it does include digitizing stations. In fact, the initial system has four sub-stations on it. They are trying to increase the number to five or six this summer. Those stations will be for the digitizing of the system manuscripts and the interactive compilation of the output chart documents.

H.E. JONES

Do you see any large public demand or interest in ortho-photo maps? I'm concerned with the relationship between the need for line maps versus the need for photo maps. That's one question. The second one is that I am interested in more details of how the stereo pairs are being used for cadastral maps in Colombia.

S.E. DAYKIN

I am not sure that I can give any kind of long-term forecast about the need for orthophoto mapping. About all I can relate to is the demand for the Gestalt output by other users for the production of maps. This demand has been steadily growing for the last three years. There still seems to be considerable interest here in Canada. I visited some parts of the U.S. and Mexico within the last two weeks, and there is a tremendous interest in the U.S. and Mexico for orthophoto mapping. The interest seems to be growing.

To answer the second part of your question, concerning stereo mates, I might best appeal to Dr. Blachut since I think he is more familiar with the Colombian operation than I am.

T.J. BLACHUT

A stereo-orthophoto is not just a graphical representation of the terrain. It is also very suitable for the derivation of digital information. It is also much more suitable for graphical plotting of maps than any stereophotogrammetic method. Actual plotting on the stereo compiler can be done using simple measuring marks. Because of this, I think that we can prove quite soon that one will be able to draw the formal map manuscript directly in a scribed form on the plotter. That is only one small detail. There are other very important characteristics of this stereo-orthophoto. In countries where you do not have trained technicians, in about 90 per cent of the world, you can organize all the orthophoto production and mapping data in such a way that the first stage that I was referring to will be run by the photogrammetric engineers. But, the conversion of stereo/photography products into final mapping of digital information can be run practically by anyone who has stereo vision.

J.R.R. GAUTHIER

I have a question for Al Daykin. You mentioned in your talk that your company was going to spend some time on development using D.T.M.'s. I was wondering if this was based on some sort of market survey. Have you had any indication that this kind of product is in demand more than other types of digitized products, based on vectors, for example?

S.E. DAYKIN

No, we have not done a market survey, and I imagine that it would be a very difficult one to do. The indication that I got having attended the D.T.M. Symposium in St. Louis last May was that there certainly seems to be a need. Three intensive days were devoted to looking at D.T.M. applications and D.T.M. methodology. I have personally seen a half dozen jobs related to orthophoto mapping and areas related to line mapping that were natural applications for D.T.M. data as opposed to mapping by conventional methods. Sometimes D.T.M.'s are more appropriate to producing the kind of information the client wants without necessarily producing a map at all. There seems to be an unlimited number of applications, but perhaps it is more by gut feeling than anything else that we think there is a market out there.

W.F. ROBERTS

There is one question from Mr. Jones that I would like to answer if I may. We, under the Council of Maritime Premiers, realized immediately that we were dealing with everyone who owned land or may own land in the future, and thus we realized that their capabilities of being able to read a map were zero. I think it is fair to say that over 90 per cent of the people of North America, as highly educated as they are supposed to be, cannot read a line map. An orthophoto map gives them an immediate instrument that they can easily use. That is why we consider it a very good tool, a very useful tool, for us and for the user. Concerning the user, I do not know if this question should be addressed to George or to Ray - have you done a user study on how we are going to use your product, your digital data base as it is compiled? How is a provincial government user or, a private user going to use it?.

J.M. ZARZYCKI

We have not done extensive studies, but we have talked to a number of potential users and provinces who are interested in the digital data. The major potential for the use of the data we produce is that the data has a geometric accuracy suitable for production of maps at 1:10 000 or 1:20 000. We produce about 80 per cent of the content required for these scales. In this area we see the possibility of provincial governments using our data in the production of their maps. We are now doing some projects to see how far we can go with this approach.

Secondly, we see that later on, digital data produced by the provinces could form a part of a digital topographic data base. We are on the way now to determining the type of standards for the exchange of digital information.

As far as the users of digital data itself are concerned, there are not many but they are important users. There are those who are using the terrain data in their engineering designs. Those who use computers in their engineering design need the information in digital form. We have been approached by several users, mostly in the area of communications, such as police departments and hydro commissions. We have also had requests from people who have a requirement to move goods, in order to determine the best routes for delivery of the goods. We are in the process of conducting a study to determine the user population of digital data.

G.C. DOHLER

I would like to ask George Zarzycki three questions. The first question is: where does your source data come from; do you have only one source from which to gather the data or different sources; are the data coming in different forms? The second question is: how many maps have you produced using your system? The third question is: can you give me an average figure for the cost of maintenance per annum of your present data base?

J.M. ZARZYCKI

The answer to the first question - sources of data. At this stage, we have three sources of data which go to our system. One is the data digitized directly at stereoplotting; secondly, data that are digitized from existing graphics; and thirdly, data produced by the Gestalt Photomapper. To answer your second question about how many maps we have produced, the system started production on November 27, 1978. So far, four or five maps have been produced, and we intend, by the end of this year, to produce 25 or 30 maps with the one system that we have now. Regarding the cost of the maintenance of the data base, I cannot give you a figure because the data base has just been built, so we do not know how much it will cost to maintain it. But we will know in the future, because this data base will become the basic source of mapping digitally.

C.H. WEIR

My question is directed to Mr. Arnold. The military are interested of course, in preserving the peace and being prepared. They are spending vast amounts of money on gear that will be given over for use by civilians, for very little additional funds. So my question to him is: what is being done, what positive action is being taken to ensure that some of the military uses can be made available to the civilians?

G. ARNOLD

I feel that I am unable to respond to your question. I looked at the R&D themes from within the Department of National Defence, from a very tiny vantage point. We have a very small cost component in the R&D field, and it has a very disproportionate status when viewed against the R&D programs within the Department of National Defence as a whole. Certainly, I would think that we share with other government agencies, and we are proponents of technology transfer.

(Mr. Arnold answers a second unrecorded question from a member of the audience)

G. ARNOLD

In answer to the question on the vertical and horizontal control that we will require in the next 10 years, one of the basic platforms in our requirements for Canada is the completion of the 1:50 000 mapping coverage of Canada. To that end, we rely significantly on the national mapping agencies in Canada to provide the basic requirements. Our requirements relate very closely to what the Surveys and Mapping Branch requires to respond to our requests to them. I can say that our requirements are the same as those of Dr. Zarzycki and they are, to a large extent, 1:50 000 mapping. The aerial survey data base work that has been ongoing is moving along very rapidly. The initial coverage, at least in terms of the data base, is now within reach, certainly within the next 10 years; in fact, probably within the next year or so.

The areas with the greatest lack of control at the moment, in terms of first coverage, are Baffin and Ellesmere Islands. This problem is currently being studied. In some areas, work that was done in the past which has not yet been con-

verted into the aerial survey data base is largely hand-done or machine-done, in such a way that records are no longer available in our current context of an aerial survey data base. With the age and the previous orders of accuracy of that work, there is a great deal of work left to be done in terms of what I like to call "aerial survey data base II"; that is, to begin re-doing a lot of the work that was done prior to seven years ago. That work I consider to be quite extensive and it will continue for some time.

In answer to the second question regarding instantaneous positioning, I feel that our greatest concern in this area is vertical control when thinking in terms of global positioning systems now coming along. The systems we now have in terms of Doppler positioning, from a control survey point of view, are reasonably established in providing horizontal positions. However, the problem of elevation is not so readily determined. Looking then at the global positioning system,where we may expect a reduction in the waiting period from the present Doppler times of 2 to 3 days down to quarters of hours to get geodetic accuracy, the problem of providing elevations to mean sea level datum is more critical. In this area of application, geodetic vertical control by satellite, there is still a question in our minds to be resolved by further R&D. That is, the problem of providing a datum adjustment equation, applicable anywhere, that will provide real time acquisition of vertical control and its adjustment to mean sea level datum for introduction directly into mapping operations.

R. GROOT

In the presentations this morning, we spent a long time discussing the mechanics of making maps; primarily, making basic topographic maps, and only sporadically have there been allusions to the resources maps, which are usually of a different character. In my area of interest, which is the geography of the country as a whole, we are concerned about the linkage of the geography *per se*, as you find it in the terrain, and the entities that have a natural delineation, with the social and economic data which are, for example, collected within the provincial and federal statistical organizations. This information is collected on the basis of administrative delineation, which does not necessarily have boundaries composed of physical features. The orderly geographic information management starts with the base maps, but may be extended into the area of socio-economic information. Thus, there is a need for linking the statistical boundaries with the geography. I know that this problem has not yet been resolved in the computer application field and that this should be identified as an area of research.

Another area of research that has not come out was alluded to by Dr. Zarzycki when he said that it is time we review our present symbology. Also, Willis Roberts said that the user, as a map reader, lacks some competence. There is very little known about the map as a graphical communication medium, and this goes back to colours, the definition of symbols, and the way people read their maps. I feel, although this is not in the realm of the technical area we are discussing this morning, that we have to look at some innovations. We should include the entire subject of the map as a graphical communications medium in the research package. If we do not, we may be making maps at considerable investment cost, that cannot be used very well.

R.E. MOORE

I would like to ask Ted Blachut to introduce two representatives of local industry.

T.J. BLACHUT

It is a great pleasure for me to introduce to you two representatives from local Canadian companies which, in spite of their size, are quite extraordinary. My connection with these representatives is partly business and partly of a personal nature, but both of these companies have developed technology that is really significant internationally.

The first representative is Mr. Andreone, who represents a company called IMAPRO Inc., in Charlottetown. He developed an amazing colour image recorder which is already being used by our remote sensing centre. He will describe the instrument to you in a few words.

The second representative is Dr. Norton, who is from NORPAK Co., located in Pakenham. The system he will describe is efficient in handling all kinds of schematics and enhancement.

G. ANDREONE

We started this company in 1976 for the sole purpose of developing what we call a colour image recorder, a system that will take data in the order of about sixty mega bytes. It is being used in the remote sensing community for Landsat data and I believe it will have applications for you in the topographical map area. This system is very flexible; the density ranges on film are running in the range of 0.12 to 1.62, and all three colours have good separation. Taking data from all the sources, you store it, and as a final product, you get the required output.

J. NORTON

We have not been directly involved in map production. Very briefly I'll tell you that we are involved in the business of developing, designing, product engineering and manufacturing, computer display systems. These are small, unsophisticated, but sometimes exotic, types of display systems. Recently, we developed a thousand by thousand colour raster display system, with some rather unique and interesting features. There are some features that have been added stemming from developmental effort at the Department of National Defence. I would be glad to discuss with anyone who is interested some of these features which I think may have some interesting applications in the cartographic field.

R.E. MOORE

Ladies and gentlemen, this is the end of the discussion. I would like to sum up by saying that is seems that three points have been raised: one, a need to manage an ever-increasing amount of data in mapping; two, a need to collect data more efficiently from people; and three, a need to have multi-purpose

use of the data and the user better identified. All these questions seem to have threaded through the discussion this morning. We have heard very interesting technological adaptations around these problems and issues. It seems that there is an overwhelming interest in computer graphics' applications for mapping, though there also seems to be a need to ensure cooperation and standardization and a better rationalization of the development in this field.

4. SECOND SESSION - SURVEY CONTROL

CHAIRMAN, P.A. LAPP

D.N. KENDALL

The Chairman for this afternoon's session is Dr. Phil Lapp.

Phil Lapp was born in Toronto. He received his B.Sc. in 1950 from the University of Toronto in engineering physics. In 1951, he was awarded an S.M. degree from M.I.T. in aeronautical engineering and obtained a doctorate in Science in 1955 for studies in instrumentation. From 1954-1967 he worked with De Havilland of Canada, becoming Director of Technical Operations for the Special Products and Applied Research Division. He then became senior Vice-president of Spar Aerospace and has been president of his own consulting firm since 1970.

His consulting work includes studies on engineering education and manpower, marketing and industrial strategies, science, and energy policy. Detailed technical activities focus on communications and space technology, remote sensing, navigation and information systems. As I said earlier this morning, Phil headed up the task force study that we had, which is the main reason why we are all here today. I think it was an excellent report. I have great pleasure in introducing to you Phil Lapp.

P.A. LAPP

This afternoon, we are dealing with survey control and we have six speakers. We are going to follow the pattern of having two speakers, then a discussion.

The first speaker is C.W. (Wally) Youngs. Wally was born and educated in Alberta. He was appointed Director of Surveys for the Province of Alberta in 1964. He qualified as an Alberta land surveyor in 1953 and received his commission as a Dominion Land Surveyor in 1955. He has served as President of the Alberta Land Surveyors' Association and as Provincial Councillor for the Canadian Institute of Surveying. He is presently Vice-chairman of the Provincial Planning Board, the Commissioner for Alberta on the Alberta - British Columbia and Alberta - Northwest Territories Boundary Commissions and a member of the Canadian Council on Surveying and Mapping. Wally's subject this afternoon is R&D in a provincial setting.

C.W. YOUNGS

Mr. Youngs presented his paper (see Appendix G).

P.A. LAPP

Our next speaker this afternoon is W.J. MacLean. Bill was with the Geodetic Survey of Canada from 1946-1954 during the pre-computer period. He participated in the Shoran project in Northern Canada. From 1954-1965, he was in private practice as an Ontario Land Surveyor, and from 1965 to the present time he has

been with the National Capital Commission in Ottawa. He participated in the introduction of coordinate control in the mapping and surveying activities of the N.C.C. Bill's subject this afternoon is how we can live with the 1983 North American readjustment and redefinition (the '83 N.A.D.).

W.J. MACLEAN

Mr. MacLean presented his paper (see Appendix H).

P.A. LAPP

I'd like to open up the meeting now for discussion. We have had two very different themes in the papers we have had: the first one dealing with the establishment of an institute, as part of Wally Young's suggestion, possibly jointly funded by a number of agencies. That's an interesting idea and it would be interesting to get comments from you. And, of course, Bill is putting out a plea to get a good clear argument about why to convert.

T.J. BLACHUT

Well, maybe Wally Youngs could elaborate a little bit more about the Institute he is proposing.

C.W. YOUNGS

This is probably not thought through as well as it should be, Ted. Alex Hittel will be, I think, discussing this. I compared notes with Alex at noon today and he may be touching on it. Does it steal all your thunder, Alex, to go into it now? Perhaps you are the one who really should be answering it.

My concept would be a coordinating role, a relatively small administrative group attached to a university, but without full-time research staff. The researchers, in fact, would be drawn from wherever they were employed, at other universities, in industry or in the government service. They would be put together as a team to take on a research function on a contract basis. That would be my concept of it. It would serve as a clearing house for research projects. I think right now one of our difficulties is that quite a lot of good research is being done in small problem areas, and we do not always have the means of getting word of that. Papers on larger research projects are written up in the CIS journal but there is a lot of worthwhile work going on in the provinces which we do not always hear about and take advantage of. I see an institute as a clearing house of information, in part.

T.J. BLACHUT

Would the institute generate the projects or would it only be asked to work on the projects?

C.W. YOUNGS

Primarily, I think, being asked to work on rather than initiating projects

would be my own concept.

L.J. O'BRIEN

I just wanted to respond to Bill MacLean's plea about the adjustment to the new datum. The problems are appreciated, there is no question about that. Regarding analogy about the town: if the town was as big as a continent, and two-thirds of the continent decided to change its street names and house numbers, and the others did not, there would be even more chaos. There would be two sets of phone books and two sets of everything else. So there is no choice as far as adjusting to the North American Datum at the national level. Sure, it is going to cause problems, it is also going to cause benefits - near the higher level of jurisdiction; it becomes less meaningful the lower you get. The answer is, as you started out by saying, that in a municipality where there is a well-established control system serving their purpose, there is no immediate need to change anything. It carries on, becomes a local datum, a local reference, and there are lots of those around. But you Bill, being with the National Capital Commission, see yourself as having to lead the way, I appreciate that fact and I think that perhaps it might be worthwhile if you were to come over to Surveys and Mapping and sit down and talk. We will certainly investigate, together with you, ways of handling the local problem, and perhaps out of that will come an approach that can be used more generally elsewhere.

G. LACHAPELLE

Regarding the proposal for an institute, I would like to say that, in my paper this afternoon, I will propose a kind of national body to coordinate geodetic research. So I think that this is related to the idea of institutes, and maybe we could discuss this further later this afternoon or tomorrow.

J.C. BEATTIE

I think one of the concerns that was identified in the provice of Alberta particularly, and I am sure that it exists elsewhere, was that the vertical control problem seems to be one that has been overlooked in terms of improving the technology of establishing vertical control. We seem to be stuck with the methods that have been around for years and years, and, as we get into more remote areas and more difficult terrain, the need for an easy method of acquiring vertical control information of all types and levels is quite important.

P.A. LAPP

In the next session we have as speakers producers of R&D and users of R&D. We will begin by hearing from a user, Al Roberts, Director of Surveys and Mapping Branch, Department of Mines, Resources and Environment, Manitoba.

Al Roberts trained in Canada during World War II under the British Commonwealth Air Training Plan as an air navigator in the Royal New Zealand Air Force. After returning to New Zealand from England following the war, he did two things which influenced his future: he articled as a student to a New Zealand land surveyor

and he married his Winnipeg fiancé. Qualified as a New Zealand land surveyor, he and his family returned to Winnipeg in 1951, where Allen joined the staff of the Manitoba Surveys Branch. After a number of northern base-line surveys, including the survey of the Manitoba-Northwest Territories Boundary, he was appointed Director of Surveys in 1969. He has been very interested in the educational needs of the surveyor, and represented Manitoba on a western committee charged with the task of achieving a degree program in a western university, and this task has been achieved. Al will speak this afternoon on survey control determination devices.

A.C. ROBERTS

Mr. Roberts presented his paper (see Appendix I).

P.A. LAPP

Our next speaker is Dr. Ted Blachut, N.R.C. Ted was born and educated in Poland. He continued his academic career at the Technical University in Zurich and received his doctorate degree from that university. In 1946, he joined the Wild Company, where he was responsible for setting up photogrammetric centres and helping to organize surveying and mapping services in several countries. In 1951, he was invited to organize a photogrammetric research section at the National Research Council in Canada. In this capacity, in the instrumental field, the analytical plotter, the N.R.D. mono-comparator, the orthocartograph, and the stereo-compiler were developed under his direction. He also holds several instrument patents. Ted is a member of various national committees in Canada and, since 1969, has been President of the Committee on Large-Scale and Urban Surveying and Mapping for the Pan-American Institute of Geography and History.

In 1970, Dr. Blachut was elected a Fellow of the Royal Society of Canada, and in 1974, the Technical University of Mining and Metallurgy in Krakow, Poland, bestowed upon Dr. Blachut an honourary doctorate degree. He is the author of over 70 publications on geodetic, photogrammetric and cartographic subjects in English, Polish, French, Spanish and German. This afternoon he will give us a brief outline of activities at the National Research Council.

T.J. BLACHUT

Dr. Blachut presented his paper (see Appendix J).

P.A. LAPP

Thank you very much, Ted. I'd like to open the meeting up now for discussion on the two papers we have just heard.

V. KRATKY

I cannot resist adding a few points to what we just heard from Ted Blachut. From the combination of what we heard this morning about analytical triangulation, on-line procedures and about the way we are going to see further progress

of photogrammetric methods, I would like to emphasize a few characteristics of a new procedure which we feel is going to gain more and more ground in changing, almost entirely, the scope of traditional triangulation procedures. It is an on-line triangulation performed on an analytical plotter instrument. It could be any analytical instrument supported by a computer.

There are three major advantages which I would like to emphasize. One could prepare data more quickly replacing the stereo comparator with an analytical plotter. Regular time or average time to measure 10-20 points in a modal would take no more than 15 minutes. Secondly, all data would be practically error-free, or at least free of blunders and gross errors - not error-free completely. It is screened during the process. All computations as the strip evolves are repeated immediately with each new entry of any additional point, which may also give the operator a chance to check accuracy, to test quality of points, to edit his data, re-measure, reject and add some more points if necessary. The third most important feature of this on-line triangulation is not just that some old instrument was replaced by a new one. Since we are using the analytical plotter, which remembers data from previous models, the identification of points, especially tie points, in strips and between strips could be simplified to an extreme. We could use coordinates of a point, which were already measured, to remember that position and drive the system in the new model to the exact, identical position, with no errors in ties. Indirectly, this means that all preparatory work, which usually represents quite a significant amount of effort in triangulation, would be saved. One does not have to prepare points in advance, nor do selection and identification of points. One does not have to bother with pass points if the analytical plotter system is going to be used for further detailed plotting. This would save tremendously, on the preparatory work and it would also simplify the approaches because we would be working on a much safer level and eventually, or ultimately, gain in accuracy as well.

These procedures are well developed, and I would like to extend an invitation to those from private industry who are interested to see a demonstration. We could arrange for an experiment or do work which would show the main benefits and advantages of the new technology in analytical control extension.

P.A. LAPP

I would like to ask a couple of questions. The first one is addressed to Ted Blachut. How does the Canadian surveys and mapping community learn of N.R.C.'s work in this area? Is it well-publicized; are there mechanisms for coordinating this work with the Surveys and Mapping Branch, for example? How does it tie into the Canadian scene, Ted? I think this would be useful to know.

T.J. BLACHUT

Well, I would say that there is usually very close cooperation. You should not forget that I was the President of the Canadian Institute of Surveying. I really tried to transfer our ideas directly to the profession. My colleagues are members of many committees. One of our scientists, Dr. Ziemann, for example, was recently working with the province of Ontario for a period of time, to help them formulate a new surveying system. We are quite prolific as far as

the publications are concerned. You know, as scientists, we have limited time. We can only do so much. We are open. Every day we receive many telephone calls and we answer many different queries, but at the same time, I think by sheer participation in the professional life, we are trying to transfer our knowledge. Now, as far as other departments are concerned, I, personally, would like to see a little more cooperation, because what we need is what I call a "proving ground". We did cooperate a while ago with EMR in the field of cadastral surveys and we tried to convince our colleagues from Legal Surveys that they should use more photogrammetry. We were not tremendously successful, but conveyed the message anyway. We had a number of similar experimental projects with provinces and municipalities. Right now, for instance, we are cooperating with the city of Montreal, in the very important field of how to use photogrammetry in city work. So, I would say that, as far as could be expected from our small group of very busy scientists, we are doing our best. Our doors are always open. The major difficulty is lack of time.

P.A. LAPP

I have a question I would like to pose to Al: where does the global positioning system, G.P.S., fit into your concerns about control for large-scale mapping? I am curious as to how the surveys and mapping community in general, particularly in the provinces, will make use of it or whether they will make use of it. Al, would you like to comment on that?

A.C. ROBERTS

Well, I think that in all situations of this nature, cost is always a factor. If the budget can stand it, if it will achieve the advantage of time and yet maintain the accuracy requirements for the specifications for the mapping, then certainly it would be used. I do not think there is any doubt about that. I can recall that in Manitoba, I had the job of going to Cabinet to support my justification for switching from one control method, which was traversing with E.D.M. equipment, to a Doppler system. With the justification was cost and time frame. The people who hold the money, in this case the Cabinet, agreed and so the change occurred. I would suggest that, in any new development, these are factors that would have to be considered. I believe, too, just to add a point beyond that, in terms of what Ted Blachut was saying about communication, a very important ingredient to users of R&D is the knowledge of what is going on, and this could be preliminary knowledge or it could be more in the advanced stages of development. I believe that a most important ingredient is the aspect of communication. I think what Doug Kendall said earlier with reference to duplication is just one valid reason for good communication: to insure that funds are not being spent in more than one location for the same type of research and development. I think that with the natural limitation of funds, this is a very important thing.

P.A. LAPP

These two papers are by a user of R&D and a producer of R&D. The first is by a user, Mr. Alex Hittel. Alex is Manager of Surveying for Shell Canada Resources Ltd. in Calgary, Alberta. He was born in Saskatchewan and educated in Alberta. He was commissioned as an Alberta Land Surveyor in 1965 and as

a Dominion Land Surveyor in 1972. Very active in all aspects of the survey community, such as the Canadian Petroleum Association and the Canadian Institute of Surveying, he has served as a private industry representative on numerous committees and workshops, and in 1977 became President of the Alberta Land Surveyors' Association. He has published a number of papers and instructed at the Southern Alberta Institute of Technology, Olds College and the University of Alberta in Edmonton in advanced survey theory and application. Alex's talk this afternoon will be on geodetic capabilities and potential in surveying and mapping.

A. HITTEL

Mr. Hittel presented his paper (see Appendix K).

P.A. LAPP

Thank you very much Alex. The final speaker in this first half this afternoon is Dr. Gérard Lachapelle, who is currently the head of the Physical Geodesy Section at the Geodetic Survey of Canada. He obtained his B.Sc. degree from Laval, his Masters from Oxford, the L.P.H. from Helsinki, and his doctorate from Graz. He is active in various national and international scientific associations and is the author of several papers on geodesy.

G. LACHAPELLE

Dr. Lachapelle presented his paper (see Appendix L).

P.A. LAPP

I know I have one question I would like to ask Alex Hittel. He was referring to the R&D budget of Shell, and said that it was eight per cent of their survey operating budget. I would like to ask Alex whether this is fairly common in the oil and gas industry, to put R&D money out like that, or is this rather characteristic of your company and no others?

A. HITTEL

I would say that it is probably not too common for the petroleum industry to participate as heavily as Shell Canada has. Shell Canada does have a philosophy that is similar to that approach. I perhaps should have mentioned that the acquisition of the equipment in that area costs roughly $3 million; that is, inertial and Doppler satellite. That's the book value of the equipment.

P.A. LAPP

Because of the fact that we are running a little late, I will leave the summary remarks to a later chairman. Clearly, a need for good communication has come out as a sort of a thread weaving its way through the fabric of our discussions this afternoon. We got into this question of a coordinating institute for R&D in universities and industry. There is a lot of subject matter here, particularly Dr. Lachapelle's concepts at the end which are food for thought for tomorrow's session. So with that, I'll adjourn this session, thanking our speakers.

5. THIRD SESSION - LAND SURVEYS

A.C. ROBERTS, CHAIRMAN

A.C. ROBERTS

Ladies and gentlemen, we now get to the practical people in this room, the land surveyors. We are now away from all of the dreams to a great extent, and we are down now to 'what is needed'. But I think that we have to remain very optimistic in looking at it from this point of view and I would like to just quote (and I do not know how accurate it is) comments attributed to the late John F. Kennedy, and that is, "some people dream of things and say why? I dream of things and say why not?" I think, provided that we can get that five per cent of the surveys and mapping budget, then why not?

In the area of land surveys, there are some very basic needs and I am hoping that these will become the higher priority needs. There are also some sophisticated future needs and I am sure that these will be touched upon by the four speakers that you are going to hear now. I think you should keep in mind that this group is representative of perhaps the largest group of users in the field of surveys and mapping across the country, and that is, the legal land surveyors. If we are looking at the marketing of new technology, then there are some clients, some customers out there who are most anxious to come to grips with advantages to their businesses or to their operations.

We have four speakers, the first one being a gentleman who really needs no introduction, Charlie Weir. Charlie is President of Stewart, Weir, Stewart, Watson, Heinrichs and Dixon of Edmonton. I think that it is important that we indicate that he has in his firm, 150 people working throughout northern Alberta in an integrated surveying operation. So Charlie, even though he is a land surveyor, is also involved in the integrated aspects of surveys and mapping. In 1979, he was appointed a member of the Board of Examiners for Canada Land Surveyors. He is vice-president of Commission 5 of the FIG and is a past-president of the CIS. Charlie will be referring to R&D from the point of view of a land surveyor.

C.H. WEIR

Mr. Weir presented his paper (see Appendix M).

A.C. ROBERTS

Thank you, Charlie. Our next speaker, Gérard Raymond, was born in the province of Quebec. He is not unique but he is one of the very few who are both land surveyors and lawyers. Raymond is working with legal surveys, and is presently the Assistant Surveyor-General. He has been very active in various professional and surveyors' associations, and today he is presenting a paper from the point of view of the Corporation of Quebec Land Surveyors, particularly with reference to the matter of land information.

G. RAYMOND

Mr. Raymond presented his paper (see Appendix N).

A.C. ROBERTS

Are there any questions from the floor with reference to either of the last two speakers?

W.V. BLACKIE

It is not a question, but rather, a comment. I would like to say a few words in support of some of the things which have been said, particularly Charlie Weir's plug for a textbook on survey law. As the Chairman of the Board of Examiners for Canada Land Surveyors, and the one charged with the responsibility up to now for examining in survey law, this is a desparate need and one which I tried to satisfy some years ago in my position as Chairman of the Publications Committee of the Canadian Institute of Surveying. We did have a problem identifying someone with the competence to write the textbook and with the time available to do it. I support Charlie in his plea for restructuring. I think that this is something that we are trying to do in the CLS community; the new act was proclaimed on March 31, and we will be going into a sort of grandfathering mode as soon as the new regulations are in place, which we expect in about a month's time.

With respect to Gérard Raymond's plea for people to collaborate with his association, I would like to assure him that in the Legal Surveys Division, of which he is a part, we would be very happy to collaborate with anybody to try to define a simple land information system that would be based on a cadastral unit as a master parcel, so to speak. We have, on our own, in a very modest way, done some research on this already and I think we will have some fairly exciting times ahead when we try to implement these new systems. Thank you.

A.C. ROBERTS

Are there any other questions or comments from the floor with reference to these last two speakers?

C.H. WEIR

I would think that with reference to the textbook, we would need several authors; probably half a dozen, on the various sections.

A.C. ROBERTS

Now we will move forward to the next speaker, Alec McEwen, who is another one of the very few - in fact, I think there are only two, and they are both in front of you today - who are both land surveyors as well as graduates in law. Alec received both his OLS and DLS Commissions in 1952 and 1953, respectively. I just realized how much time he has spent overseas; he spent nearly one-third of his active professional life overseas, not counting the period that he was overseas during the last world war. Alec has had considerable experience in various areas;

he is presently the International Boundary Commissioner. Alec, in this particular situation today, is representing the Ontario Association of Land Surveyors and will comment with reference to what members of the association would like to see, as users of R&D.

A.C. MCEWEN

Dr. McEwen presented his paper (see Appendix O).

A.C. ROBERTS

The next speaker is listed on the program as the only producer of R&D among these four speakers. Willis Roberts is well known, I am sure, to all of you. He was instrumental in the formation, and perhaps we could call him the architect of, the Survey, Mapping, Land Registration and Data Bank Program, which started in 1968 in the maritimes. Willis is now Executive Director of what we commonly now call LRIS. He was very active in the establishment of the surveying engineering course at UNB and has been a guest lecturer since the course began. I should say that I came on the surveying scene much later than Willis did and I was always referred to as the "other Roberts". So I would like to call on the "other Roberts" to give us his views on the need for changing the bulk of the effort from the macro to the micro-requirements for information collection.

W.F. ROBERTS

Mr. Roberts presented his paper (see Appendix P).

A.C. ROBERTS

I would like to call for any questions from the floor.

L.J. O'BRIEN

When you start comparing expenditures on what is called R&D in one area and what is called R&D in another, then I really think that you have to define R&D.

J.H. O'DONNELL

Just a further word regarding the textbook of survey law. As I recall, in 1975 the estimate for the production of that text was somewhere in the order of $100 000.

Although we had some form of commitment from certain agencies and associations, when we approached the Canadian Bar Association, there was not as much interest as we expected. We also, as mentioned, had difficulty in locating people interested in undertaking this task. I will be having a discussion with our publications committee chairman, Alec McEwen, and will be proposing to review this file during our spring council meeting next month. I will then recommend appropriate action back to the Canadian Council on Surveying and Mapping for further discussion this fall.

A.C. ROBERTS

Thank you. You see, out of a conference like this comes positive action. We will follow that up with very great interest.

T.J. BLACHUT

Could I provoke some discussion on this last question? We had a very interesting presentation by Gérard Raymond, who more or less stated that the cadastral system and land information system in Quebec is really quite useless. It is in a situation of disarray and something must be done about it. Logically, the Corporation des Arpenteurs would like to institute some studies to see what should be done. I, from my limited knowledge, have the impression that in the other provinces of Canada, not all of them, the situation may be slightly better but not altogether ideal. I was exposed to the system developed by Willis Roberts and I must say very frankly that I admire very much what has been done. If Mr. Roberts were an author or editor of one of these textbooks, particularly concerned with the legal aspects, what would he do? Would he describe what has existed in the past or would he like to come up with a beautiful manual that would describe his new system?

W.F. ROBERTS

Our research in R&D has been all mission-oriented. We have not been attempting to put a textbook together, especially with regard to the legal field that people are talking about here. We have about six separate publications on land surveys now and I have a list of seven more which could be done, covering topics such as "overriding interest" and other things. I think it is possible, if a Centre was established - then yes, a publication could be turned out quite easily.

I also want to reply to Hugh O'Donnell. I understand the Candian Bar Association has now changed its mind, and they are switching money, and along with the government of Canada, are going to set up a centre of excellence on legal survey problems. It is starting to be quite well organized. If this is the case, then there is a centre that can do the research, the study, and turn out the books. We have a big problem in the Maritimes with reference to the study of roads and highways, identification of "overriding interest", not only identification, but then there is the question of how you put this information into your data base and account for it as a parcel-indexed piece of data? We are mission-oriented in our place, to develop and implement a project and hand it back to the provinces.

T.J. BLACHUT

Now, sir, my question. I am very much for writing books. I have written a book that is going to be published very soon on urban surveying and mapping. But, in order to write a book, we have to know exactly what it is about. Since we are in the process of very drastically changing our land information system, (I hope so!), then I am asking whether we should really prepare books that would describe the old-fashioned systems that are not useful, or should we, first of all, define and try to establish new systems, as you did, and then come up with a new series of textbooks to describe our activities?

W.F. ROBERTS

I think that the first part has been pretty well covered with several books.

D.N. KENDALL

It is my pleasure to introduce to you the Chairman for this morning's session, Doug Peden. Doug was born in Edmonton and educated in Ottawa. He had a distinguished career in the Air Force as a pilot during the war. After the war he became Manager of Hughes-Owens and subsequently, in 1954, was a founding member of Wild of Canada. He has run Wild as President ever since. Doug has been instrumental in much of the popularity of the Wild instruments throughout Canada. He was chairman, at one point, of the Ottawa Branch of the CIS.

D.H. PEDEN

To start off the activities this morning, our first speaker is Paul Caden, who is Product Manager, Photogrammetry, Canadian Marconi Co. He came to Canadian Marconi from Teleglobe of Canada, where he was successively Chief of Switching and Manager of the Service Department. Mr. Caden, who is active in the early design of many computers and real time systems, designed the computer base for the CMC navigation instrument product line and computer systems for real time mapping operations, before becoming involved in telecommunications management activities. He will speak to us this morning as a producer of R&D on communications, navigation and mapping or, as he put it, from spark-gap transmitters all the way through to analytical plotters.

P.T. CADEN

Mr. Caden presented his paper (see Appendix Q).

D.H. PEDEN

Thank you, Mr. Caden. There will be chances for questions a little later on, as you know. The next individual on our program will be Dr. Al Stewart, who will present to us a number of suggested R&D requirements which have been submitted to him from a number of organizations across Canada. Just a little bit of background on Al, whom most of you know. He was born in St. Stephen, New Brunswick, graduated from UNB, received his Master's in Geodetic Science from Ohio State in 1955, and his Ph.D. from Ohio State in 1973. He has had many

years of experience in aerial surveying and mapping in EMR and for the past three years has been the Science Advisor, Surveys and Mapping Branch, EMR. He is the man responsible for the organization of this conference.

R.A. STEWART

Thank you, Mr. Chairman. We want to take this opportunity to acknowledge the contributions that have been sent in by some of the people across the country who could not attend. Since the authors are not here, it is probable that discussion on these comments now would not be fruitful. But, they will provide food for thought for later discussions this morning and this afternoon. Eleven sets of suggestions were sent in.

The first one if from John Barnes, President of J.D. Barnes Ltd. He suggests that the following items that should be considered: improved efficiency in the Space-M aero-triangulation package; development of computer programs to automate the collection of survey data, in particular, cadastral surveys; procedures for receiving support and funds from Energy, Mines and Resources. This last one, I think, should not be one of the main topics of conversation at this conference! However, it is a concern that he has expressed.

Some suggestions covering hydrographic topics from Gerry Ewing, Assistant Deputy Minister, Oceans and Aquatic Sciences, Fisheries and Oceans Canada: improvements in the accuracy of off-shore positioning, and whether there is still a need for monumentation of off-shore points; methods of speeding up levelling; other methods of establishing vertical control than those which we now have; improvements in the definition of vertical datums and their relationship to mean sea level; correlation of the reference system determined by Doppler satellite observations with that used for vertical control.

Some suggestions from Larry Monaghan, Vice-President of Marshall, Macklin, Monaghan Ltd. This submission is a bit heavy on how companies might liaise with government agencies in attaining research work; for example, on how to consolidate and advertise the various assistance programs offered to industry for R&D. These are concerns of his that perhaps could be better addressed by Industry, Trade and Commerce and a few other departments that are established granting agencies. He says that money is needed for private surveying firms to develop and carry on research on survey methods.

A submission from Bill Schwartz, Controller of Surveys, Saskatchewan. He is thinking in terms of not so much the grandiose schemes but the smaller things, which I think have been his forte all along. He has a fair amount of expertise in some of these smaller requirements, such as projection conversion systems.

Then we have a letter from Ernie McMinn, Director of Surveys and Mapping, British Columbia. He wants to emphasize two points: one, to work on integrated survey control, to better adjust the maze of interlocking traverses to precise control points; secondly, to explore the legal position and the educational needs in cadastral surveys.

Dick Groot, Director, Geographical Services, Surveys and Mapping Branch, EMR, is here. He and Roger Defoe sent in a list of requirements, and they deal with geographic information systems. One is to develop a digital system for the storage and the presentation of geographic data. They recommend that work be done in computer graphics to investigate the potential of computer graphic systems relative to the national geographic mapping requirement. Colour should be investigated from the point of view of thematic mapping and aeronautical charting. Other requirements are the investigation of the design and application of symbols relative to thematic mapping; and, the feasibility of automated generalization techniques.

Clair Traynor, Director, Central Survey and Mapping Agency, Saskatchewan, proposes that discussion take place on how the provincial government can work up agreements with other agencies, ensuring that all survey agencies be made aware of research that is being carried out.

Tom Seawright, Manager, Legal and Survey Standards Branch, Ontario Ministry of Consumer and Commercial Relations, recommends improvements to the land registration system for Ontario. The primary areas of interest for the Ministry are plans of survey which define property limits, and property maps which provide a visual index of properties in the province.

G.M. Thomson, President, Corporation of Land Surveyors of B.C. submits a rather general request that information on Canadian mapping and surveying research, in fact, all developmental work and details of research capabilities should be more readily accessible.

Bill Ratz, Manager, Surveys and Plans Office, Ontario Ministry of Transportation and Communications suggests the development of a standard micro-computer interface plus encoding to provide the additional capability by an analog stereoplotting instrument for digital map compilation.

G.K. Allred, Executive Secretary, Alberta Land Surveyors' Association, asks that consideration be given to the design of a simple, durable and inexpensive cadastral survey monument. Other important issues are research on land information systems, and establishment of a geodetic institute.

D.H. PEDEN

The next speaker is well known to most of us in his present position, but a little background at this point might be of interest to us. Don McLarty was born in England and received his early education in Argentina. He served as a fighter pilot with the RCAF during the last war, was shot down in the Middle East in 1942 and, as I understand it, because he did not care for the food very much, he successfully escaped from prison camp in 1943. After retirement from the RCAF, he completed his education in political science and economics at the University of Toronto. Don is to speak to us on the potential of R&D for the air survey industry.

D.W. MCLARTY

Mr. McLarty presented his paper (see Appendix R).

D.N. KENDALL

I would like to ask a question of Mr. Caden. He talked mainly about the analytical plotter which is being developed now at Canadian Marconi, but he did not say too much about the satellite-positioning equipment. I would be interested to hear, first of all, whether additional research is going on at Canadian Marconi on the satellite-positioning equipment, to get the accuracy up from what I believe is now one metre to the ten centimetres which was discussed yesterday, and secondly, I would like to hear what he has to say about the competition around the world from other people, other companies, in the same field.

P.T. CADEN

We now have a considerable research and development effort at work in the factory and in our labs that involves seven or eight professionals and their support in producing follow-up instruments of higher qualtiy.

D.N. KENDALL

That is, instruments for the positioning equipment?

P.T. CADEN

That is right, in response to your question, for the satellite-positioning equipment. We have new generations of equipment in the various stages of gestation.

D.N. KENDALL

Could I ask where the funding for this is coming from? Is it entirely company funds or is it government support, either from EMR or from the Department of Industry?

P.T. CADEN

Initially that satellite navigation line was started up under the old P.A.I.T. funding.

D.N. KENDALL

Department of Industry.

P.T. CADEN

Yes. Now, I believe, it is continuing using just company money.

D.N. KENDALL

Can you speak about competition?

P.T. CADEN

I can say a little about competition. I cannot say a great deal about it, because Franz Blaha is the Product Manager of that area, and he is not here today. However, I do believe that the next generation of equipment that we are developing will be superior to the next generation of Brand X and Brand Y. We are in a good competitive situation now and I believe that with the next generation we will be in a better one.

G. LACHAPELLE

Do you have plans to manufacture satellite receivers for the new global positioning system in the next five, ten years?

P.T. CADEN

Yes. We have a fairly heavy commitment to this. We have some 50 people working on G.P.S. as of now and we made this heavy commitment to this area of development about a year ago.

G. LACHAPELLE

What would you say would be the percentage of this R&D pertaining to positioning for surveying purposes?

P.T. CADEN

That is very difficult to answer, because when you start off on a new program and you have to generate the whole technology base, it is awfully difficult at the beginning to say what piece of this is going to be applicable to what particular narrow function. This is one of the risks in technological enterpreneurship.

W.J. MACLEAN

We have heard G.P.S. mentioned many times during this conference. I sort of visualize this as an exotic system that will have an important function in navigation and basic control. Do you see it getting small enough, portable enough and inexpensive enough for the land surveyor?

P.T. CADEN

Yes. What you are talking about is something you can put a handle on and carry around.

W.J. MACLEAN

Yes, brief case size.

P.T. CADEN

And something that costs on the order of ten K.

W.J. MACLEAN

Or double that... but somewhere in that order.

P.T. CADEN

I think you are probably looking at five or six years.

W.J. MACLEAN

Is that right? Many of us have watched the programs of ISS, hoping that is would lead to something like that. Right now it is in a truck and a helicopter. We do not really care about angles and lengths. We want positions, and I hope that before my career winds down, those of us who are responsible for property identification and the preparation and collection of data for land information systems can just settle down on position only. When you say five or ten years, you are encouraging us no end. Almost regardless of what it costs!

P.T. CADEN

When I said five years, that was a guess. at the rate at which miniaturization and costs have been declining in the past and as the rate is now - it looks like about five years. But, I can remember saying 15 years ago that the pocket calculator would be here in only 40 years. So I do not have a good track record.

W.J. MACLEAN

I hope you keep the track record up!

A.C. HAMILTON

Can you, without breaking company confidentiality, give us an indication of the number of satellite receivers that have been marketed and the projection, just in order of magnitude, or is this confidential?

P.T. CADEN

I could tell you this without breaking any rules of company confidentiality, except that I do not know. If you would like to leave me your card, I could call you later in the week and tell you.

A.F. GREGORY

I cam here as a producer of R&D but I find myself very strongly inclined in support of the user of R&D at this point in time. Yesterday and so far this morning, we have heard much about the needs to improve geometry and mensuration and the precision of surveying and mapping. I have a couple of concerns that flow from

what we have heard so far. My question or comment is not directed to any individual in particular, but to the group as a whole here. In addition to precision in geometry, you have heard a lot about data base management and digital processing, and there is no doubt in my mind that these are extremely important things; certainly, you people are much better able to judge that than I, and they do comprise principal R&D needs. But, there is still a pressing need for another type of R&D which has not been mentioned. I had hoped that Dick Groot would expand a little further on what he started out to say yesterday. I had thought that Gérard Lachapelle might go on - he encouraged me when he went from geodynamic mapping, where they were looking for accuracy of the order of three centimetres - on to talk about mapping with accuracies of the order of one metre. When he said 'mapping', I said 'oh boy, somebody is going to talk about my area'. But then he said 'one metre' and that is not my area because that is not my concern. My accuracies are considerably smaller than that.

There has been little consideration so far of the needs of thematic mappers, and that is really what I am getting at. The thematic mapper uses the base maps that the surveyors and the topographic mappers make. There is a primary need at the present time for continuation and expansion of the production of base maps in remote areas of Canada. There are planning bases for all of the thematic mapping that is done for resource development and for environmental monitoring. We need those 10 000 maps in northern Canada at a scale of 1:50 000. We need them now. And we need the updating on the ones that have been published. What R&D needs to be done to get out those maps quickly, accurately, at least accurately enough for the needs of the thematic mapper, as opposed to the needs of the position surveyor? Our accuracy requirements, as I said, are lower - ten to one hundred metre accuracy would satisfy many thematic mappers. So I am making a plea then for an entirely different type of R&D; for acceleration of the mapping in the remote areas; for acceleration of the updating for reduction of costs; and for the production of a type of map which, at 1:50 000 scale, or certainly less than 1:250 000 scale, can meet the needs of thematic mappers in northern Canada.

Now, to follow on from that, I would like to pick up a theme that Don McLarty mentioned, and that is, the problem of finding a source and the funding for R&D. Our particular company has been principally involved for the last five or six years in R&D work and we have found that R&D is a very difficult area in which to make a living. Somehow you have to find an operational project that brings a little money in. It is our experience that when it comes to funding products or electronic equipment, when it comes to digital processing, where things can be specified fairly well, the government procurement system seems to work not too badly. But when it comes to the funding of concepts, of improvisations - the initial stages which lead to products - the funding and the procurement system of the federal government is inadequate. Well, I would like to leave discussion of that until later today, when we will hear something on the procurement system, which I understand will be given to us later in the morning. But, I would like to support Doug Kendall in that competitive bidding is not the way to get R&D and that if you are really going to do something about R&D for surveying and mapping in Canada, you are going to have to get a better procurement system.

D.H. PEDEN

Thank you, Al.

J.M. ZARZYCKI

Al Gregory mentioned topographical mapping; he wants to do it much faster and I agree with him, but, to accomplish the 1:50 000 mapping of Canada at a faster pace, we would not need more R&D, we would just need more dollars. We have the capability with the help of the Canadian air survey industry to finish the mapping of Canada in the next six years. The question is dollars, not technology, at this stage.

As far as the production of maps to the satisfaction of the thematic mapper is concerned, by necessity, and by definition, the topographical maps at 1:50 000 are maps for the general user. Many thematic uses of these maps must be satisfied: geologists, geographers, foresters, military people, engineers, and so forth; therefore, the map cannot be directed to one specific map user. It has to be general.

As I mentioned in my talk, we are considering the fact that now, some of the cartographic nomenclature will have to be revised, and we are in the process of conducting some research. There is naturally a possibility for participation by people from outside in the definition of a better way of terrain representation. In this respect, I agree with you, that research is required.

A.F. GREGORY

I would like to say something, George, in that connection. You are quite right, more money is needed if you are going to use the current techniques to speed up the mapping. I am saying that there may be - and perhaps I am wrong - techniques of improving cost-effectiveness, and perhaps different techniques to improve the 1:50 000 maps.

R. GROOT

I would like to expand a little bit on what Al Gregory said about thematic mapping. What I was referring to yesterday was really that, in listening to the presentations that had been given I felt we were very much concerned with techniques and the development of hardware, very technically-oriented. But in our profession, I think we have to look a little bit beyond the information that is tied to the ground, the man-made and natural geography. If we begin to speak about geographic information systems and the provision of the foundation which we give to these geographic information systems, through positioning systems and mapping systems, we have to take into account how to integrate all the socio-economic information. In most cases, this information is not collected on the basis of geographical, natural features but is collected on the basis of artificial things, administratively-defined systems. I believe if we do not take this into account, the users of the geographic information systems will try to find solutions which may not be cost-effective, in terms of how they match with the systems that we build; and, a great diversity of incompatible systems may result. In a

meeting such as this, when we take into account this link in building the systems, in doing the research, we can avoid a lot of duplication. That is what I was trying to say yesterday.

The other thing is: coming back to how maps are perceived, what is the logic of spending huge sums of money in making maps which we find out later, the user does not understand? So there is a pay-off to be made in doing research on cartographic presentations.

R. ORTH

I would like to comment on thematic mapping, because 1981 will see the launch of Landsat D and the thematic mapping instrument. I will outline briefly some of the things that can be done with satellite imagery today. Landsat currently is capable of 1:250 000 Class A map accuracy standards, if a precision rectification job is done on the imagery. Such a product will be released in the near future by the U.S. and by the Canada Centre for Remote Sensing. This fact was put forth in 1976 by Professor Konecny at the ISP Conference in Finland and I think it is worth keeping in mind, because there are instances where people may require base mapping at a smaller scale than is easily obtained from aerial photography.

When Landsat D is launched, it will be a 30-meter resolution, 7-band thematic mapper. In the future, advantage will be taken of the global positioning system so that people will be able to get almost a real time product which is of the accuracy consistent with this kind of resolution. Later on, the French satellite Spot will have a stereo capability and about a 10-meter resolution. It will also have a multi-spectral capability. This will be about the year 1985.

The thrust of all this has always led me to wonder whether or not - in developing maps, it is the small scale views of the earth that become operationally available - we could start, or perhaps look again at mapping "from the top down" point of view. In other words, we have routinely available imagery of the earth at a small scale which can be used to begin any mapping cycle or revision. We could then move in, having detected changes on the satellite imagery and fly these specified areas using aerial photography. This kind of approach has been used very effectively to make maps in the Pacific Northwest with a slightly different application (in Washington State and Oregon, for the forest industry), but still with Landsat, aerial photography and ground visits. It is a very "top down approach" and it has tremendous cost benefits for the kind of maps that are being produced at the scales required by certain agencies in the United States.

D.H. PEDEN

The next speaker will be Professor Angus Hamilton, who is well known to most of us. Angus has kindly consented to leave the University of New Brunswick for a little while to come to Ottawa to give us his paper on place-related information systems. Angus is a University of Toronto graduate where he obtained his B.A. in science in 1949 and his Master's degree in 1951. He served with the RCAF from 1941-45 which included approximately two and a half years attached to the RAF in India. He joined the Shoran section of the Geodetic Survey of Canada in 1949, becoming Chief of the section in 1954. In 1958 he joined the Gravity Division of the Dominion Observatory as Senior Scientific Officer. Angus has been extre-

mely busy and active in the CIS for many years. In 1971 he left EMR to take up his present position as Chairman, Survey Engineering Department at UNB.

A.C. HAMILTON

Prof. Hamilton presented his paper (see Appendix S).

D.H. PEDEN

It is now my pleasure to introduce to you Dr. Pierre Bourgault, Assistant Deputy Minister of Planning and Evaluation, Department of Energy, Mines and Resources. Dr. Bourgault is a native of Saskatchewan. He received his B.A. from the University of Ottawa in 1950, his B.Sc. in 1953 and his Ph.D. in electro-chemistry in 1961. In 1960 he joined Mathy, Johnson, Mathy & Mallory in Toronto as Director of the laboratory and was responsible for Research and Development, Engineering and Quality Control. In 1967 he became Divisional Manager of the same company. Dr. Bourgault joined the Science Council of Canada in 1969. In 1971 he was appointed Dean of Applied Science at l'Université de Sherbrooke. In 1973 he was named Deputy Secretary, Ministry of State for Science and Technology. Dr. Bourgault joined EMR in his present position in 1976. In this position, he ensures that energy, minerals, and the science and technology programs of the department are meeting the needs of Canadians. He is a member of the Design Council of Canada and many professional bodies. He holds many patents, several of which are commercially exploited. Dr. Bourgault is also the author of a number of scientific papers and of Science Council of Canada special Study No. 23, which covers the innovation and the structure of Canadian industries. This is a first-class study and is highly recommended as a most relevant study for those engaged in R&D. I understand that many of his papers are available through certain book stores that sell government publications, as well as from the Science Council of Canada. Dr. Bourgault has agreed to talk to us today on research and development.

P.L. BOURGAULT

Dr. Bourgault presented his paper (see Appendix T).

L.J. O'BRIEN

I want to be sure I understand: what does the percentage mean, when you say 3 per cent for R&D, 3 per cent of what? Net worth?

P.L. BOURGAULT

It is 3 per cent of sales. Another way to look at it is in the technology-based industries where you find that the amount of money put into fixed capital, new investment and capital investment is roughly comparable to the amount of money that is put into R&D. In the electronics industry in fact, the U.S. experience is that they put about $2.00 into R&D for each dollar in capital. But that is not very capital-intensive, but R&D intensive.

L.J. O'BRIEN

How is the grant money accounted for? They are given money to carry out a certain job, it is not their own money they are spending. Is that additional to the 3 per cent?

P.L. BOURGAULT

No. That is the total performed. I might just say something about the service industry and the R&D level there, which we heard about from Prof. Hamilton.

Service industries account for about 65 per cent of Canadian business today. As for the total expenditure in the service industry, the last figures we had were just under $100 million of R&D, which does not make it a very technology-intensive industry as it presently stands, or at least as it is measured by R&D intensity.

R.A. STEWART

Do you have any figures on, or would you comment upon, the relationship between the economic health of a country and the amount of money it contributes to R&D? You know Germany and Japan are doing well, yet Britain and U.S. are going down. Surely it is more than motherhood, it must be a good thing overall to contribute money to R&D. Would you comment on that?

P.L. BOURGAULT

Well, you know there have been a number of studies which have tried to make a direct link between the amount of R&D and the success of a country. They have not been terribly successful in achieving good scientific correlations. A certain number of things have been said, though. One of them is that the countries which have put the accent on technology-based industries have really taken that as an approach to economic development. These countries - Japan, Switzerland and Holland - really did not have many natural resources. They have had faster economic growth rates than countries that said "we are rich in resources, we will develop our resources".

Britain has had a fairly high R&D level and has not been as successful economically; I think there are probably other factors to take into account as well. You can do it by sector as I did earlier. The R&D industries themselves are the ones that really draw, the ones that create the most jobs. They have all the desirable characteristics that you would look for in industrial development. I think the greatest success has been in countries like Japan which have not particularly emphasized R&D, but have emphasized using technology. They have gone out and purchased, or borrowed whatever they could get - they have taken it home and worked it over. There used to be a comparison between Canada and Japan, because we had a lot of technology and Japan had a lot of technology. But we had it in such different ways. What we were doing was this: we were bringing in engineering drawings and giving them to someone in the shop who could read a drawing that said, "you wire the brown wire from position one to position two with silver solder". Now that does not give you the capability to build a television set or whatever you are dealing with, whereas the Japanese in fact,

bought licenses and went back home and re-drew and re-did their drawings and they converted them, adapted them totally to their environment. From there they were able to build and there is the vast difference. Some of the U.S. firms were caught by that because in the 1960's, there was a conventional wisdom proven, in large part, by data that had been obtained between Canada and U.S. - that if you sold one dollar of technology you would sell 100 dollars worth of product. Therefore they thought that if they sold one dollar of technology to the Japanese, we would sell them 100 dollars worth of product. It did not work that way.

A.F. GREGORY

I am concerned about two aspects of your talk. The first is the model of an R&D agency that you used and the second concern involves the statistics which I know have been developed not only by MOSST, but by the Science Council. In my view, both these concerns, which I will not express in detail here, relate back to one focus: that is, that innovation flows, to a very large extent, from small groups, not from large companies, although there are very obvious exceptions one of which you did mention - a very important one. The small groups or small businesses are not able to respond to R&D requirements in the same way that large companies respond. It is my belief that there is much more industrial R&D going on in Canada and other countries than has been reported in these statistics, developed by MOSST. These statistics have been used by the Science Council in their study called "The Weakest Link". It stems from the fact that a lot of R&D is done in small companies because: when you staff does not have a contract, they are put onto R&D to develop things that you want to do and that you think need to be done. This means that the company does not bring any money in; it has no contract on this particular R&D, it is not reported as R&D. Tax incentives are known value for R&D done on that basis. This concerns me because I think it influences the whole R&D policy in this country and in other countries. For example, we are told in some of the agreements that are set out in support of R&D that profit levels of 7½ per cent to 10 per cent are guaranteed and that no company should really lose money unless it is by mis-management or so on. Our company is a small company, 10-15 people, and we have had 11 contracts for R&D not counting management or anything else. From audits done over the past four years, we have made an average of 3 per cent on the contracts; we have had major losses of as much as 150 per cent on some of them, depending on the size of the contract. Profit levels are a very important part and this is part of what Don McLarty referred to earlier, although he was not necessarily tying it into R&D. I am concerned because the models that have been used relate to large companies, large organizations, ones that have a financial momentum. I am just wondering what your comment is, in your experience, as far as small companies and R&D are concerned. Many people are of the opinion that small companies are the focus of R&D at the conceptual and improvisational level.

P.L. BOURGAULT

Well, I guess on the question of the contribution of small companies to innovation, which is really the nub of the issue, I would have to say that everything I have seen would indicate that small firms tend to be more innovative than big firms. As a matter of fact, Christopher Freeman, who is now at Sussex University,

did a study of this in Europe. He found that the correlation between innovative countries and countries with big companies would seem to indicate at first glance that the big companies drive innovation; however, looking at it closely, he found that it was the small companies that had been innovative. I do not think that is a contradiction because the innovation quite frequently is done by the second tier people, the people who in fact respond to big companies. This is particularly true in areas like the automotive industry that cover a large part of our economy. In the Ford Co. for example, I think 80 per cent of the so-called Ford innovations were innovations by Ford suppliers, i.e., small companies. But I think, in order for that to happen in a country, Ford would have to design their cars in that country. If the company were not doing that, then the innovative small people in the supply industry would not have an opportunity. So I think that explains Christopher Freeman's result, that big firms have a role in that sense.

Now, the other point - the numbers were not as large and do not reflect the total R&D. Well, I really could not comment much on that; I had assumed that firms probably would or should attempt to report it, if there was a tax break as there will be now.

T.J. BLACHUT

Could I make a very short comment - because I think that the question raised by Dr. Gregory is extremely interesting. Canada is weak in secondary industry and as a result, most companies that begin work in this field are by nature small. We have all kinds of schemes in the government which basically support development and technology transfer. From the very beginning, I always claimed it was not sufficient because if you proved it was within a sound structure, the development percentage of R&D would not be such a tremendous item as compared to marketing, sales and engineering. The small companies do not have the resources and we are not provided with them. So as a result, we are leading technically, scientifically and otherwise, and I could quote many examples. We develop outstanding technology in the field of surveying and mapping; the whole world is following today. But we are not manufacturing and we are not selling, and I think that as long as there is no correction to these support schemes, we will find it very difficult. We are in the learning process. Let us not forget that all these schemes were developed only a very few years ago.

P.L. BOURGAULT

Actually, I have been very critical, in the past, of the way in which government funding has taken place, of some of the IT&C programs. If you are a large firm and can employ a professional grants writer, you could do pretty well. But, if you are a small guy and do not have a track record, no matter how brilliant your idea is, you tend not to do so well and you can spend more effort and more cost in getting a contract, because usually the small firm is asking for a small amount of money. The small firm has often spent as much trying to get it as the darn thing is worth. So you might as well forget it. That has been a very serious problem in Canada. I guess it is the conservatism of the bureaucrats who judge; I prefer to see a system that is after the fact. The person whose business in on the line should make the judgement, providing he is putting in some

money of his own. But after the fact, perhaps you can audit and give him the tax break. Or, it may not be a tax break, it could be a grant that is awarded in lieu of the tax break if the company is not in a taxable position. That kind of process would not hold up ideas and would permit things to go forward. I think it is a much better system. Regarding projects selections, I must say that I do not see how a bureaucrat could add very much to decision-making. I think in terms of selecting areas that may have a different proposition, which is what we try to do.

B.J. GILES

One question on your organization that you described. I am not too sure whether that was a recommended organization or just an example. But my question is addressed specifically to the relationship of R&D in that organization. It seems as though the activity of R&D, engineering, manufacturing and marketing (from the arrows you showed), was R&D-driven. I noticed there was no arrow between marketing and R&D. I think maybe that is one of the weaknesses; that development should be market-driven and that either R&D should be a part of marketing or else the requirements for development should come from the user.

P.L. BOURGAULT

I agree with you that there should be an arrow, and as a matter of fact, I thought I had said that was one of the weaknesses of the drawing; there should have been an arrow going from marketing to R&D. But, I think there is still a place, at least at the corporate level, for some R&D which is not too strongly market-driven. By and large you are right, I think it should be primarily market-driven. However, you do need a cadre of people who can really keep to the forefront within the technology range, for that awareness role - to indicate where the opportunities might be. It is, to some extent, an iterative process. You should be able to tell the marketing people as well where they can look. I have been disappointed with some marketing people, and with one in particular concerning the development of dimmer switches, switch box dimmers that are now very popular. We developed one of them in our firm before they were marketed at all in Canada. I do not think we were the first firm in the world to develop one. It was certainly very early on. We took it to a reputed marketing group and asked them to do a market study for us. They came back and told us the dimmer switch would never sell. So we dropped it, and of course, they are now selling quite a lot. So you have to be a little bit of both, but in broad terms, I agree with you.

6. PANEL DISCUSSION

D.N. KENDALL, CHAIRMAN

D.N. KENDALL

I want to announce the panel for this afternoon. The panel discussion is going to be, in many ways, perhaps the most important part of the whole conference. During the discussion, we will be able to come up with recommendations as a result of all the things that we have been talking about for the last few days. The following people very kindly agreed to serve on the panel:

Pierre Bourgault, ADM, Planning and Evaluation, EMR; Brian Giles, Systemhouse Ltd.; Don McLarty representing the Air Survey industry; Ted Blachut representing the NRC; Les O'Brien representing Surveys and Mapping Branch, EMR; Alec McEwen, land surveying endeavour.

What we will be doing is debating the points that I think are the most important points that occurred during this conference. We will be debating these in the panel and I hope that you will be participating actively and interfering in the debate.

We have had, during the course of these two days, a lot of recommendations and they need analysing and pulling together.

I think you can divide most of the recommendations that we have had into what you might call "Tactical Research" and "Strategic Research". By tactical, I mean things that need to be done right away, of short term and that have an immediate effect. Strategic things are those that will affect us five and ten years from now. What I have done, for the purpose of this panel, is to select some of the areas of probable concern which have arisen during this conference and I thought we would debate them one by one. I think there are about 15 areas and from these 15 areas we should come to some conclusions as to what we can recommend. I'll ask the panel to debate these different concerns and I hope that those who want to participate from the floor will put their hands up and be as active and as controversial as they wish.

Now the first subject that I suggest we talk about is whether we agree or disagree that the research and development dollar should be spent more on compilation techniques than on hardware development. Of the 490 million dollars spent in survey, which is a figure that seems to have emerged at this conference, 90 per cent of that figure is spent on compilation and only 10 per cent on the acquisition of hardware. So if we are going to make real savings and changes in the mapping process, it is going to be in the compilation process. I put that as a thesis - or a theme - and we will see what the panel has to say about this particular point.

We'll start on my left - this is very unfair because nobody on the panel had any warning of any subject that is coming up. So we are really going to test the mettle of the panel in terms of being able to respond off the cuff.

B.J. GILES

I would like to make a few comments on what seems to have been the major theme in the mapping area, and that is the requirement for information management systems and the application of the improvement of interactive graphic techniques, that is, the requirements that seem to be software-oriented. I have a number of comments, first being: is software really an R&D activity? I know in DSS, and to a certain extent in ITC, as far as their funding programs are concerned, software does not receive the same regard as does hardware development. As a result, the cost of that software development is borne directly by the users of that software.

D.N. KENDALL

Excuse me, there has been a change in the Department of Industry's views under the guidance of the Board of Economic Development that has now ruled that software is definitely a capital asset - it is now known as an intelluctual asset.

B.J. GILES

Another comment in that same area is that the requirements that have been identified all have solutions effectively available now. The one thing that is essentially holding back full implementation is simply the availability of funding to carry out that development. It is an obvious fact that the average user is not prepared to pay the cost of an individual development. It might be useful if there were a mechanism whereby a group of users (essentially an initial recipient group) could get together and form a common specification, such that the development costs could be spread around, because there is no common specification in the cartographic equipment area.

D.N. KENDALL

It appears as though we must have common specifications if we are ever going to have central banks and access to central banks for data, otherwise cross access would be impossible.

Pierre, have you any comments on the question that in the light of the fact that 90 per cent of the expenditure on survey is in the compilation field - that is the area that should be attacked, primarily from the point of view of R&D.

P.L. BOURGAULT

Well, I guess I would agree that it is the area that should be attacked primarily. But to the question of whether it should be 90-10 in the proportion of expenditure, I would say no, for two reasons. One is that it does not follow that the payoff would be in the order of the ratio of expenditure. Hardware break can in fact mean a great deal, and I think you have seen that with some of the new techniques that have in fact radically changed. So that is number one. Number two reason is that the industrial spin-off benefit should be considered as well.

T.J. BLACHUT

I would like to modify slightly your phrasing of the question, because first of all, the purpose of research and development is really to increase our efficiency. And if you take the particular area of compilation - for example if you had more efficient, for instance, image correlators or digitizers we could of course make our map compilations much faster, much cheaper and so on. So I do not think it is really a correct formulation. However, we all agree that there is one area, and Professor Hamilton put it in a very nice perspective, where we all must think of how to store the information so that it would be a base for the map compilation also. So I rather suggest that we formulate this long-view way of thinking. Particular stress should be put on the formulation and design of data systems for general survey and mapping purposes, including also the broader needs of modern society.

L.J. O'BRIEN

I disagree with what you said - that 90 per cent should go into compilation. Mainly, I think, as has already been said, if you put a dollar into hardware at that ratio you are going to save nine dollars in compilation. Compilation involves the use of hardware. I can think of the two specific areas where I like to see some break-through in research. The first area is the measurement of precise vertical.

On the compilation side, the other big need I think, is in how to revise existing maps more economically and efficiently. But I am only using those two as examples to indicate that I do not think it is as neat as just saying that since 90 per cent is spent on manual operations, that that is where you should divide up these limited dollars.

D.N. KENDALL

These are the words spoken by a photogrammetrist - "the large dollar is the land survey dollar, in fact, rather than the photogrammetric dollar". What does land survey say about that?

A.C. MCEWEN

Well, I think this is true - there are an awful lot of land surveyors and their requirements are, I suppose, not for a lot of the developments in expensive technology. Yesterday one of the speakers referred to some of the land survey requirements as being rather mundane. If they are, I see no reason to be apologetic about this. Surveyors have to be concerned about things like stability and permanence of survey monuments and for the very reason there are so many land surveyors engaged in these activities, that obviously is an area where much research needs to be done.

D.W. MCLARTY

The air survey industry as you well know is export-oriented and our concern is

in being able to produce a product at the cheapest possible price. Where the development dollars go really is not of all that much concern to us, except that the less we have to spend on expensive black boxes, the better I suppose.

D.N. KENDALL

I think at this point we will close the subject on this particular item. There is no agreement on this unless we get some different views from the floor now. There is no agreement that the research dollars should be spent 90/10. There is, I think, a feeling that compilation, and therefore greater efficiency, and therefore lower costs of production, is an important area for research, but not necessarily at the 90 per cent level. Probably some split nearer 70/30, in terms of equipment, may be the right answer.

M.E.H. YOUNG

One point that has been stressed throughout the proceedings here, as far as mapping is concerned, is the requirement to establish digital data bases and switch the basic compilation over to digital recording. That is going to result in some considerable procedural changes, but I do not think those problems fall under the area of research and development but rather the hardware. The things that are making it very expensive and will continue to do so are in fact, the initial cost and the subsequent high operating costs of the hardware we are using today.

In addition to the operating costs are lost man-hours due to the unreliability or the down-time of the systems themselves. There is, in my view, a great amount of work, research and consideration that have to go into these subjects, that are basically more hardware than procedure oriented.

Z. JAKSIC

I think that we should not discuss the question of 90/10, 70/30, or whatever. I think it is an irrelevant question. Because if we set it now as 90/10 or 70/30, it will stay for years and we do not know what is going to be of importance - compilation or hardware - at some later date. It looks now to some that it is 90/10. But it could be completely reversed in a few years from now.

D.N. KENDALL

The only comment I would make against that is that somebody has to make a decision, and it is nice to leave things in a general area. However, if you want action, you finally have to get down to numbers and say this is what we are going to do. Let us move on to the next subject.

The next item is that of the creation of a central data terminal. This theme has come right through this whole conference - that we've got to create a central data bank, and that it is illogical to have those data banks created by the provinces independently, and also by the federal government, causing duplication. In addition, there should be cross access to these data banks, which means that the data banks have to be on a uniform basis. There has also been a very

strong plea that the data bank not only contain location information but also information on each site; such as buildings, taxation, geology, forestry, soil, land use, and so on. If we are going to have central data banks, we've also got to have the hardware to enable us to create those data banks and at the moment, as I judge it from the discussions we have had, the item that is missing - the most costly item - is the creation of the data terrain model. I am going to try out some of the panel on this point.

B.J. GILES

First of all, working backwards, I really am not in any position to comment on the importance of the digital terrain model versus the cartographic feature type of storage. Our experience to date has been oriented towards the more traditional production of maps on a feature basis. One can see the advantages of a DTM, but I think those are more in terms of organization and the ease of data management, rather than the actual utility of it. So I shall defer any judgement on the importance of it. As far as the central data bank is concerned, overall, this concept has been raised in many other areas of course, and to date nothing has been done about it. There has been general agreement with the principle but the practice has not borne the principle out, and in most cases, data banks are organized for specific applications rather than for a universal application. I think that there is very little merit in collecting data unless you know the application to which they are to be put. The more universal, the more essential the data bank; the broader the potential range of applications, the larger the problem to find out how to organize and to utilize the data bank. It is a concept that tends to fall down, basically from the enormity of the task, and principally, in the area of definition.

L.J. O'BRIEN

I have always been a little bit bothered about the idea of a centralized data bank having, I think as Angus put it, all the information about everything available to everybody. It is a matter of resolution in my mind; I cannot imagine why someone in Alberta, for example, would want access to detailed land information on a routine basis, on say, New Brunswick. It seems to me that the centralized data bank, if there is such a thing, would be more of a clearing house on indexing, i.e., what is available and where and what it consists of. But the user of it would have custody of it, keep it up to date, and keep it himself. So I would say semi-central data bank would be a useful concept to put money into.

P.L. BOURGAULT

I think it would be important to have at least compatible and accessible data banks, if one did not have a central data bank. I am not sure that that is really very different but - if that is accepted then we should probably move relatively quickly before patterns get set and non-compatible systems get developed.

R.G. CODE

I would like to interject something which has to do with the subject of "compatibility". I have a copy of an agreement that we have with the University of Guelph. The cost of this research and development will reach the figure of about $326 000.00. If it goes above, I have to explain why. I'll read Schedule "A" - Work & Services Required. "The initial objective of this research and development project is to provide a fully documented pilot production system for the semi-automated production of Ontario basic mapping (These are what we call our O.B.M. maps), which (here is the punch) is compatible with the semi-automated cartography system used by the Surveys & Mapping Branch in the Department of Energy, Mines & Resources, Ottawa". Now, this is a desirable thing but self-imposed. This is the kind of condition we in Ontario, at the provincial level, are going to force upon municipalities. Because with your map, whether it is in hard copy or digital form, you have got 90 per cent of your data base. So, common systems, common grid, compatibility is the name of the game. This is the way we see it.

D.N. KENDALL

So you are forcing compatibility within a province, and nobody at the moment is advocating forcing compatibility nation-wide.

J.M. ZARZYCKI

First, I do not subscribe to the proposition put by the Chairman - that we should have one big data base. I think this is most impractical, because everybody has his own information he wants to keep, it is his responsibility to up-date his information. However, what is very important, is to have a means by which information contained in different data bases can be exchanged. Many data bases are using the same basic information. For instance, in the case of topography, the topographic data base is one on which many other data bases depend - whether forestry or geology or any other. So what we want to avoid is having everybody digitizing the same information. If the information is already there, it should be available for use by other people. Now we have, as a matter-of-fact, already started a mechanism by which we will establish our national standards for exchange of digital information. As a result of a resolution passed by the Canadian Council on Surveys and Mapping, the Topographical Survey was charged with the responsibility of setting up a mechanism by which this could be accomplished. In the next two days, the technical committees of this steering group will meet to start working on establishing national standards for exchange of digital information. I would like to emphasize the word "exchange". We are not looking for national standards of digital information across Canada, because they will be as different, just as maps compiled in Québec or Ontario or the Maritimes are different. What we are looking for is a standard for exchange of data, and I think this is the key point.

A.C. MCEWEN

With respect to such things as the provision of geodetic control, coordinates of

monuments, etc., the important thing is to have the information available. There is no need for central storage of everything.

T.J. BLACHUT

It is generally recognized that it is not very practical to think in terms of a huge data bank that will encompass everything. To be practical today, it could be one on a provincial basis. Another comment I would like to make is that we should learn from mistakes of others, and beware of creating data banks without having proper information. What should be done, and this applies particularly to our colleagues from the Legal Survey sector, is to decide first upon the system of surveying and then they should start in such a way that we could use their data. Otherwise, a system could be established without knowing what future volume may be required.

W.F. ROBERTS

The data base concept should be primarily concerned with exchange of information. I do not see it as one giant central data bank. What we should be looking at is an efficient way of doing things. I have been asked many times about the duplications and the redundancies between, say, federal mapping and provincial mapping. Why is the federal government doing 1:50 000 mapping and are you doing 1:20 000 mapping? Now, it appears that we can start the data exchange in earnest, because it appears that data obtained for 1:50 000 mapping can also be used for 1:10 000 mapping. However, at best, this will only be a partial answer. The commitments of the federal government and of the provincial governments are totally different. For example, the land surveyor wants to see the fence on the map, and this does not appear on the 1:50 000 map. Therefore, there must be a re-evaluation of the commitments of the different governments. In fact, I suggest that we start with the large scale mapping in the provinces, then the smaller scale maps can be made by generalizing these.

R.G. CODE

The federal government's mandate to do mapping was established a long time ago. At that time, it was decided that the optimum scale for national mapping was 1:50 000. Now, however, I believe that that decision should be reviewed from the point of view of mapping at larger scales.

L.J. O'BRIEN

Do you mean that the federal government should get involved at scales of say 1:20 000?

R.G. CODE

Yes, they are popular. They are useful. They are needed. Every province is setting up a small mapping organization - as we are in Ontario. Why shouldn't the national government also be producing these larger scales?

D.N. KENDALL

This subject is obviously very complicated and requires a great deal more thought. It should be referred to the Surveys and Mapping Branch, EMR for consideration.

The next subject is map revision. The more maps we produce the bigger becomes the requirement for keeping the maps up-to-date. I suspect that we have not yet developed the cheapest way of revising our maps. Does the panel and do the delegates think research money should be spent on developing more effective ways of revising maps?

L.J. O'BRIEN

This is a high priority need - no question about it.

T.J. BLACHUT

This is a very important subject and it should be considered.

P.L. BOURGAULT

It seems to me that a large precentage of the S&M Branch budget is going to map revision - so you put your money where your costs are.

B.J. GILES

It must be remembered that with digital mapping there is a problem in implementing a cost-effective means of map revision. The techniques have to be developed to match graphic procedures.

J.M. ZARZYCKI

Map revision will become more and more a larger portion of the Topographical Survey activity. We have to attack the areas where there is a lot of labour involved. One of these is finding out where change has occurred. The second is in the compilation stage, where the features now have to be taken off or whatever - digital mapping will help here.

J.R.R. GAUTHIER

The need to keep data up-to-date will be even greater when it is in digital form - rather than graphical form. Simply because the currency of data is much more apparent to the user when it is in digital form.

A.C. HAMILTON

We believe that a lot of the revision data will flow in from the various agencies whose data is contained in the system. For example, power line changes, forest cover changes etc. would be supplied by those directly involved with these things. Perhaps the potential breakthrough in revision will be in this dynamic network of data bases.

L.J. O'BRIEN

There must be a legal requirement that change be reported, or the system will not work.

A.C. ROBERTS

We have tended to look at monumentation with a great deal of orthodoxy. We must however, look at it not only in terms of cadastral points, but also in terms of control points, because all control needs good, permanent reference points. Perhaps there should be some radically different type of control point.

D.N. KENDALL

The next items concern the Task Force Report suggestion that 5 per cent of the S&M Branch budget be devoted to R&D. More specifically, that this 5 per cent be divided up so that 1/3 of it is used in-house, 1/3 goes to universities and 1/3 to industry.

L.J. O'BRIEN

The three 1/3 parts were meant only to convey the suggestion that there should be 3 parts to the total expenditure - not that the three sectors should get exactly 1/3 each. It must be remembered that this does not represent a lot of money. For example it could mean that all of the universities would divide up only $500,000. and all industry would divide up their $200,000. This is meant only to supply money to attract other money to good ideas.

P.L. BOURGAULT

Considering that the Canadian surveying and mapping industry is a $490 million a year industry, and calling it a "medium technology" type industry, and say that we were striving for 1 per cent for R&D, that means that we should have roughly $5 million for R&D. That amounts to 3 times what EMR could provide. I would think that the suggested 5 per cent should apply more to industry. In conclusion, the amount that EMR would supply is small, and the needs would have to be fulfilled by considerable input from other sources.

D.N. KENDALL

It should be stated here that, if you had some funds from say, EMR, you would be more likely to get additional support from the Department of Industry, Trade and Commerce.

A.C. MCEWEN

As to whether 5 per cent is reasonable or not, it is useful to remember that the government's stated objective is that the national expenditure on R&D should reach 1.5 per cent of GNP by 1983.

T.J. BLACHUT

Even if we are presently spending only 0.9 per cent of GNP for R&D in Canada, the figure is much worse when you consider only surveying and mapping. Then, I believe the figures state that our expenditure in R&D is only 0.3 per cent.

D.N. KENDALL

The next item is the hydrographic sector of the surveying business. Hydrography has special R&D needs and these were very well presented. Unless anyone has further comment on these, we can support and encourage their program and views.

The next item concerns where geodetic surveying is headed. Where does the survey industry stand in relation to geodetic work and how can the survey industry keep up to date if it must spend say, up to $3 million each on such systems as the ISS and Doppler? Are we supporting these two particular developments or are we only supporting R&D indirectly through the purchase of equipment.

L.J. O'BRIEN

The software side of these two systems is being well supported by Geodetic Survey work. We have done very little in the way of hardware development, it is far too expensive.

The main problem now in geodetic surveying is not in positioning work but in levelling or vertical requirements, i.e., in precise levelling. That is where the big push must be made.

D.W. MCLARTY

If members of the aerial survey industry must in future raise, say, millions of dollars in order to buy new exotic equipment in order to compete nationally and internationally, then they are faced with a big problem. At this time, no solution comes to mind easily.

J.M. ZARZYCKI

With regard to the capability of industry to apply new technology, it is mainly a question of the market. If the market is there, if there is a need for it, you will buy it. We should mention here also, in connection with ISS and Doppler, that because of the development work done by the Geodetic Survey in software, Canadian companies should have an advantage. They can get the software free.

G. LACHAPELLE

The R&D work in geodesy should be reagarded as a package - not horizontal and vertical separately. It is all integrated. Any developments say, in inertial systems will influence satellite geodesy, improvements in vertical will influence positional work, etc. We should say that R&D effort should be directed toward improvements in "positioning systems" and not particularly specify say, precise levelling.

D.N. KENDALL

The next subject is entitled "The problems of industry in Research and Development - especially those of small companies". The first problem in doing R&D is getting the funding. What we have been discussing today is using part of the budget of Energy, Mines & Resources for the funding of research in industry, universities, and in-house in government, of course. We had comments yesterday and again today that it is more satisfactory, more likely to achieve a result, if the industry concerned contributes part of the cost itself. I think this brings into question the various sources of funding which were available to industry. The Department of Industry, Trade & Commerce has approached this problem from two points of view.

First of all, the point of view of the company which is profitable and therefore probably a medium to large size. The tax laws have been changed in the last budget, so that anybody doing R&D today gets first of all a write-off of 100 per cent of the money which is spent on R&D. Then, if the expenditure on R&D is in excess of the base of the previous year - he gets an additional 50 per cent. On top of that - there is a 10 per cent write-off after tax, from the bottom line of the tax he has paid - which is therefore worth 20 per cent. This is a type of investment allowance as it were. So that in effect, 170 per cent can be written off. Therefore, what is left is a 25¢ to a 30¢ dollar. A large and wealthy company can operate almost more economically in R&D in Canada than anywhere I know. Our tax climate is now excellent.

Unfortunately, for a smallish company, that does not have the tax base, in other words, it is in its early stage of development and therefore does not have the profit against which to write off these costs, the advantage is not as great. Therefore the smaller companies are dependent on grants. If we consider EMR as being one source, the company should then look, as its second source, to the programs which now exist in the Enterprise Development Board which have actually replaced the old PAIT programs. Whereas the old PAIT program was $25 million a year - the new Innovations Support Program is $61 million a year, and that can now pay on approved projects 75 per cent on the direct costs of R&D. It will not pay the overhead, and it no longer audits the overheads, but will accept the direct costs which is a very much simpler program than before.

Moreover, these approvals can be granted in the provinces. In each provincial capital there is a local board, an Enterprise Development Board, and if the total cost of the project - or support being looked for - is less than $200 thousand dollars, it can be dealt with expeditiously and in the capital, without having to come to Ottawa with the complications which tend to be involved in approaching the federal government, at the top level. So the funding, I believe, is availa-

ble. What is not available to everybody is the knowledge as to how to get access to the funding. This, I hope, will become better known during the coming months.

I would like the views of people from industry, as to whether, if they do R&D work for EMR, they expect to get 100 per cent funding or whether they would be willing to contribute some reasonable part of the total cost of the program from their own resources.

D.W. MCLARTY

Well, as you know, Mr. Chairman, in the past years industry has spent fairly substantial sums of money on R&D, particularly the larger companies. And I think as George Zarzycki pointed out, where there's a market for a service or a product, somehow or other we have found the funds to apply to the necessary research and development.

That has usually been in the large companies. The smaller companies have much greater difficulties in raising any funds whatsoever for research and development. I think the Enterprise Development Board incentives probably would be of help to the smaller companies. The tax incentive is of doubtful value because many of the smaller companies are not in the profitable position that you would have to be in to take advantage of the tax incentive.

With regard to contributing to any funding required in addition to what funding may come from the Surveys and Mapping Branch budget, I would say that yes, quite definitely, the companies will be prepared to contribute their share on a project that is agreed by all to be worthwhile.

B.J. GILES

We have embarked on an internal R&D program of our own. The analytical work and the work we are doing in interactive graphics is currently being self-funded, although we will be looking for outside assistance in that area. The reason that we are providing the funding is because we see long-term benefits. We develop something for the market place, and we obviously aim to write off our development funds from future sales. So in terms of companies contributing the funding, well I do not see that there would be any question to that, if there were long-term rewards for that investment.

If it is a situation though, of contributing the results of the development to a broader part, whereby the developer does not get the same returns as he would on a commercial basis, then of course the measure of contribution will be questioned; or at least will be in proportion to the sharing, if you like, of the rewards of that development.

I think we are really talking about development therefore, at two levels. The development of a company should normally be coming out to further their own position in the industry; and the second level is perhaps contributing to a broader development plan - in the form say, of a contractor. If it is contracted R&D work, then the only benefits the company really would get from it is the techni-

cal knowledge and expertise.

P.L. BOURGAULT

I would be a bit of a devil's advocate with respect to the EDP for example. You painted a very nice picture, but you know a company could in fact get R&D, the way I figured it out, for about 15¢ on the dollar.

If you had 150 per cent, which, when you take the tax at the 50 per cent tax level, works out to 25¢ on the dollar. Then you can take .0 per cent off that, which will bring you down to nearly 15¢ under ideal conditions.

However, if you take it in aggregate, industry does about $840 million of R&D in Canada and the total contribution by the Enterprise Development Fund is $61 million, I think you said - per year. The tax break I believe was being estimated at a value of $25 million by the Department of Finance, in foregone taxes. So putting the two together is about $85 million, which is roughly 10 per cent. In fact industry is getting research for a 90¢ dollar - on average, as opposed to the ideal situation. It is just another way of looking at it and making it look much less attractive.

D.N. KENDALL

I think the Department of Revenue has miscalculated. If we do the research - they are going to lose the revenue. I think they miscalculated on the amount of revenue they are going to lose.

P.L. BOURGAULT

I suppose the amount that EMR would have, if it is one and a half million divided three ways, 500 thousand: it is not going to make a very big dent in the means of industry. I still come back to the point that I had initially, I think the amount of funding that is going to be available looks small.

D.N. KENDALL

However, it is certainly bigger - if it is divided three ways. Meaning there is also some contribution from the companies themselves, and some contribution from the department of industry, plus the NRC and the various other funds which are available.

I think there is also the factor of comfort to EMR if people are willing to share the risk with them. I think that is a very important factor.

T.J. BLACHUT

That applies only to the commercial-oriented products. If you have a product on which you can start the manufacturing and indeed make a business out of it, I think it is very obvious that the industry should contribute. But, if a Department, - and it happens to us - wishes to develop a simple piece of equipment

that is very essential to pursue our research - then of course we could not expect industry to contribute financially. You see the difference, because they are two different things. We try in the National Research Council, to establish Canadian manufacturing in certain areas. We hope that in such a case we are supporting industry.

A.F. GREGORY

Mr. Chairman, I want to thank you for this opportunity because I just happen to have come from a committee which was considering this very same problem in respect to the consulting engineering profession in Canada - and I am a member of the R&D Committee for ACEC. We are in the midst of preparing a brief on this particular point. The thing that I want you to grasp is that by and large, members of ACEC are small companies.

The present thrust of our brief suggests that research and development programs of the Canadian government do not represent a significant portion of the fees earned by consulting engineers. Of the approximately $1 billion in fees earned annually, only $10 million is earned in research and development from the Canadian government.

With over 1.1 billion spent by the government in the science sector, this low participation by a highly skilled technical group such as consulting engineers should be a matter of great concern to the government. We figure that at least 5 per cent to 10 per cent should be invested.

Now why are the engineers not involved? We have not been able to resolve that. We are looking at it, we have ideas and the ideas that I am going to present now are largely mine - they are not a consensus of the Association of Consulting Engineers. They go back to this very point - that they are a small group, they are not a highly profitable group. The kind of money you are talking about, and looking at profit, is a very small sum - and to expect these types of people to contribute significantly to the cost of development I think is highly unrealistic.

Now, the other aspect that I can see is that participation in government programs for a small company is a very difficult thing to achieve. After long lag times, your enthusiasm dies. By long lag times I am talking nine months to a year from the time you had the idea and developed it to the stage where you present it until the time when you start getting some money. If you get any money.

The Science Council and MOSST and other groups have told us that innovation is well covered in Canada, although perhaps not adequately. The Science Council has prepared documents talking about the weakest link and have tried to identify the weakest link. My point is that there is a missing link, and the missing link is the coverage on improvisation and on conceptualization. And that is the area that is dominantly covered by small companies. If you look at the history of innovation in Canada, and in many other countries around the world, you will find that much of the innovation, although not all of it by any means, is done in small groups who have for one reason or another, split off from larger groups, or they have had an idea somewhere and got together. These people literally get

together on shoe strings to make things work and then they try to find funds. I say if you are trying to get a participating fund from those people, it is like trying to get blood from a stone.

I think the same thing holds in surveying and mapping. There are some types of R&D that are needed for surveying and mapping, the data base development sort of thing - which are large scale operations, require the support of large companies and require the major support from government. But there are also a lot of products which are small company-oriented products - the type of thing the small companies can do.

Now, people say "well, you have the unsolicited proposal route". But my response to that is that there is really no such thing as an unsolicited proposal. If you cannot identify, and what is more, get support from a government officer, then forget it. And that means that you have to convince a government officer that what you want to do is the right thing. Either that or you assume that the government officer knows what needs to be done. So I will leave it at that.

W. CHAPMAN

For those that might be interested to see what the EDP program is about, I have a number of copies of the brochure with me and I would be glad to leave them with you. More than that, I think it would be appropriate to say right now that over the past few months our department, in pursuit of its objectives of industry development and trade promotion, has been drawing up industry sector profiles.

We are now forming the base of some sort of a sector profile for the surveys and mapping industry. We look forward to the outcome of this meeting which may identify areas in research and development for surveys and mapping.

J.M. ZARZYCKI

I would like to address a question to the panel on the subject of the direction of the R&D fund. The funds are limited, and let us assume that we agree on which areas they should be spent. Should we direct the funds to chosen instruments, to create centres of excellence in industry, or would we split the funds with everyone who wants to take advantage of new funding?

P.L. BOURGAULT

Clearly with limited funds, and funds are always limited, you cannot spread them too thinly. In Canada I think we have a special problem. I know when I did the work for the Science Council, one of the main impediments in my view, was the fragmentation of Canadian industry. We had a multiplicity of firms. In many cases, as many firms producing products in Canada as in the United States, and twice as many as Japan and France that have much bigger markets.

With this kind of industrial structure - well, just to view an example - in the pharmaceutical industry, there were 140 plants, 75 different firms registered in the association. Then they turn around and say our market is too small. Govern-

ment grants often contribute to this multiplicity of firms. We have encouraged the Japanese firms, for example, to come in and assemble television sets when we already had nine producers and we could really have supported only two or three. I would hope that the money would not be used to fragment - and although the decisions are hard - I would hope that they would be channeled in such a way so as to reinforce strengths where they exist.

End of panel discussion.

7. SUMMATION AND CLOSING REMARKS

D.N. KENDALL

Now we have to finish off the business of the last session, which is really "What do we do now"? I am committed, as chairman of this meeting, to report to the National Advisory Committee on Control Surveys and Mapping.

I shall draw up a letter to the NACCSM outlining what has happened at this conference and the main conclusions reached. This is your last chance to say anything. Is there something you feel should be raised or that you would like to raise?

R.G. CODE

Assuming R&D dollars were available, I have lost sight of some of the objectives, and I wonder what strings, or what attachements would go to dollars. For instance, I think of these dollars being in two categories. One, the motherhood dollar, and the other is the cut-throat dollar.

Now, on the one hand we have a dollar that might be spent for the benefit of a group in industry or a collection of people who would benefit from R&D.

Then we have another category where Company A develops something to make itself more competitive. There you get into the cut-throat dollar.

Now if this is dollar spent, and assuming government dollars are being spent, or a proportion at least, is it fair to put company A in a better position vis-a-vis its competitors?

Now, collectively if that dollar went to companies in Canada which would be placed in a more competitive position in terms of off-shore earnings, then I would say spend all you can spend. But I would hesitate to suggest that dollars be spent, or given - conditionally of course, for certain purposes - to create disunion among what is I understand to be a rather fun-loving and energetic type of industry, surveyors and mappers; they are all at the top scale (in my view at least). However, that is only a thought.

D.N. KENDALL

I think the business ethics or equity of this situation is fairly clear. If the Crown fully supports a project, the development belongs to the Crown, including any patents and so on which emerge from it. If the development is shared with a company, particularly if it is a 50-50 sharing, then the development and the project belongs to the company that contributed the 50 per cent. If you get something in between, say an 80 per cent contribution, then I think you have to write the rules as you see them at that particular time. There is the black and the white of it. There are shades of grey in between. Is there anything else anyone would like to raise?

J.L. ROBINSON

One of the things that has been missing from the conference, which has bee bothering me in terms of the users, is the educational component. The thought came to me the other day when someone pointed out that 90 per cent of our kids cannot read maps. There are two things wrong in that statement: maybe the teaching of map-reading is wrong or, maybe the maps are wrong. What I am concerned about is that we have been talking about research and development here and there is a group of users that I wish we knew more about, that is, everyone from the kids in school to John Q Public. I do not think we have attacked that part of it. Research and development for whom - for what? The general public wants maps for travel purposes, maps of parks, etc. Have you tried to get some input from the teachers, both the geography teachers and the university people who are using maps in their classrooms. This is something I do not think we have a handle on at all. I deal with it in terms of atlases; we do not know who uses atlases, whether they use one page or all the atlas. I do not think we really know who uses maps and what they want. I would simply suggest that perhaps at some other time we make some kind of an effort to find out what that general public (in the broad sense I am using) really wants from maps, and then maybe direct some of our research and development towards maps for the "general public".

D.N. KENDALL

I now launch into my closing comments.

I think as we approach the close of this two day session we must thank God for one thing. In these days when the social scientists want to get into everything, at least no one has suggested research projects along these lines: for instance, we might have been asked to research the effect on the home life of a photogrammetrist who had to operate all day with an analytical plotter. Or worse still, we might have been asked to research whether every surveyor views the opposite sex as a bundle of contours.

We have had a lot of recommendations over the two day period, some of which are clear enough that we ought to be able to recommend them to our final authority. Others need a lot more thought. We have tried to re-hash in our panel some of the recommendations, and I would think it only fair to give Energy, Mines & Resources a little time to muse over some of the less obvious suggestions.

Many of the suggestions made good, immediate or short term sense. We should not ignore the immediate! As Confucious says "A thousand mile journey begins with the first step". But it is even more important that we know where we want to be on the journey five years, and ten years from now.

What seems to emerge is that we have in Canada a survey industry, and I am using industry in a wide sense here, that employs some 22 000 people, pays them quite well and does an annual business of just under 500 million dollars.

This calls for better systems, better exchange of information, better software and simply, better management. There is no denying, of course, that cutting costs in surveying also involves some hardware design. I believe, however, that

too often we are faced with the hardware which we then fit into our operation rather than designing the hardware to meet our special needs. Manufacturers might not agree with that.

We discussed dividing the R&D effort among government, industry and the universities. I am not sure that one can arbitrarily divide the dollar available among the three. I think one first has to know what R&D one wants to do and then see how it can best be done. As I said in the beginning, we cannot afford research purely for research's sake. I think it should be enough for us to endorse the aims of reaching an expenditure of 5 per cent of EMR's annual budget on R&D but not specifying when or how the split exactly should be made, as long as we see progress towards the goal.

I think we should be seriously concerned, however, if targets of approximately that level have not been met within five years.

I think we are wedded to the concept that well-directed research and development pays off in financial terms in say five to eight years, through lower costs and higher employment, - and must therefore be pursued. There are many examples that prove this.

Equally, badly-directed research can be most costly. EMR probably needs a senior officer with a responsibility for the R&D effort. They may well have one already, I am not sure.

It only remains for me to thank you for attending and participating so actively. I think you have been, if I may say so, an exceptionally good audience and the participation has been very good.

We have had excellent papers and owe a debt of thanks to those who prepared them. Some of them need follow-up and I am sure that EMR will do so.

A special vote of thanks goes to Ray Moore who conceived this conference and to Al Stewart who did the leg work. I hope that they too feel it has been worthwhile.

That is all I have for today, so may I wish you Godspeed back to your ridings and best wishes for election day.

R.E. MOORE

For the past two days, there have been numerous views expressed on R&D. These have ranged from survey posts to redefinition of the geoid. I have never heard any single session that dealt with such a span of activities. As Chairman of the National Advisory Committee, I will ensure that proceedings and results are printed and that recommendations are made to the federal government.

I want to thank the speakers, the panel members and particularly the Chairman, for responding to my call. You have all contributed a great deal and on behalf of the Advisory Committee I want to thank you particularly.

My final thanks go to the Chairman, Doug Kendall. He participated in our discussions of last September at the last Advisory Committee meeting and since then he has chaired our organizing meetings and has unselfishly contributed his valuable time.

I recall one of our meetings, a meeting set for 5 o'clock, when Douglas came in 20 minutes late and apologized to the rest of us. We accepted his apology with some good-natured comments because he is always on time (It was only later that we realized that he had driven a few hundred kilometres from Northern Portugal to Lisbon; he flew to Montreal, then to Ottawa and took a taxi to our meeting). This is the kind of dedication that Doug Kendall has demonstrated throughout his professional career and exemplified today. Thank you very much for chairing this conference; you made it all possible.

APPENDIX A

ONTARIO SURVEYS AND MAPPING BRANCH PAPERS FOR R&D PROPOSALS

By

R.G. Code

Surveyor-General and Director
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ABSTRACT

Decision-makers need, today more than ever, increasing amounts of information upon which they may base their decisions. They must now be better able to state exactly what they want, so that R & D can be scheduled in such a way as to address and incorporate their requirements.

Two specific examples given are (1) that large scale topographic map detail must be stored in geo-referenced data bases, and (2) that digital topographic data bases from different agencies must be compatible, integrable, and easily transferable.

Resources managers and executive decision-makers are developing an almost insatiable appetite for a variety of information regarding program management and policy.

One of the reasons for this stems from the fact that policies and programs may no longer be developed in isolation, as has been too often the case heretofore. Governments are attempting to determine to the fullest extent possible, for example, the effects of a new program X on existing programs A, B and C. Hence, in documenting for approval and funding the policy proposals and the operational aspects of program X, its proponents will require a variety of information about A, B and C. The proponent of X is also forced to examine and document how his program affects programs A, B and C. You can be sure that the managers of A, B and C will insist that such an assessment of the situation is correct. The case of program X is simplistic. However, it is illustrative of what is taking place.

The need for information is developing at an ever increasing rate. Technology is responding to this need in what may loosely be referred to as *the computerization of data*, which includes data collection, storage, retrieval, manipulation, management and display.

While technology also has been advancing at a phenomenal rate, there are indications that in some areas, there has been a lack of direction as to which routes it should take.

One reason for this is that management has not always been able nor is it now entirely able to define what it wants. One instance of this was evident during the Canadian Northlands Data Needs Seminar, convened at the University of Manitoba in January, 1974 to determine the information needs of managers of northern resources. No clear direction came from that conference, at least not to me. When I asked one of our assistant deputy ministers who attended, "What are your needs?", he responded, "I think you know what we want, just go ahead and produce it. We'll leave how it is done up to you". With those terms of reference, we are forced to determine management's needs, as is so often the case. I believe we are meeting with some measure of success. We (I mean the *collective we* of federal and provincial communities) are gradually beginning to nail the boards together. If we were to take time to measure our achievements, we would find that some progress has been made towards solving many of the problems and issues raised and identified at meetings in the late 60's and early 70's, such as the "Conference on the Concepts of a Modern Cadastre", the conferences on urban surveying and mapping, on control surveys, and others sponsored by the governments of Canada and by the learned professional societies and associations.

Today, we are here to talk about the applied research and development needs. The setting is appropriate and the scheduling of the meeting is timely. Much time and effort went into the work of the Task Force on National Surveying and Mapping and it is encouraging to see the speed with which EMR is investigating the recommendations of the report.

That lengthy preamble was purposely designed to highlight the fact that much

of the information required by management people must be positionally related and that we must take the needs of management into account in carrying out R & D on, for example, semi-automated mapping systems.

My submission for R & D proposals today includes two papers. The first paper deals with maps while the second deals with data bases. We acknowledge, however, that some R & D has begun in some of the subjects discussed in these two papers.

PAPER NO. 1 -- MAPS

Specifically, this refers to (a) large scale topo maps i.e., larger than 1:50 000 and (b) thematic maps and associated reports.

More and more, positionally-related information is being stored on computers. Much of this information is related to topographic features. Therefore, we believe it is important and necessary that topographic features form part of a comprehensive georeferenced data base, that they be in digital form *and* that they be stored in *their true relative position* to all other information in the data base.

For the purposes of clarification or enhancement of specific topographic features, it is sometimes necessary to displace or distort them when depicting them on a map. For example, roads are often depicted somewhat wider than they actually are; contours in areas of sharp relief are often slightly separated for clarity.

In order to satisfy the requirements for such clarification and enhancement as we move further into digital mapping, R & D is required to develop certain capabilities, some of which are as follows:

- to displace automatically cartographic features which are stored in their true relative position in the data base, to prevent *cluttering* when such features are plotted on a map.

- to perform automatically dual-line road intersection clean-outs and river clean-outs at bridge crossings while plotting overlapping or intersecting features that are stored as complete and continuous entities in the data base.

- to *generalize* automatically the detail on small-scale maps derived from larger scale digital maps; for example, eliminating small lakes, changing narrow dual-line rivers to single-line rivers, changing symbology of map features.

- to permit the correlation of (man-made) cultural features and cadastral information (derived from survey plans and legal descriptions) with digitized data in the data base.

- to permit the processing of data contained within any user-specified area in order to determine areas, volumes, and lengths of topographic or cultural features stored in the data base. This includes the semi-automatic

- production of charts, reports and graphics in order to present the information required in the most suitable and useable form.

- to permit the transfer of georeferenced data between existing computer file systems, e.g. land titles, assessment, and then, the subsequent plotting of this data on a topographic base.

PAPER NO. 2 -- DATA BASES

This deals with compatible, geographically referenced data base systems, and integrated digital topographic data bases.

Regarding *compatibility* I am referring to a compatible, geographically referenced data base system, which is a system of files of information, structured to ensure that the data in the files can be readily accessed and correlated by persons other than those for whom it was orginally created (produced).

A characteristic of a compatible system is the use of a single universal reference base. Although the single universal reference base (or grid) is only a first step to compatible systems, it is perhaps the most important one. The information which should flow in and out of, and between systems, must be geographically referenced (i.e., it must have position attached to it). It should be in digital form, and it should be related to topography. This is how we see R & D needs which we suggest, should be supported by all three levels of government.

Specifically these needs are:

- to provide a query and retrieval capability across geographic data base file systems in all levels of government. For example, authorized municipal, provincial and federal employees should be able to retrieve data by terminal from both their own files and the files of other users of the data base. In other words, integration is required to provide a comprehensive information utility.

- to determine and design data base structures and access mechanisms. For example, should our geographic data base be structured as a digital terrain model or should it be structured on a cartographic feature basis? Also, what are the advantages and disadvantages of each option? The choice of structure is an important one; if not *built in* during the design and development phase of the geographic data base, some applications will become computationally very expensive.

- to provide a facility whereby a user can create access paths into different file systems of the same geographic data base. For example, to permit a land-use planner to retrieve data from a variety of associated areas such as forestry, wildlife, and cadastral surveys.

- to allow the correlation of satellite imagery data with information stored in the topographic element of a geographic data base.

- to provide the capability for managing and manipulating polygons. For example, to perform efficient and effective multi-level polygon overlay analysis; also, to merge polygons by deleting shared boundaries, to automatically compute the area of the aggregate polygon and to merge the attributes previously associated with the first set of polygons.

- to permit and facilitate automatic aggregation of statistical data associated with spatial entities in terms of *any* other associated spatial entity, *or*, in terms of any user-defined window or polygon. For example, the aggregation of data associated with land ownership parcels to city blocks, to enumeration areas, and to municipalities.

- to permit the depiction of customized graphic products and reports from the geographic data base. For example, the capability should exist to extract data from the geographically referenced data base and to produce tables of figures or graphs, or any other presentation that gives a clearer picture of the data than can be provided by the traditional two-dimensional map.

APPENDIX B

RESEARCH AND DEVELOPMENT NEEDS OF THE CANADIAN HYDROGRAPHIC SERVICE

By

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ABSTRACT

The Canadian Hydrographic Service undertakes limited R & D work in-house on chart production problems. The Service attempts to do enough R & D to keep abreast of the state-of-the-art. In most of its areas of interest, the Service is the major, if not the only, Canadian user of its developments. However, for selected procedures and instrumentation development, research is contracted to universities and the private sector to the amount of about $1 M per annum.

Specific requirements are outlined in the fields of data base management, alternatives to the echo sounder, computer-assisted data collection, tide gauges, navigation and positioning systems, and chart production.

Although this contribution has been placed under the general topic of *mapping*, the activities of the Canadian Hydrographic Service encompass control surveys as well as even having some bearing on *cadastral surveys*. In my remarks, I would like to give some information on the task of the Hydrographic Service, then briefly discuss our achievements in the field of computer assisted techniques and finally, review our R & D needs in the areas of software and hardware.

The task of the Canadian Hydrographic Service, an element of the recently formed Department of Fisheries and Oceans, is to carry out hydrographic surveys and produce nautical charts and associated publications to permit safe navigation in waters extending to two hundred miles off the coast, or to the edge of the continental margin, whichever is farthest, together with adjacent international waters of direct interest to Canada, and last, but not least, all navigable inland lakes and rivers. The mandate for our activity as a federal agency is contained in the BNA Act, The Canada Shipping Act, the Geneva Convention and the Government Reorganization Act of 1979 that provided the legislation for forming the Department of Fisheries and Oceans.

It is evident that our task is not nearly complete since the adjacent waters in areas off southern Canada are not surveyed to acceptable standards and, except for reconnaissance surveys and surveys of a few major traffic routes, the waters contained within the Arctic Islands are largely unsurveyed. Assuming that our resource base remains unchanged in terms of man-years and dollars. ($25m and 550 m/y), there remain about fifty years of work to complete our present survey program to modern standards. In addition, recognizing that surveying and mapping or charting are iterative activities, this figure will undoubtedly increase as demands change.

Faced with limited resources to meet this major challenge, the Service has always been anxious to make full use of any technology which would enable it to do a better or faster job. During 1930, one of our ships was the first hydrographic ship to be equipped with an echo sounder and in 1956 an electronic positioning system, which enabled us for the first time to work effectively out of sight of land, was used. In the late 1950's a start was made on automating the collection and analysis of tidal and water level data, including the prediction of tides by digital rather than analogue techniques. In 1966, a contract was awarded to the University of Saskatchewan to evaluate the feasibility of compiling and drawing nautical charts using computer-assisted techniques. This contract work formed the nucleus for our developments in automation in the chart production area.

We now have small research and development teams in our three major regions working on hydrographic surveying and chart production problems. There is a specialized team in Ottawa working on automated cartography, one in Dartmouth working on navigation problems and a third in Burlington working on tides, currents and water level instrumentation. The role of each team is to do enough R&D in-house to stay abreast of the 'state-of-the-art' in order to evaluate new instrumentation as it becomes available, to interface various components into complete systems and to prepare specifications and monitor the progress of work contracted to industry. At the present time, research contracts to universities and to the private sector for developments in navigation systems, tidal development, acquisition and processing are in excess of $1m per annum. It is important to realize however, that

in many of the areas mentioned, the Canadian Hydrographic Service is the major, if not the only Canadian user of much of the equipment being developed and because of this, it is often more economical to do the work in-house rather than by contract. This has become one of the greatest deterrents in establishing a viable hydrographic survey industry in the private sector. There are, nevertheless, many areas where the techniques and instrumentation used in hydrography are the same or similar to those used in the other areas of surveying. In these areas I see an excellent opportunity for collaboration with universities and the private sector.

Before outlining what we see as our major needs in R & D, I must state that the technology already exists to solve many of the problems we have identified and that I will be discussing. The main challence in R & D is to identify those innovations which are practical and cost-effective to utilize. The varying budgetary constraints that are peculiar to each agency are important factors in deciding what is cost-effective. For this presentation I have categorized needs into four general areas and will now attempt to provide some insight into these needs.

1. DATA BASE MANAGEMENT

It is felt that the highest priority of almost all agencies here is to develop efficient management systems for larger volumes of data and to be able to make these data useful to a broader spectrum of users. The question of which data are to be in computer-compatible form and which data are to be selected for final storage is an important consideration. In the mapping field, it is easy to envisage the transfer of information between digital data bases, but if this is to become practical there should be standardization of terminology at all levels of government - federal, provincial and municipal - and in the private sector. At the same time, it should also be recognized that computer compatibility will not occur and that attention must be given to developing concepts which facilitate conversion and maintain a high degree of flexibility. Emphasis needs to be given to developing man/computer communications systems, particularly in the area of interactive graphics. I see a large requirement for common interest in data base management and a need and an opportunity for private sector participation.

2. INSTRUMENTATION FOR HYDROGRAPHIC DATA COLLECTION

a) Alternatives to the Echo Sounder

The task of the present-day hydrographic surveyor may be fairly compared to that of a surveyor flying above impenentrable cloud trying to produce a map solely from the readings of a radar altimeter and knowing only his elevation above some reference surface. Even this is a great improvement over the tools of the hydrographer of 50 years ago who obtained his data by suspending a weight on the end of a line. The hydrographer today is looking for a breakthrough or improvement over conventional survey techniques comparable to the advent of aerial photogrammetry. What we are really seeking is a system that will make the water cover more transparent in at least one portion of the electro-magnetic or acoustic spectrum, so that a complete picture of the sea floor physiography can be obtained

rather than just a profile beneath the ship's track. Methods that have been looked at are swath-sounding techniques using complex transducer arrays, side-scan sonars and sector-scan sonars. These systems offer some promise but have not yet been fully developed for routine hydrographic use.

One promising alternative for shallow water charting is the aerial hydrography system, the development of which was started by the Canada Centre for Remote Sensing and the Canadian Hydrographic Service in 1970. This system integrates a sophisticated inertial guidance system, capable of determining the position of the aircraft to ±10 m and its attitude to ±30 arc seconds, with an air survey camera using film with an emulsion selected to give maximum water penetration. A laser is now being incorporated to provide the ground truth and to extend the range of the system to a water depth of up to 30 m. The hope is that this will enable bathymetric contours to be compiled for all areas in which the bottom can be seen photographically with classical techniques only being required for check lines and shoal examinations.

This prototype aerial hydrography system was turned over several months ago to Philip A. Lapp Ltd. as the prime contractor to make the system operational. Three subcontractors are involved: Terra Surveys for the photogrammetric plotting, the GENESYS Group for software development and data processing, and the University of New Brunswick for the analytical aerotriangulation and measurement of depths. The system has potential not only for hydrography but also in other mapping areas.

With the emphasis on the development of Canada's frontier and offshore oil and gas resources, there is an urgent need to find ways and means of expediting surveys of waters that are covered by ice for all or part of the year. Icebreakers are a very expensive and poor platform due to their erratic progress through the ice and the problems of air and ice passing under the hull. There has been considerable research done in this area within the Service and by contract, but an urgent need still exists to develop over-ice profiling systems for obtaining bathymetry in the Canadian Arctic.

b) Computer Assisted Data Collection

Over the past 12 years we have made considerable progress in developing automated data-logging systems for use on ships, launches and tracked vehicles. With the advent of microprocessors it has become practical to incorporate on-line processing of depth and positioning data. In this area of data collection, our most pressing need at this time is reliable recording devices. Magnetic tape systems and punched paper systems have been used and solid state recording systems considered, but to date we do not have a fully reliable recording system.

c) Tide Gauges

One of our aims is to process field data in as close to real time as possible. One of the key inputs is the height of the tide or other variations of water level. Tide gauges that can be laid on the bottom to collect this information are now reasonably reliable. What is needed is a link, probably acoustic, that would either transmit the data to the ship in real time, or that could be inter-

rogated periodically to obtain the data without having to recover the gauge. There is also a need to develop standard packages of two gauges, one for atmospheric pressure and one to measure the tides, to relate vertical control networks to mean sea level. These will be required mainly for Arctic use, to operate unattended for long periods.

3. NAVIGATION AND POSITIONING

In the area of navigation and positioning, there is a need for research into electromagnetic propagation anomalies due to heterogeneous terrain and a need to develop inexpensive systems for the yachtsman. There is also a need to obtain information on the operation of navigation systems in the Arctic so that when and if a viable gas or oil field is found, ships will be able to traverse this area in safety.

4. CHART PRODUCTION AND MAINTENANCE

The automated drawing system developed by CHS has been producing chart graticules and the lattices for electronic positioning systems successfully for several years, and interactive drafting of compiled data is used for the drawing of the final charts. No significant time savings are anticipated in this drafting process because digitizing is a manual process; however, a digital data base of the chart data is being built parallel to the production of the graphic. Computer-assisted interactive compilation has been done on a developmental basis and most of the required system capability is available and can be effectively used once the compilation data base is available in digital form. Improved methods of automatic digitizing are nevertheless urgently needed and these would have many applications in the area of map and chart production.

In the area of chart maintenance, since a nautical chart is subject to constant hand amendments based on weekly Notices to Mariners, from the moment it is printed until it is replaced, alternative methods are needed to replace this labour-intensive process. There is also considerable research that could be done in the area of presentation to ascertain whether or not the product that is being provided to the mariner truly meets his needs.

SUMMARY

In summary, our most pressing R & D needs are in the areas of:

- Data base management;
- Instrumentation for hydrographic data collection;
- Instrumentation and techniques for navigation and positioning,
- Improvements in chart production and maintenance.

I would be most happy to discuss these needs with each of you on a one-to-one basis.

APPENDIX C

A VIEW OF THE APPLIED RESEARCH AND DEVELOPMENT NEEDS OF CANADIAN MILITARY MAPPING

By

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ABSTRACT

Military mapping requirements for applied research and development are highlighted by the large military R & D programs of the U.S. and other countries. Trends of offshore R & D are reviewes with examples of position-fixing systems, digital terrain models, terrain analysis and digital/analog storage. The impacts of offshore R & D are then related to the Canadian military mapping role and a selection of development subjects is proposed.

ABSTRACT

Military mapping requirements for applied research and development are highlighted by the large military R&D programs of the U.S. and other countries. Trends of off-shore R&D are reviewed with examples of position-fixing systems, digital terrain models, terrain analysis and digital/analog storage. The impacts of off-shore R&D are then related to the Canadian military mapping role and a selection of development subjects are proposed.

INTRODUCTION

1. Canadian military mapping requirements are necessarily extensive in responding to the varied activities of the sea, land and air forces in both national and international defence roles. The provision of domestic and foreign coverage in survey control, maps, charts and related information is primarily conducted through cooperation with the national mapping and charting agencies in Canada and through exchange agreements with military mapping agencies in other countries. Where coverage is not available from these sources, the requirements are tasked to the Mapping and Charting Establishment for production or contracting out.

2. It is necessary to put this role of the Canadian military mapping activity into context with the large applied research and development programs of other military mapping agencies. Within the overall sweep of technological change introduced with satellites, inertial guidance, lasers, communications, mobility, fire power and, through it all, computer power -- the requirements of improved weapons delivery systems and survivability are having a significant impact on military surveys and mapping. The effects of related research and development to improve military mapping products and services have initiated extensive new programs, typically represented by digital terrain data bases and digital image analysis. Equally significant changes in product formats, data storage and distribution are in hand or expected. The scope and inevitability of these changes place the Canadian military mapping activity in the position of adopting the new products and services developed by others and of adapting our resources to similar accession, production, storage and distribution technologies. The related military mapping applied research and development needs in Canada are to:

- Maintain a continuing awareness of related military applied research and development within DND and abroad in the United States, Australia, United Kingdom and NATO forces.
- Maintain a continuing awareness of related civilian applied research and development in Canada and abroad.
- Participate in related but unique requirements of the Canadian Forces.
- Adapt the resources and procedures of the Mapping and Charting Establishment to accommodate these changing technologies and requirements.

GENERAL TRENDS IN MILITARY MAPPING AND CHARTING

3. Trends in applied research and development related to military mapping and charting are highlighted by several examples that are expected to have a significant influence on future activities in Canadian military mapping.

POSITION-RELATED DEVELOPMENTS

4. Probably the most familiar position-related developments include the various commercial Doppler survey systems patterned after the DMA military version GEOCEIVER and designed for positioning from the U.S. Navy TRANSIT satellites. Extensive Doppler survey control has aided geodesists in the integration of old and new control networks in preparation for an earth-centred datum to be introduced by 1983. Ramifications to mappers include extensive global accommodations of maps and charts to this new projection and datum and technical concerns in translating the vertical components of this new *Instant Datum* to mean sea level.

5. The Global Positioning System is expected to be fully operational by 1985. With near real-time precision positioning, it will eventually replace the current Doppler survey systems, introducing requirements for new navigation and survey receivers and for innovative procedures in air surveys, control surveys and photogrammetry.

6. The NATO initiated Position and Azimuth Determining Systems (PADS) independently developed by the U.K. and U.S. military for artillery location surveys has been extended with the assistance of civilian R&D to provide an effective means for rapidly establishing accurate horizontal, vertical and gravimetric control over large areas. Continuing developments are aimed at improving its cost/performance effectiveness.

Digital Terrain Model Developments

7. It seems only a short time since MCE was involved in the development and production of solid three-dimensional models configured to European 1:50 000 scale topographic maps covering the training areas of the CF104s. This approach has now been completely overtaken by the development of analytical models extended to continental coverage.

8. Digital Land Mass Simulation (DLMS) has become a driving force in military applied research and development abroad. Reference scenes from these analytical models are required for:

- Updates to inertial guidance of unmanned low level weapons and surveillance systems.
- Navigation correction by radar reflectance matching for manned low level aircraft sorties.
- Training by simulation of aircraft missions to improve flight crew experience levels and significantly reduce fuel consumption.

- Operational research simulation of strategic and tactical battle scenarios.

- Purpose-oriented studies related to intervisibility and communications.

9. Developments to date have provided standard production specifications and manual digitizing and photo-interpretation systems. On-going developments are directed towards automating these systems and handling the enormous digital data problems of accession, storage, display, manipulation and retrieval.

Terrain Analysis Developments

10. Parallel with the development of data bases for digital terain models, other disciplines are active in the development of improved engineer intelligence support.

11. With ever increasing fire power and mobility in the battlefield, Command and Control Systems are being developed to provide battle commanders with field level information systems. Included in the overall store of data must be extensive interpretations of the terrain, its related vegetation cover and man-built structures. Digital storage and analysis of terrain data is expected to provide current, reliable information on: trafficability, mobility, line-of-sight, fields of fire, concealment, etc. Much of the information will be prepared in advance as map products, Military Geographic Information Documentation (MGID) and field-deployable data bases.

12. Some current developments having limited Canadian participation include: standardization of data elements, digital production of test areas and concept phases of an information system.

Digital/Analog Storage Developments

13. Related to this future growth of data bases in support of digital terrain models and terrain information systems, there is a need for the means to display and copy images of this data.

14. Both military and civilian developments are directed to manipulation of digital data from raster-to-vector and vector-to-raster. Effective utilization of vast stores of analog data in current map and chart inventories requires transfer of the information to digital data bases by mass digitizing in either raster or vector formats. Although interactive editing and data base revision is currently popular in vector formats, development trends point increasingly towards all-raster formats.

15. Data base storage of this magnitude can become reasonable in terms of MCE capabilities with the expected introduction of optical digital disk technology. It has been estimated [1] that with a forecast 1×10^{10} bits capacity, one disk would have sufficient storage to hold the topographical data in the NTS 1:250 000 series for all of Canada.

1. Dr. A.R. Boyle, University of Saskatchewan.

16. Other data base storage developments are directed to micrographic analog storage of map and terrain data using electron beam recorders. With a companion scanning option, an electron beam recorder provides a means to move back and forth between the digital and analog media. Portability and accessibility of large bases for display and copy is then reasonably assured with both micrographic and digital options open for the future.

17. Military sponsored developments related to volume base plant lithographic printing and to rapid mobile electrostatic printing have been closely tied to the growth of industrial developments in the commercial industries. Some recent advances of interest in the U.S. include:

- The use of a laser plate maker for exposing litho-plates directly from magnetic tape.
- Optical enlargement of electron beam recorder micrographic colour separations.
- Computer-controlled electrostatic printer-plotters.
- Investigation of map-size *Xerox type* colour copiers for field use.
- The possible extension of ink-jet printing to map-size, full colour reproductions.

IMPACTS ON CANADIAN MILITARY MAPPING

18. The exchange and mutual support activities within NATO and other alliances require compatibility among products, techniques and equipment. This is currently referred to as RSI which means Rationalization, Standardization and Interoperability. However, there are difficulties in adapting the scope of these vast technological developments to the scale of operations in Canada.

19. Canada cannot be expected to either initiate or duplicate large development programs like those of the U.S., for example. The Canadian military capability for R&D in the mapping and charting field is strictly limited in both budget and manpower. Compatibility then requires that we adapt as well as possible to these significant changes within the scope of available resources.

20. It is intended therefore to shift the focus from the background of the large off-shore military R&D programs to the smaller, current adaptation concerns in the Mapping and Charting Establishment.

FORECAST OF CHANGES AND DEVELOPMENTS

21. A list of the changes and developments of specific interest to the Canadian Forces that have been either started or are foreseen within the next few years are summarized in four groups:

- positioning systems;
- analytical photogrammetric systems;

- digital compilation systems; and

- reproduction systems.

Positioning Systems

22. Doppler survey systems, now in use by a number of Canadian agencies, will be brought into service this year by MCE. The U.S. Global Positioning System is expected to be operational by 1985. An inertial survey system is being considered for acquisition within the next five years.

23. The use of Doppler to rapidly acquire accurate position data will be enhanced then overtaken with the introduction of the Global Positioning System (GPS). In turn then, the GPS will require the development of new receiving equipment and a convenient adjustment of the height component to mean sea level.

24. In the interim, before GPS, there remains a requirement to improve the effective positioning of supplementary height control for standard mapping. Possible subjects for further development include:

- Hardware and software improvements to the inertial survey systems as currently available.

- Laser APR improvements and cost-effective implementation.

Analytical Photogrammetric Systems

25. An AS11A analytical stereoplotter has been in use at MCE since 1967. A three stage stereo-comparator will be installed in 1979. A contract has been awarded to acquire three additional analytical stereo-plotters. The increased use of analytical techniques will improve efficiency and flexibility while decreasing response time. It is anticipated that space shuttle cartographic imagery will be available within the next 10 years.

26. With the increased use of analytical methods, there is a potential to improve further this capability. The following are proposed development subjects:

- Enhancement of the analytical stereoplotters by adding automatic correlation.

- Enhancement of block adjustment programs to further reduce the density of vertical control required and the overall processing time.

Digital Compilation Systems

27. Digital techniques for the compilation and editing of topographic and geographic information will be in use in MCE within two years. MCE has been producing digital terrain elevation data (DTED). The capability for the acquisition of topographic and geographic data in digital form will enlarge the scope of MCE from that of a producer of paper products (maps and charts) to a pro-

ducer of geographic information (including maps and charts). It will be feasible and economical to produce special map products to meet particular needs and to readily provide print-outs of related geographic information.

28. With the planned installation of interactive digitizing at the B8 stereoplotters and the manual digitizing work stations, together with the procurement of an automatic digitizer, the following are proposed development subjects:

- Automatic digitization in line with the work being done at the University of Saskatchewan.
- Techniques for reducing the manual preparation now required to digitize colour separation negatives.
- Techniques for more effective manipulation of information in digital terrain model data bases.
- Techniques for the mass storage of digital geographic information, including methods of accessing and updating files.
- Standardization of a national format for topographic and spatial geographic data to allow optimal interchange of data between diversified users with a minimum of format translation.

Reproduction Systems

29. Procurement of an automated finishing plotter with photo head and/or CRT head is forecast for MCE. The system will improve the rate of production of colour separation negatives required for lithographic printing.

30. A mobile printing capability is currently maintained, based on a semi-automated screen printing press.

31. The increased production of special map products results from the use of digital compilation systems, and since the number of copies for such products is comparatively small, there is a requirement for an improved short-run reproduction system.

CURRENT DND R&D PROGRAM

32. In DND, R&D related to surveying and mapping is accomplished through a general technology program called Mobility/Counter-Mobility. In-house R&D is conducted at Defence Research Establishment Suffield (DRES) and, to a limited extent, at MCE. Extra-curricular R&D is conducted at several universities. Most has been directed to the selection, measurement and presentation of terrain parameters affecting ground vehicle trafficability.

33. At MCE, projects include the adaptation, test and evaluation of new equipments and techniques for the production of maps and charts.

34. At DRES, projects include experimentation with a laser profiler for terrain roughness measurements and other investigations into the measurement of parameters related to soil and snow mechanics.

35. At universities, projects include development of terrain transects in four areas of northern Canada, development of trafficability thematic maps and the development of algorithms and computer programs related to the manipulation of data in a Topographic/Geographic Data Base.

SUMMARY

36. In summary, the scope for applied research and development in support of Canadian military mapping is restricted on the one hand by the magnitude of developments in the U.S. and other countries and on the other hand by the limitations on resources within DND to support costly developments.

37. Some of the opportunities for development have been identified, that will either be adopted by the Canadian Forces or strongly influence Canadian military mapping products.

APPENDIX D

RESEARCH AND DEVELOPMENT IN TOPOGRAPHICAL SURVEY

By

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ABSTRACT

Research and development work undertaken by the Topographical Survey is in direct support of the Division's objectives and activities. Thus, Topographical Survey is both a producer and user of R & D.

In order to reduce the labour component of map production, and thus reduce the time and expense required for production, an integrated digital mapping system is being developed. Other smaller, but significant investigations have been conducted on such things as the use of photogrammetry for cadastral applications, applicability of photomapping, and uses of remote sensing satellite data for revision. Finally, the current pressing needs for R & D in topographic mapping are listed.

Research and development projects undertaken by Topographical Survey are the responsibility of our Systems Engineering Group and are carried out in direct support of the Topographical Survey's objectives and activities. They are, therefore, revision-oriented. Our objective is to ensure the availability of topographic information concerning the Canadian land mass and its representation to standards of the National Topographic System. These objectives are realized by:

1. Obtaining of aerial photography, and the extension of survey control by photogrammetric methods, generally known as aerial triangulation. This operation results in the establishment of a number of control points with known X,Y,Z coordinates on each aerial photograph. These aerial photographs together with the control points form the aerial survey data base.

2. Compilation of new maps at a scale of 1:50 000.

3. Revision or updating of existing maps.

Thus the R&D effort, although directed to support a specific program, is broad in scope and includes all aspects of the mapping process from the acquisition of the imagery (aerial or space photography) to the production of the first copy of a map. It is not limited to the technology of map-making, but also includes investigations and studies about terrain information content, its representation and portrayal. We also address the question of how different techniques and instrumentation can be applied in the most economical and rational way.

To a large extent we produce R&D for our own use although other federal and provincial government departments as well as the Canadian aerial survey industry have benefitted from it. In that context we are both the producers and users of R&D.

Our staff consists of four computer scientists, two co-op students, three engineers and two technicians. In addition to in-house work, we give contracts to universities and consultants and support the unsolicited proposal route of bridge financing available through DSS.

R&D work can be divided into four general phases:

1. Basic research;

2. Exploratory development;

3. Advanced development;

4. Engineering development.

At Topographical Survey, we do not carry out basic research, but concentrate on the latter three phases, and as a rule, do not develop new instruments, leaving this field to the National Research Council. However, we often take existing off-the-shelf components and combine then into one system engineered

specifically to meet our requirements.

To give you a better understanding of the type of research and development undertaken at Topographical Survey, I would like to mention some of the projects we undertook in the past several years.

In the field of primary data acquisition, which includes aerial photography, we have updated and revised the specifications for aerial survey photography and recently have added a chapter on colour aerial photography.

We have tested contact printers for production of diapositives and suggested modifications and in fact, modified some of our printers to ensure adequate contact with film material.

Many year ago, extensive tests on APR were carried out in order to determine the operational procedures and data reduction methods. Methods were developed to employ aerodist for determination of X,Y coordinates of the camera at the moment of exposure.

One of the major efforts in recent years was the development of an adjustment program for aerial triangulation. Faced with the task of mapping large and inaccessible territories where the cost of establishing ground control was a very significant element of the total mapping costs, we were looking for a means of reducing the amount of ground control required for adjustment of aerial triangulation without compromising accuracy.

The access to large computers made it possible to develop aerial triangulation adjustment methods which resulted in a significant reduction in horizontal control requirements. Topographical Survey developed adjustment program SPACE-M (which stands for spatial photogrammetric adjustment for control extension) using independent models. This program has been installed and is maintained in various computer centres across Canada and is available for use by the Canadian mapping community. It includes lake levelling constraints that resulted in a reduction in the requirements for vertical control in addition to a significant reduction in the horizontal control requirement.

On top of this main development, various computer programs have been written for pre-processing of stereo comparator and stereo plotter measurements. The expanded power acquired by this development made it possible to extend control required for mapping by photogrammetric means at a much faster pace and for less cost than in the past.

In addition to the development of the SPACE-M adjustment program, the largest R&D effort was directed towards the development of an integrated digital mapping system.

This development was undertaken for two basic reasons:

- to reduce labour in the map production and revision processes and therefore reduce the elapsed time in the map production cycle.

- to provide terrain information in digital form for the technical or sophisticated map user.

The integrated digital mapping system consists basically of an input component, a data base management component and an output component in terms of graphical representation of the data.

Initially there were two parallel developments going on in the branch. One development was directed towards an automated cartographic system which would use as input manual digitization of existing graphics; the other system was devoted to digitization from stereo plotters. Later on, these two parallel efforts were combined to achieve the overall objective of developing an integrated digital mapping system.

Development efforts in auto-carto lead to a system based on a PDP-10 computer having the capability to collect and edit (on a limited scale) data from manual digitization of graphic sources. A classification system for cartographic features, a file system and a data base management system were developed to store and manage a very large amount of topographic data. These systems now permit the establishment of a national digital topographic data base. As part of the auto-carto system, a graphic package was developed which permits the cartographer to have full control over the symbology for the automatic drafting of the reproduction materials.

Efforts in digitizing directly from stereo plotters started with the design and fabrication of a prototype digitizer suitable for digitizing topographic data directly from stereo plotters. This led to the D1600 digitizer, which is built and marketed by Cybernex Limited and has been effectively applied to many aspects of photogrammetric mapping.

Simultaneously, a system for the collection of digital data from a number of stereo plotters connected to a PDP 11/45 computer was developed. This system, called the DIGICOM, was not implemented in production as it did not have effective editing capabilities. An effective interactive editing capability is the key to any successful stereo digitizing system and is the Achilles heel of any digital mapping system.

The appearance on the market of interactive graphic systems developed primarily for printed circuit design and other engineering drawing applications made it possible to achieve an effective editing capability in the stereo digitizing mode, and held promise to make digital mapping an economic proposition. We conducted an extensive evaluation of existing interactive graphic design systems (IGDS) available on the market before deciding to acquire the system developed by M&S Computing. Initially, IGDS was integrated with our DIGICOM, combining the best of our data collection systems with the best of commerical interactive graphics systems. This combination allows the plotter operator unrestricted access to his data for viewing at any scale and performing any necessary corrections. This system has been successfully applied in the compilation of an experimental map comprising a complex urban area of Ottawa.

Subsequent development by M&S Computing of a stereo digitizing system using a dedicated micro processor at each station made the DIGICOM system obsolete.

I would like to emphasize that in the development of this stereo digitizing system, we were not engaged in a massive design and development of hardware and software. But we have taken off-the-shelf equipment and software, modified them and integrated them into one mapping system.

The development of this system is a typical example of the type of R&D effort on the part of Topographical Survey. It comprises exploratory and advanced development as well as engineering development.

Two years ago we purchased the Gestalt Photomapper II because of its capability to produce digital terrain models. However, the implementation of this capability in production required considerable development of software and engineering procedures applicable to the production environment.

For example, software had to be developed for the fast processing of digital terrain models off-line to produce a homogeneous digital elevation model for an entire map on a UTM grid and for subsequent interpolation of the DEM to produce digital contours. Matching this data with planimetric data compiled on the digital compilation system was another development and implementation task.

The total digital mapping system was transferred to production at the end of November and is now in a production engineering shake-down stage.

Having briefly described these two major developments, I would like to mention some smaller, but nevertheless, significant efforts.

Occasionally we test or evaluate stereo-plotting instruments to determine whether they would be acceptable for contract work either for aerotriangulation, or for small scale or large scale mapping. We have tested for the accuracy and cost of using photogrammetry for cadastral applications. Methods were developed to permit stereoscopic transfer of targeted field control from identification photography to mapping photography. In the area of photomapping, we carried out comparative tests of orthophoto equipment and established the accuracies attainable with the equipment. The applicability of photomapping to many diverse mapping needs was also tested as well as the accuracy of the map. As a result of pilot projects carried out by this division, photomapping became an accepted method of meeting mapping needs for many organizations.

Remote sensing techniques are being investigated to determine which one could be beneficially employed in our mapping program, particularly for map revision and detection of changes.

As a result of pioneer work carried out by our staff, LANDSAT imagery has been used successfully to position offshore features, to locate navigational hazards, to plot new roads and reservoirs on maps in wilderness areas and to accomplish interim map revision.

The present WRS used internationally for indexing LANDSAT imagery was developed in Topographical Survey.

Now let us look to the future. What future developments are necessary to support the objectives of Topographical Survey?

In the area of data acquisition, there is a need for a system which would determine precisely the tip and tilt and possibly the position of an aerial camera at the moment of exposure. The standard error of tip and tilt determination for a survey flight lasting several hours should be in the order of 10 seconds of arc.

Currently, investigations are underway to assess Synthetic Aperture Radar (SAR) and satellite-born radar altimetry for possible application to topographic mapping.

An urgent need exists to develop instrumentation for automated detection of changes in topographic features as they are depicted on photographs taken at different times as well as changes between existing maps and new photographs in order to facilitate the map revision process.

Photography from space, obtained either by means of the proposed space shuttle service or from other satellite systems, will require intensive investigations to determine its applicability and usefulness in a national topographic mapping program.

In the area of digital mapping, the needs for further developments are many. Present methods of digitization of existing graphics are cumbersome and time-consuming.

There is a need for automatic line-following devices and for effective raster scan processing and economic raster-to-vector conversion.

Further hardware and software improvements are needed in the interactive system for editing of digital data.

The computer-assisted placement of names on a map is another area which is in need of development.

The possibility of printing maps directly from digital data, eliminating the present photo-mechanical process should be given more attention. Furthermore, the standards and conventions for graphical representation of terrain data should be re-examined in light of present needs and the possibilities offered by new technology.

Further research and development is needed in the area of data base structures and management for digital geographic data bases.

Finally, on a more futuristic note, in the era of expanding mass communications when we will be able to shop from our home by a computer, view pages of our favourite books and items of personal interest displayed on a television

screen in our living room, — we may consider a new map distribution system appropriate to that environment. A map distribution system can be envisioned which will, in fact, allow any householder to automatically select the map he desires and to display it on his television screen, select the area of his interest, and then by pressing a button, get a hard copy printed next to the TV set, as he waits sipping a drink mixed for him in a computer-controlled bar.

APPENDIX E

APPLIED DEVELOPMENTAL WORK ASSOCIATED WITH ORTHOPHOTO MAPPING

By

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ABSTRACT

This presentation highlights the developmental work associated with an extensive orthophoto mapping project for the Council of Maritime Premiers.

A number of photographic products and reproduction techniques were tested and a sequential procedure was developed for the efficient production of a high volume of map sheets within the economic constraints of the project.

It is clear that there is a need for a realistic set of specifications for aerial photography intended for orthophoto mapping, and further developmental work is required to ensure that optimum results are achieved during the map reproduction processes.

INTRODUCTION

Late in 1975, Atlantic Air Survey began high volume production of 1:10 000 contoured orthophoto map sheets for the Council of Maritime Premiers, using the Series 1 Gestalt Photo Mapper to produce the differentially rectified orthophotos.

Although some mapping had already been carried out in prior years by the individual provinces, there were problems concerned with trying to ensure uniform quality, and the meeting of delivery requirements. Optical slit-scanning instruments that were manually operated were slow, and attempts at film mosaicing techniques using marginal aerial photography produced less than satisfactory results. For these reasons therefore, the Council of Maritime Premiers decided to contract the majority of further orthophoto mapping to a local contractor, and to utilize the Gestalt Photo Mapper.

It should be noted that the Council's mapping agency, LRIS, contracts separately for aerial photography to standard ICAS specifications and carries out its own aerotriangulation and block adjustment.

Once Atlantic had its equipment and staff assembled, the mapping process was divided into five operations carried out sequentially, and development work associated with each phase follows.

THE GESTALT OPERATION

Production of Gestalt orthophotos began using the film and chemistry as well as preparation techniques recommended for the Gestalt. We soon encountered random problems with scaling and rectification of the output imagery however, and quickly realized that the three-point orientation program accepted erroneous data and produced false rectifications. Subsequent software modifications for a four-point solution remedied this situation, and the computer now prints out residual errors in the absolute orientation solution, enabling input errors to be checked prior to production.

Extreme variations in quality of the original aerial photography could not readily be handled effectively with the standard film recommended for the Gestalt, and considerable time and effort was devoted to experimenting with various film types and chemistry in an effort to achieve more uniform output. These efforts were largely unsuccessful however, and it would seem that a standard set of orthophoto aerial photography specifications could go a long way towards solving this most important aspect of orthophoto mapping, regardless of the orthophoto instrument employed.

COMPILATION PRODUCTION

This phase involves stereo plotting of five metre contours, as well as drainage features which frequently require enhancement, particularly in wooded areas. Compilation is generally carried out at the same time as Gestalt production, requiring two sets of film positives from the aerial photography on which control has been pre-marked.

There was little experimental work involved here, except in the manuscript preparation stage which we attempted to automate. Each map sheet must be compiled on a separate manuscript, with the following points plotted prior to compilation:

- Four geographic sheet corners given as plane rectangular co-ordinates.
- A line joining the sheet corners to indicate plotting limits.
- Six photogrammetric control points covering three stereo models, selected from the 15 to 20 given in the block adjustment.
- An average of 20 survey monument locations appearing on each sheet.

All of this data was available on computer-compatible magnetic tape, so it seemed logical to assume that manuscripts could be derived on a computer-driven flat bed plotter more accurately, efficiently and therefore more economically. Unfortunately however, the data was not in the most convenient format for computer searching, and production costs were considerably higher than for manual preparation. Time and lack of software did not permit merging or re-formatting the data to take advantage of the automated process on subsequent contracts.

THE MOSAICING OPERATION

Initially, we experimented with film mosaicing techniques, but eventually abandoned this process due to tone matching problems and the high costs involved. Paper print mosaicing was next attempted using silver stabilization process paper, but tonal range left something to be desired, and paper stability was not the best. Next we tried polycontrast papers, but this requires much experience and skill. Standard multi-grade enlarging paper on resin coated stable base material proved most suitable, and for a time we developed this in an automatic processor. Eventually, however, we found that hand processing enabled better tone matching, more quickly and with much less waste.

Photo mounting techniques that were attempted included wax, rubber cement, standard photo glues and others, until we finally settled on a spray adhesive. The base for mosaicing was originally a separate control plot, but ultimately became

a duplicate film made from the stereo-compiled manuscript.

A number of films were tested for copying the mosaic laydown with a variety of developers, comparing machine processing with hand development. Once a constant density and contrast range of the mosaic prints was established, a standard continuous tone film using machine-developing provided a satisfactory quality copy negative, most efficiently.

THE DRAFTING PHASE

Initially, we tried printing the orthophoto map image on photo sensitized scribecoat material, but the lack of *see through* quality made tracing the contours difficult. We then attempted printing the orthophoto image on yellow scribecoat using Kwik-proof sensitizers, but later encountered photo reproduction problems due to the properties of the yellow coating. Eventually, we settled on conventional tracing techniques using a rust scribecoat.

A production technique was developed for scribing grids and sheet corners quickly and precisely, using the co-ordinatograph. Further experiments on the co-ordinatograph led to a fast, precise method of producing the masks or windows required for the orthophoto copy negatives, based on each east-west line of map sheets.

THE FINAL REPRODUCTION PHASE

Reproduction of the final end product involved the following materials:

- A photographic halftone proof print of the complete orthophoto sheet for checking by the client.
- Two combined halftone negatives of each full map sheet.
- Five positive matte copies, comprising three contour sheets, one planimetric copy, and one property map sheet.

Each product involved in this final phase required the greatest amount of experimental work by combining various halftone screens with a number of film and chemistry combinations to retain as much detail as possible, together with uniform tone.

In summary, the time and effort involved in developing these techniques required almost one year, and added about 25 per cent to costs, including training of staff. Needless to say, our first contract for about 200 map sheets was a costly venture, but the experience gained was used to advantage on subsequent contracts. And in retrospect, our equipment selection might have been different if we had developed the methodology first, but this was not possible nor practical.

Further research is required, however, to develop a total density control system through the entire orthophoto mapping process. Ideally, complete densitometric monitoring should be carried out through all mosaicing and reproduction stages. The use of light intergrators, calibrated transmission and reflection densitometers, as well as automatic monitoring and replenishment controls of film pro-

cessing equipment, would ensure consistent results. Only in this way can the optimum exposure and photographic processing be determined to achieve maximum fidelity of detail with uniform tonal qualities.

Finally, I might add a few words about our current Research and Development program, related to the Gestalt, covering two areas in particular, digital terrain models and stereomates.

Over the past 10 years, computer modelling and computer-assisted design techniques have had a major affect on all branches of engineering. In terrain-related fields however, these developments have lagged, due primarily to ineffective methods of representing the terrain surface for computer processing.

Considerable work has been carried out in programming for design calculations after the route or site has been selected, but the ability to choose alternatives has been limited due to the prohibitive cost of extracting data of sufficient accuracy and density to represent the entire area of interest.

Gestalt digital terrain models provide a solution and can make a major contribution toward more efficient land use and construction planning. Our major R & D interest for the next year or two will be concerned with continuing development of user oriented applications software for interactive design using DTM's.

The second area relates to stereomates which were developed successfully on the Gestalt some three years ago, working in conjunction with the Photogrammetric Division of the National Research Council. Stereo-orthophoto pairs should prove to be of great value in field work and for mapping in developing countries. Cadastral mapping using stereomates is presently being carried out in Colombia for example. Further applications need to be explored and additional developmental work will be required in this area.

APPENDIX F

RESEARCH AND DEVELOPMENT CAPABILITIES IN THE GRAPHICS DIVISION OF SYSTEMHOUSE LTD.

By

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ABSTRACT

Systemhouse Ltd. (SHL) is involved in the field of surveying and mapping and the appropriate and services are briefly described. Development within the Graphics Division is examined in relation to the product areas, and the development resources are summarized. The particular orientation of development to user requirements at SHL and the application of this approach to SHL graphic product plans is outlined.

SUMMARY

Systemhouse Ltd. is involved in the field of surveying and mapping and the appropriate products and services are briefly described. Development within the graphics division is examined in relation to the product areas, and the development resources are summarized.

The particular orientation of development to user requirements at SHL and the application of this approach to SHL graphic product plans is outlined.

INTRODUCTION TO SHL

Founded in Ottawa in 1974, SHL provides a comprehensive range of computer consulting, design and implementation services. With offices across Canada and a total staff approaching 500, SHL is now ranked as number one in computer consulting and programming by the Canadian user community.

THE GRAPHICS DIVISION

SHL has been engaged, since its foundation, in the development of systems for automated cartography, initially with the system known as AUTOMAP for the Australian Army Survey, and the AUTOMAP II Systems for resource and thematic mapping in the Canadian federal government.

From our foundation, we have taken an end-user solution-oriented approach to specific requirements; designing and implementing solutions where none previously existed or custom-implementing specific solutions that are more cost-effective than existing general purpose or package facilities. We recognized at an early stage that many of these solutions had broader market implications and we are now determined to develop and support certain appropriate activities on a product basis. Automated mapping is one such activity.

MAPPING PRODUCTS

Prior to the formation by SHL of a specific graphics product group, SHL had designed and implemented a series of interactive map compilation and editing systems known as AUTOMAP, AUTOMAP II, and AUTOCHART. Similar in general nature, these systems were designed respectively for topographic map compilation; revision and production publishing; natural resource and thematic map compilation; manipulation and interaction; and nautical data compilation and chart composition.

Input to these systems is in the form of aerial photographs, compilation manuscripts, and digitally-encoded survey and remote sensing data files.

Output is in the form of graphic displays, plots and print masters or colour separations for publishing.

Each system maintains on and off-line graphic data bases and several interface-to-external, large, geographic data base systems.

Recognizing the potential for the analytical stereoplotter in the broad area of aerial survey and photocompilation, we have become involved in the upgrading of existing analytical plotters to suit them to interactive mapping and more recently, in the provision of a new analytical stereoplotter designed for the commercial survey and mapping market. This stereoplotter, known as AUTOPLOT, is cost-competitive with the widely used mechanical stereoplotter instruments.

AREAS OF DEVELOPMENT

We are continuing our work in the field of integrated mapping systems, applying interactive and realtime computer processing techniques to the photogrammetric, photocompilation and editing procedures and to map and document presentation for general display and the printing process. In addition to consolidating and enhancing our most recent system development, AUTOCHART, we are developing specific techniques and capabilities appropriate to specific mapping and graphic application areas.

We are attempting to improve productivity and 'throughput' in document digitization and are continuously evaluating new techniques with potential for automatic operation.

In this context, we are prepared to develop and manufacture specific instruments and devices - normally computer oriented - where our investigations show the techniques and application to be cost-effective and an improvement over previous methods.

The current outstanding example of this is our development of AUTOPLOT. This development is continuing with respect to the instrumentation itself, the software for each of the potential instrument applications and on a systems basis, integration of AUTOPLOT with the interactive data processing facilities of AUTOMAP/AUTOCHART.

Options to AUTOPLOT are being produced to meet the requirements of the military and specific government agencies.

DEVELOPMENT FACILITIES

In addition to our very extensive computer systems and programming design staff capability, we have installed in-house, a minicomputer development system, and shortly, will have installed a second system. Both systems will be used for our graphics system and the development of application software and testing.

We operate mechanical and electronic design and development workshop facilities with the capability for prototype production and testing and the preparation of full production manufacturing specifications and documentation.

The mechanical workshop is oriented to our development of analytical stereoplotters, mechanical interfacing to photogrammetric instrumentation and plotting equipment and product packaging. Similarly, the electronic facility is oriented to stereoplotter control, electronic instrument and peripheral interfacing. Our electronic work is strongly microprocessor-oriented and it is perhaps of interest that we have successfully involved our software staff and facilities extensively in the microcode development and testing processes.

This facility, which is undergoing extensive expansion, is additionally supported through operating arrangements with a number of local Canadian design and development organizations which have specialized expertise in areas complementary to our own.

METHOD OF DEVELOPMENT

The success of our involvement as computer systems engineers and programmers in photogrammetric and cartographic applications results from our attempts to gain a detailed understanding of the users' requirements and a joint approach in the preparation of the detailed specifications for implementation. This approach of early user interaction with our designs has resulted in excellent individual or custom implementations: can we use it successfully for the development of products for the general market? We believe we can, and have begun the formation of a two-tier approach to user specialist involvement in our development program.

First, we are creating an Advisory Board to be comprised of senior members of the photogrammetric, cartographic and other professions. Board members will assist us in the foundation and monitoring of our development program and of the resultant products and facilities.

Secondly, we are selecting, for each product or facility being developed, a small, but representative group of user organizations which will collaborate with our designers during design and development, carry out operator evaluation of the prototype versions and provide us with on-going operational performance feedback.

CONCLUSIONS

For a company whose major resource is people and one with an extraordinary rate of sustained growth (from 20 to 500 in five years), it is remarkable that we should branch out into product development, and perhaps even more remarkable that mapping should be one of the product areas. Stated simply,

this field offers great opportunity for the application of computer and graphic techniques and an intriguing challenge to develop and apply computer and electronic state-of-the-art.

We at Systemhouse Ltd. are however, heavily results-oriented and while our commitment to development in the mapping area is long-term, it is our present intention to confine activities to relatively short-term (up to 1 year) goals.

APPENDIX G

NEEDS FOR R&D IN SURVEY INTEGRATION AND LARGE SCALE MAPPING

By

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ABSTRACT

The increasing need for integration of surveys and for large scale maps as a prelude to a computerized land-related information system has placed demands on provincial and municipal surveying and mapping agencies. These agencies require research and development of systems and techniques oriented to this larger scale and to the type of data to be collected. This paper identifies some of the areas of concern at the provincial level in the field of survey control.

ABSTRACT

The increasing need for integration of surveys and for large scale maps as a prelude to computerized land-related information systems has placed demands on provincial and municipal surveying and mapping agencies which require research and development of systems and techniques oriented to this larger scale and to the type of data to be collected. This presentation identifies some of the areas of concern at the provincial level in the field of survey control.

The role of most provincial surveying and mapping agencies has dramatically changed in the last decade from one of dependency on the federal agency for technical support to one of implementing provincial programs to complement those of the federal agency. The evolvement of provincial competence in this field has been significantly assisted by the federal Surveys and Mapping Branch policy of joint project planning and implementation and of providing technical advice on request. By this process, our provincial agency has had the opportunity of adopting federal standards, field procedures and computing processes without the major costs of research and development.

Demands on provincial and municipal agencies will continue to increase for densification of the geodetic base; standardization and production of provincially and municipally oriented medium and large scale maps; planning and adoption of geo-referenced land related information systems; integration of land survey systems and other programs designed to achieve provincial objectives. The scale of these programs becomes larger at a provincial level and larger again at the municipal level. Inherent in these changes in scale is a need for revised field and office procedures, which raises the question of the proper role of a provincial agency in research and development. To illustrate this concern we need only to look at the proliferation of automated drafting and mapping systems being independently researched and acquired by municipalities, surveying and engineering firms and larger companies. Most are being installed to overcome an internal drafting bottleneck and yet have the potential of playing an important role in future data exchange between industry, municipal governments, provincial governments and the federal government. In this illustration my assessment of the need is in two areas, i.e., research of technology to ensure compatible interface between systems and the development of standards for adoption of common codes.

Another area of interest at the provincial and municipal levels which, due to scale, may not be as high priority at the federal level, is the production of orthophoto maps. These have the potential of being important parts of a large and a medium scale map series but do not have broad user acceptance. I attribute this to the loss of quality of image resulting from conventional methods of production from the original photography through to the printed map stage. The potential exists to retain most of the original photo quality of the image by development of scanning techniques to map production rather than conventional screened photo-lab processes.

The integration of land survey systems in an overall provincial coordinate system is another example of an area of more concern at the provincial and municipal levels than at the federal level. This subject will be of major importance in the next few years as people who are not directly involved in surveying and mapping but who have an interest in land related information systems become more familiar with the significance of the relationship between land related data and land ownership and boundaries.

I have used the above few examples to illustrate a need for research and development at the provincial and municipal levels where it may not exist or may be of low priority at a federal level and, which results from the emphasis being given in most provinces to programs in the surveying and mapping field for accurate and up-to-date information.

The invitation to present this paper proposed the subject of *survey control*, so I will confine my remarks to this area, recognizing that, as a provincial surveying and mapping agency, we have an interest in research and development in the areas of land surveying and mapping as well. In this field, we have, as a provincial objective, the completion by 1988 of a monumented geodetic base with a spacing of monuments every 20 kilometres. Additionally, urban areas having a population over 3000 and other identified growth centres are to be monumented to a density of a monument every 300-500 metres. Urban fringe areas are to be to a density of 1000-2000 metres. Related programs include simultaneously tying in the land survey system and deriving coordinates for land boundaries represented by it, aerial photography at a 1:50 000 (and larger) scale, aerial triangulation and mathematical adjustment, and commencement of 1:20 000 (and larger) mapping. These programs are planned cooperatively with the federal Surveys and Mapping Branch and much valued assistance is being received from them in planning and carrying out the programs. There is a need however, to find more economical or more precise ways of achieving the results and these are identified as follows:

- Monumentation - much of the work is in isolated areas requiring helicopter transportation. We are continually searching for a monument design which will be stable horizontally and vertically and yet easily transported and installed, at minimal cost.

- Targetting - Our present approach is to lay out targets at the monumentation stage and arrange for identification photography at a scale of 1:15 000 - 1:20 000. If the survey technique is a helicopter-mounted inertial survey system, targets must be in place and secure enough to withstand the helicopter landing at the time of survey. Commonly used plastic film targetting material is not degradable and must be recovered for environmental protection. The need is for a process that requires only one trip to the site.

- Survey Technique - While inertial survey systems have the advantage of being capable of covering large areas in a relatively short time, they require landing sites at approximately a 10 kilometre spacing. Our survey requirement is 20 kilometre spacing. The results are extra costs in preparing landing sites that, in isolated areas, are significant. Our need is to develop a method of spanning up to 20 kilometres without landing for the ZUPT. points.

The Doppler Satellite technique is capable of providing positions for a 20 kilometre grid but is relatively slow and may not provide the desirable accuracy vertically in all cases. The need is for development of higher precision and faster production, at less cost.

Other survey techniques have potential for this type of work and require further research and development. An example is the possibility of multi-lateration using lasers and aerial platforms such as balloons, fixed wing aircraft or helicopters.

- Aerial Photography and Triangulation - This process could be significantly improved upon by developing a technique for determining the precise coordinates of the camera at the time of exposure. Possibilities exist in conjunction with the preceding paragraph regarding a multi-lateration process for survey positioning using a fixed wing aircraft.

- Records Management - Considerable effort and cost go into the computing and records management area. It is particularly important that a system be developed that will readily permit recomputation of positions from original field data as software is improved and that will have the flexibility of handling re-adjustments to a new datum or to a re-adjusted primary net. The need is to avoid independently doing this type of research and development in all provinces if a common system can be developed that is satisfactory to all.

There is a continuing role for the three levels of government, the universities and industry in research and development. The need is for co-ordination of effort to minimize duplication and to ensure that the results are known to all users. It is recommended that the feasibility of establishing a *Canadian Surveying and Mapping Institute* to fulfill this co-ordinating function be explored. Such an institute would have the potential of drawing on the expertise available in all sectors and could serve as a clearing house for proposed projects. Funding could be by a combination of grants and recovery of costs for specific projects undertaken on a contract basis. Joint funding by provincial agencies of research and development of systems and procedures of common need is desirable. It is hoped that one of the results of this conference will be recommendations on the alternatives in achieving this.

APPENDIX H

REQUIREMENTS FOR R&D IN SURVEY CONTROL

By

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ABSTRACT

The 1983 North American Readjustment and Redefinition will present new concerns and problems to the smaller survey agencies. The National Capital Commission (N.C.C.) is representative of these smaller agencies, and some of their concerns are presented in this paper. They are, for example, heavily committed to the establishment and utilization of survey control. One of the big problems will be to develop clear arguments in favour of converting existing control records to a new datum. The cost of not converting versus the cost of converting must be determined.

SURVEY CONTROL

When offered the opportunity of a few minutes before a captive audience such as this, I hesitated only long enough to give the appearance of modesty, but, in truth, welcomed the chance to state one of the problems of an organization heavily committed to the installation and application of survey control based on the 1927 North American datum. The degree of involvement at N.C.C. is neither the smallest nor the largest in Canada, but our concerns are similar to those of others.

To be brief, we have gone the traditional route. Through the good services of the Surveys and Mapping Branch, EMR we were provided with ample first order control ready for breakdown into second and third order networks. Until we could assemble the necessary expertise and equipment, the Branch even did our second order work, but now we are reasonably independent and are glad to extend cooperation and assistance to municipal organizations within our 4600 sq. kilometre geographic region. Though no formal "pecking order" exists, my organization tends to set the standards, develop the yearly programs, and generally maintain the records for the Ontario portion of the region. We will continue to do so until the province of Ontario organizes itself to the level achieved by the province of Québec. It would be fair to claim that the survey control throughout our region (Ontario & Québec) is of a consistent quality thanks to regular contact among the organizations active in and concerned about the control survey principles.

So, what is the problem? What requires any serious research and development attention? Behind the general appearance of orderliness lurks the potential of confusion that will at best cause controversy and confusion; at worst, could destroy the effectiveness of our expensive asset. The problem is how to accommodate to the 1983 North American Readjustment and Redefinition. If the answer is a simple negative "no change necessary" on receipt of new and better values for existing first order control then, for the time being, we simply carry on. But we know that life has a harsh way of dealing with those who choose to ignore the winds of change indefinitely. We at least owe to those who are labouring on the N.A.R. the courtesy of investigating the technical, managerial and economic problems of using the fruits of their labours.

What can producers of research and development do?

1. TECHNICAL

My organization will have about 1700 second order and 3300 third order monuments in place by 1983. In addition, we will have coordinate values on about 16 500 legal survey monuments, published on survey plans on public record in the Registry Office. Cost to date is about $2 000 000.

We require an accurate, dependable computerized method of converting the above northings and eastings to corresponding northings and eastings on the new datum. At the grass roots level, there will be need for simplified programming capable of field use with handheld calculators. Long before 1983, we will need to know

that this can be done and the time frame and dollars required to implement it. I understand that the nucleus of a program exists now, called ESTPM at EMR but that it needs developing and testing. Could the research and development community do this - and will there be direct user's costs involved?

2. MANAGERIAL

I supsect this is a much more difficult task. Survey control has been sold on the basis of permanent referencing. To encourage utilization of control, station values have been widely distributed and are an integral part of both the manual and computer based records in many offices. In some organizations they were accepted reluctantly and labelled unnecessary at least until experience was gained. Even if there were no financial costs suggested, and "new values" were simply provided, the task of reorganizing data is going to seem to be a heavy burden and a very unproductive one at that. What is needed from the research and development community? We need some advice on what data must be converted and all the good reasons why it must. This country has been exposed to a program of metric conversion whose characteristics are somewhat similar to our problem. Experience gained and methods used might well apply. If people believe in something they will make it work. There is a big task ahead in developing clear arguments in favour of converting existing workable records to a new datum which will no doubt be changed again.

3. ECONOMICS

The cost of *not converting* versus the cost of *converting* needs to be determined and would no doubt be analyzed during the execution of the above two assignments. With increasing emphasis on justifying expenditures in competition with strident demands for expenditures on an endless list of worthy projects, anything other than nominal or "housekeeping" costs must be identified and justified. Could some cost accountants do some research and development work well in advance of 1983?

So far, I have referred only to the N.A.R. as the reason for changing coordinate values of survey control monuments. For many of us, the trend of some of the provinces towards the national U.T.M. projection in lieu of the current functioning projections is an added possibility. Needless to say, if changes are necessary, or mandatory, all changes should occur simultaneously.

At the risk of some exaggeration, but as a measure of the nature of our problem, let us consider the following analogy. Think of your home town with its existing street pattern, street names and house numbers. Without changing the physical position or characteristics of any of the houses, suppose that someone decreed that some administrative changes were necessary. These were simply to change every street name and every house number. The easy part would be to reprint the street signs and replace the numbers on each house. This is the solution to the technical problem. The solution to the managerial problem involves the revision of all the telephone directories, the commercial and personal mailing lists, the records of all the drivers' licenses, car ownership and taxation records and on and on. The Post Office would be faced with a

massive problem of coping with new and old addresses while the general public was preparing the new address lists. The potential confusion boggles the mind and it would seem likely that the administrators who inflicted the policy on the nation might well find themselves out of office.

In our case we have four years, minimum, in which to assess and solve problems and we need all the help we can get. Will the research and development community help us?

APPENDIX I

POSITION DETERMINATION DEVICES

By

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ABSTRACT

The requirement is stated for the development of position-determining devices that can produce survey control which is accurate and economical enough for large-scale mapping (e.g. 1:2 000) and survey system projects. Such devices would reduce the current dependency on time-consuming, expensive and inefficient survey methods.

The Surveys and Mapping Branch of Manitoba executes control surveys, either directly or indirectly, by contract, to support provincial mapping programs and to develop a provincial control survey system.

Small-scale mapping of northern Manitoba is being produced at a scale of 1:20 000 under a DREE program. The positional accuracy requirement for this mapping is ±2 meters at a 95 per cent confidence level for the horizontal ground control and ±1 meter at a 68 per cent confidence level for the vertical ground control.

Large-scale mapping of communities throughout Manitoba is being produced at a scale of 1:2 000 for a number of government agencies. The positional accuracy requirement for this mapping is ±0.2 meter at a 95 per cent confidence level for the horizontal ground control and ±0.1 meter at a 68 per cent confidence level for the vertical ground control.

The provincial control survey system is being developed to form the foundation of a land use information system. Accuracy requirements for surveys under this program are second and third order for horizontal and vertical control, respectively.

The necessary ground control for our small-scale mapping program (DREE 1:20 000) has just recently been completed. Doppler Satellite technology was employed to provide the horizontal ground control. The technique used produced a position determination with a standard deviation of approximately 0.7 meter, at a cost of approximately $4000. per point in 1978 dollars. In comparison, had the horizontal ground control been established using the conventional tellurometer traverse technique, the survey would have cost 2½ to 3½ times as much.

Control surveys for our large-scale mapping program and provincial control survey system are still being executed by employing conventional instrumentation, that is, the theodolite and EDM equipment. Utilization of such instruments is, however, restrictive upon the survey. Many monuments are placed in an insecure and/or unsuitable location in order to accommodate the physical limitations of this mode of survey. In addition, such surveys are time-consuming and dependent upon a large contingency of manpower. The result is an expensive, inefficient survey.

Because of accuracy requirements, today's available *Positioning Determination Devices* cannot be utilized for large-scale mapping and control survey system projects. If however, the required accuracy could be produced, savings in time and money would be realized. It is therefore recommended that *Research and Development* be applied to achieve *Position Determination Devices* capable of meeting accuracy specifications for large-scale mapping, as is now available for small-scale mapping.

APPENDIX J

BRIEF OUTLINE OF NRC ACTIVITIES IN PHOTOGRAMMETRIC AND RELATED RESEARCH

By

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ABSTRACT

The Photogrammetric Research Section of the National Research Council concentrates on the more long-range, basic research projects and systematically pursues selected goals. This paper describes briefly some of the projects undertaken, and the contribution made to the national and international fields of surveying and mapping. N.R.C. is also offering scientific support to Canadian industry, for example, the initiation of the manufacture of photogrammetric instruments based on domestic inventions.

In Canada, there is an army of about 22 000 people active in the field of surveying and mapping, and the total financial outlay for this activity is about a half billion dollars annually. This impressive figure represents, however, only an initial fragment of the total picture, which should be kept in mind when considering the socio-economic function and importance of surveying and mapping. Competent authors agree *that economic and cultural losses to the country caused by lack of, or inadequate quality of* surveying data and products exceed manifoldly the actual total cost of surveying and mapping operations - which is obvious, and could be demonstrated by many concrete examples.

Moreover, modern science and technology are using measuring methods as developed by geodetic disciplines in scores of other fields, and some of these applications e.g., in medicine, are of vital importance to society.

Research and development can be classified into two basic categories, both of obvious importance:

- long range, more fundamental research concerned primarily with basic problems and methods.

- operational-type research concerned with the adaptation of existing technology to operational needs, including development of efficient production systems, or adaptation of existing methods and instruments for the specific purpose of a production process.

On should not think that there is an overriding importance and need to classify all research projects according to the above categories. Occasionally, it may also be difficult to draw a clear line between two categories of projects. This distinction may help us, however, to better define the role and responsibility of the NRC, which pursues more general scientific and national goals.

As you will see, NRC's main projects belong to the first category of a long range, basic research effort, which systematically pursues selected goals. The scope of this presentation does not permit me to give you any comprehensive description of various projects active at this moment, but instead I will mention some of the typical areas of NRC activities.

1. Even before electronic computers were developed, the Photogrammetric Research Section embarked on systematic research and development of so-called *Analytical Photogrammetry*. Our small research group (19 persons at present) became a leading centre, pioneering the photogrammetric determination of ground control (one of the basic problems in mapping) initially by strip triangulation and later on, developing triangulation in blocks with corresponding adjustment procedures. About 200 mapping centres and agencies have been, and many still are, using the basic NRC formulations with the newest updates.

2. An extension of this intense preoccupation with analytical methods was the invention at NRC in 1957 of the so-called Analytical Plotter. This was, no doubt, one of the most revolutionary developments in photogrammetry since its inception, which drastically changes most present photogrammetric

technology in general. I will come back to this subject later in this outline.

3. There are many consequences of the introduction of the Analytical Plotter. One of them was the brilliant concept and development of the Gestalt Mapper by private industry in Canada. Another is the development of so-called *on-line analytical triangulation*, which puts the photogrammetric determination of ground control on quite a different footing. ISP created a special study group on the subject, for which scientists from NRC assume responsibility.
In passing, one should note that another revolutionary development in Canada was the invention of the *automatic image correlater*. Many present advanced mapping and cartographic processes are based on these two inventions.

4. The versatile laboratory facilities and general climate of scientific research at the NRC have been conducive to a number of research and development projects which require this kind of environment. As an example, one might mention the development of the Air-borne Profile Recorder (APR) technique and instruments subsequently used extensively in Canadian and foreign mapping operations. This early post-war development has been extended to the development of specialized APR equipment used in forestry work. Working together with the map-making industry, the newest prototype of the NRC-APR equipment is being prepared for test flights and evaluation, using the powerful ANAPLOT and computational approach in processing APR data.

5. In a different field, NRC scientists have formulated the theory and practical proceedings for correcting the distances measured by electro-magnetic means for the effect of atmospheric refraction. These methods have been approved by the International Geodetic Union and are quoted, often in extenso, in leading geodetic textbooks.
Basic mathematical formulations can be extended to other non-conventional mapping operations. Using these approaches and various theoretical work carried out in its laboratories, NRC has established very useful cooperation within and outside of the topographical field with a number of Canadian industries, research laboratories, the Canada Centre for Remote Sensing, Statistics Canada, the Department of Transport, universities and hospitals. Projects in this area have covered such diversified subjects as the determination of parameters relevant to airplane accidents, critical measurements in nuclear power plants, development of suitable mapping techniques for statistical purposes, development of photogrammetric measuring techniques in support of medical diagnostic processes and biological studies, determination of critical parameters in the development of elastic safety barriers along the highways.

6. Novel ideas are often too new to be properly understood and embraced by practising users, particularly if these ideas are not promoted by powerful, and in our case, foreign idustries. However, interest is rapidly growing in the so-called *stereo-orthophoto* concept developed at NRC, due to its simplicity and unique adaptability to general mapping requirements. A large pilot project in the field of cadastral land inventory based on this

novel technique in Colombia, South America, is being instituted jointly by the Colombian and Canadian governments. However, a number of other countries and mapping centres are interested in this approach, and further development in this field can be expected.

7. Another example of NRC research efforts in this general field is the photogrammetric unit at the Department of Indian and Northern Affairs, concerned exclusively with the recording and maintenance of historical sites. This unit, established with NRC help, lives its own life but is in frequent consultation and cooperation with the NRC. Another very advanced photogrammetric technique developed in connection with the NASA space program is an automatic and on-line, 30-times-a-second, monitoring and control of complex docking manoeuvring between space platform and shuttle aircraft. As one can imagine, this highly automated technique could have important industrial applications in the area of remote manipulation of objects.

8. A different, *non-cartographic* project under development, which has already resulted in a remarkable national and international impact and has led to new instrument manufacturing activity, is the Moiré screening technique for spine deformation. Thousands of school children are presently being screened for this dreadful disease in Canada, U.S.A. and Japan, with other countries to follow.

9. Another important field of research activity, for which NRC is well-known internationally, is concerned with the basic geometry of aerial photographs. Precise knowledge of optical and metric characteristics of aerial photographs is essential for proper use and further progress of photogrammetric technique. The NRC has developed and operates excellent camera calibration facilities, basic to Canadian (domestic and foreign) mapping operations, for further studies in this complex area. In recognition of the unique Canadian contribution in this field, the International Society for Photogrammetry has asked the NRC to assume responsibility for pertinent studies conducted by an international working group specifically established for the purpose.

10. Photogrammetry is only one of the surveying and mapping (geodetic) disciplines and consequently a meaningful research program must view the photogrammetric methods and techniques in the broad context of general surveying and mapping. NRC scientists have made and are continuing to make contributions in the broad field of surveying and mapping, of which photogrammetry is an essential part. In particular, they have formulated integrated surveying and mapping activities at large scales, including cadastre, for which provinces and municipalities (urban surveying) assume responsibility. A large number of articles and publications in book form dwell on pertinent questions and a number of Canadian and foreign, regional and central authorities have sought the advice of NRC experts in this extremely important area. NRC scientists have also been instrumental in organizing numerous local, national, foreign, panamerican and international conferences concerned with modern concepts and technology in the general surveying and mapping field.

11. In this brief outline, I have mentioned only some examples of NRC photogrammetric research project versatility, in the assumption that these examples will permit the reader to create a more comprehensive image of NRC's role and effort in the field of photogrammetric and related research.

In addition to its own scientific effort, the NRC is also expected to offer scientific support to Canadian industry. This has been the case from the very beginning in the field of photogrammetry as far as the large and very vital map-making industry is concerned. Considerable effort, however, has also been spent to initiate in Canada the manufacture of photogrammetric instruments, based on original, domestic inventions. The quality and number of these inventions is most impressive, but their conversion into domestic instrument manufacturing activity has been rather slow. After several ups and down and various manufacturing programs based in part or totally on NRC inventions and concepts, encouraging progress in this area is evident. Using as a vehicle special NRC industry-oriented programs, NRC has signed cooperation agreements or has otherwise entered into close cooperation with manufacturers eager to further develop and manufacture instruments. This difficult effort represents a logical extension of scientific work and achievement, which, when systematically pursued, will demonstrate the unique value of scientific work in the economic development of the country.

APPENDIX K

GEODETIC RESEARCH AND DEVELOPMENT CAPABILITIES AND POTENTIAL OF SHELL CANADA RESOURCES LIMITED

By

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ABSTRACT

Orbiting artificial satellites and inertial guidance systems have opened up new possibilities in establishing accurate ground coordinates more efficiently for many purposes. This paper describes briefly how Shell Canada Resources Limited seized the opportunity to lead in the development of new technologies in surveying, particularly in software development for satellite and inertial survey systems.

INTRODUCTION

The declassification in 1967 of the U.S. Navy Navigation Satellite System developed by the Applied Physics Laboratory of John Hopkins University, Baltimore, provided a new and distinct challenge not only for the geodetic community but for industry, manufacturers and government agencies. Artificial orbiting objects in space provided a clear objective in opening up the possibilities of establishing highly precise co-ordinates anywhere on the earth's surface.

The Doppler Satellite System provided a clearly defined challenge to a country such as Canada. Our large land mass, together with a continental shelf extending several hundred miles offshore, coupled with remote unpopulated areas, lends itself well to space geodesy. More recent developments indicated that inertial guidance systems and the proposed Global Positioning System would play an even greater part in the surveying and mapping community. At the outset it became apparent that in order to develop these new technologies, considerable resources and devotion by the best Canadian geodetic expertise would be required before Canada could effectively utilize their concepts for control surveys.

ACQUISITION OF FUNDS FOR R&D IN SURVEYING AND MAPPING

During 1968, a basic change in allocation of funds by Shell Canada was undertaken that paved the way towards accommodating application orientated R&D associated with surveying. This basic change led to the acquisition of the first satellite receiver in Canada during early 1968.

After about three years of intensive work, a major capability in the area of space geodesy became apparent. The program led to the development of a rigorous three dimensional satellite program during 1971 titled 'Shell 3535'. Although many refinements have been implemented to the program now known as GEODOP, the basic concept is still valid and in wide use today.

EMR POLICY STATEMENT 1972

In harmony with the Policy Statement on R&D issued by EMR in 1972, which basically requested industry to undertake a more active role in application development and research towards Canadian needs, Shell Canada agreed internally to make a firm committment towards surveying R&D programs on a yearly basis.

LEVEL OF R&D TOWARDS SURVEYING AND MAPPING

Since 1972 approximately $300 000. per year has been devoted towards surveying and mapping R&D technologies. The above amount includes hardware acquisitions and represents approximately 7 per cent of the surveying operating budget per year. The acquisition of inertial technology has had a considerable impact on level of effort since 1976. We anticipate that new systems such as GPS will require a continued level of effort over the next five years.

CAPABILITIES

Shell has strong software capabilities in the area of control surveys. Some of the major developments include the following:

1) Remote Data Acquisition Systems

Two years ago, Shell designed the interface which permits the retrieval of raw satellite field data from a remote location, to airplanes that happen to be within 50 miles or line-of-sight of a particular station. This technique is being successfully used in the Arctic Islands where ice movements are being monitored by Doppler satellite systems.

2) Geoshell 791

This program is basically GEODOP mounted upon a general field computer HP2100 system, and provides the capability of producing final results during field operations in near real time, in any country.

3) ISCAP

Extensive software developments have been successfully carried out in providing computer programs associated with the Ferranti inertial systems. These programs were initially developed by Shell on a Univac 1170 computer and are now being mounted on an HP2100 general purpose system.

HARDWARE INERTIAL SYSTEMS

Shell purchased two inertial systems from Ferranti in 1978 and in January 1979 became the merchant agent for all high precision Ferranti platforms in North America. Three FILS MK II systems have been ordered for delivery in 1979. A complete maintenance and service facility for these inertial systems has been established in Calgary.

HASSELBLAD CAMERA MOUNTING

A technique which permits a helicopter to determine height above ground is under design using a camera mounted beneath the helicopter, and taking photographs while hovering above the target.

CONCLUSION

Increased effort and encouragement is required in order to develop the potential of the surveying and mapping industry.

Although some software developments have originated in Canada, very little hardware development has been accomplished locally. Further attention must be given to providing forms of incentive programs which would encourage continued investigation towards research in surveying and mapping industries.

APPENDIX L

RESEARCH AND DEVELOPMENT CAPABILITIES AND POTENTIAL OF THE GEODETIC SURVEY OF CANADA IN THE 1980's

By

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ABSTRACT

The current objectives and resources of the Geodetic Survey are described, together with users of Geodetic Survey's outputs. Allocation of resources to be devoted to geodetic R & D in the forthcoming ten years is treated. Related recommendations of the Task Force on National Surveying and Mapping are followed to a large extent. Objectives and outputs of major geodetic R & D projects are given. Contracting out of geodetic R & D, and cooperation with institutions involved in geodetic R & D are discussed. Related proposals are put forward.

INTRODUCTION

The Geodetic Survey Division of the Surveys & Mapping Branch is responsible for carrying out the Geodetic Service of the Earth Science Services Program of the federal government. The objective of this service is to ensure the availability of geodetic information concerning the Canadian landmass, with emphasis on the provision of a national reference network. This objective is realized through (1) the establishment and maintenance of the basic national geodetic control systems of monumented control stations, positioned accurately in latitude, longitude and elevation, (2) the management and maintenance of a geodetic control data base and (3) the provision of control survey information. The Geodetic Service also includes, as a sub-activity, the provision of related professional advice in geodesy, for use by governments, industries and the public. The organizational structure of the Geodetic Survey Division is described in *(Surveys & Mapping Branch 1977)*.

Users of the Geodetic Service outputs are (1) other Earth Science Services such as the Topographic Service *(Zarzycki 1979)*, Land Boundary Service, Earth Physics Service, (2) other programs of the federal government such as the Energy Program, Land Management and Development Program, Fisheries and Marine Program, and various Transportation Programs, (3) services of provincial governments such as provincial surveys and mapping branches or equivalent, (4) industries such as private surveys and mapping firms and (5) the public at large. Geodetic needs for Canada were discussed by various authors (Blackie, Gale, Godin, Krakiwsky & Vaníček, Simpson & Lennox, and Walcott) at the Geodesy for Canada Conference held in Ottawa in 1974 *(Surveys & Mapping Branch 1974)*.

In the fiscal year ending March 31, 1979, the operating budget of the Geodetic Service was $7094 K. The authorized man-years for the same fiscal year were 185.

RESOURCES TO BE DEVOTED TO R&D

During the past 10 years, 1 per cent to 3 per cent of Geodetic Survey's resources has been devoted to R&D, the variation in the above figures depending upon the manner in which R&D is defined. However, in view of the use of increasingly complex technologies in geodesy such as satellite and inertial positioning, the above allocation has, in recent years, been found insufficient in order to improve greatly the cost-effectiveness of geodetic operations using modern technologies. The Task Force on National Surveying and Mapping *(Lapp et al., 1978)* recently recommended that the Surveys & Mapping Branch conduct a strong and

viable R&D program designed and directed toward the solution of medium and long-range Branch problems. It called for a minimum allocation of 5 per cent of the operating budget of R&D. In the case of the Geodetic Service, this would mean an increase of 2 per cent to 3 per cent.

The Geodetic Survey Division, in trying to apply the recommendations of the Task Force on National Surveying and Mapping, will attempt, in the next 10 years, to allocate about 5 per cent of its operating budget to geodetic R&D. This will depend in part on the availability of extra funds. In 78/79 dollars, this translates into an annual expenditure of about $350K, which includes salaries of researchers and operations and materials (OM) expenditures. OM, in the case of geodetic R&D, consists of computer cost and research contracts to universities and industry which will be treated in a forthcoming Section on CONTRACTING OUT GEODETIC R&D.

An attempt made at allocating the above $350K to various R&D projects related to the Geodetic Service over the next 10 years is summarized in Table 1. The objectives of these projects will be discussed in detail in the next Section. To repeat, estimates given in Table 1 are in FY78/79 dollars and are based on the assumption that 5 per cent of the Geodetic Service operating budget will be devoted to R&D. Depending upon the impact of new technologies on the objective of the Geodetic Service, this percentage could be increased as necessary to improve adequately the cost-effectiveness of operations related to that Service. Also, projects and estimates quoted in Table 1 indicate trends and must not be interpreted as divisional policy.

GEODETIC R&D PROJECTS

Geodesy may be divided into three subdisciplines, namely (1) positioning, (2) earth's gravity field and (3) time variations in positions and the earth's gravity field *(Vanicek & Krakiwsky 1978)*. Positioning, which deals with the establishment of control points, is, together with related operations such as positioning data management, by far the most important product of the Geodetic Service. Users of this product, the Topographic Service being the major one, greatly outnumber users of the two other subdisciplines' products.

The earth's gravity field, its modelling being the output, is currently requested by relatively few external users. The major user is, in fact, positioning which uses gravity-related information in order to establish control points using classical methods (e.g., triangulation, traversing, levelling) with greater accuracy. Also, gravity-related information is required when using modern positioning methods such as satellite and inertial. Because of the growing use of these modern positioning methods and the redefinition of horizontal and vertical North American geodetic (classical) networks, the demand for gravity field-related information from external users is expected to increase significantly over the next 10 years. Geodetic Survey has allocated an adequate part of its R&D resources to this subdiscipline for about five years.

The third subdiscipline of geodesy, i.e., time variations in positions and the earth's gravity field, has been given little if any attention by the Geodetic Survey up to now because of very limited demand and difficulties associated with

the evaluation of time variations which call for very accurate measurements. Levelling, for instance, has had the potential accuracy to be used for the evaluation of time variations in vertical positions and limited work has been conducted by the Geodetic Survey in the past *(Frost & Lilly 1966; Gale 1970)*. However, there is a growing demand for very accurate geodetic operations related to the evaluation of time variations in positions which are then used in various disciplines related to geophysics. At present, the Earth Physics Service, provided by the Earth Physics Branch (Department Energy, Mines and Resources) is the major user of outputs related to time variations in positions. Also, the Earth Physics Branch has its own capability in the above suddiscipline of geodesy and any future effort by the Geodetic Survey will undoubtedly be coordinated with that Branch.

The aim of geodetic R&D at Geodetic Survey during the next 10 years will, following the recommendations of the Task Force on National Surveying and Mapping, be designed and directed toward the solution of medium and long-range Branch problems. More specifically, R&D will be directed at improving the accuracy, rapidity and cost-effectiveness of methods related to positioning (control points), earth's gravity field and time variations in position and earth's gravity field with strong emphasis on positioning. Results of this R&D will, of course, be of interest to most external users. Utilizable R&D outputs by these users will consist of (1) more accurate control points established by the Geodetic Survey, (2) more accurate and cost-effective methods related to the three subdisciplines of geodesy described earlier and (3) more accurate and cost-effective methods of processing, including computer software, and handling related survey and geodetic data.

The major geodetic R&D projects forecasted for the next 10 years are listed in Table 1. Each is now described in more detail.

Satellite Positioning - R&D in hardware and software in order to achieve optimal results with current Transit system and forthcoming Global Positioning System. A 10 cm accuracy in x, y and z (tridimensional cartesian geocentric coordinates) is expected with this GPS system within about 10 years. Outputs directly utilizable by external users will be more cost-effective methods and data processing packages (computer programs). R&D is to be carried out partly in-house and partly in universities and industry through contracting out. Contracting out will be discussed in the next Section.

Inertial Positioning - R&D in hardware and software in order to achieve optimal results with current Inertial Survey System and possibly with second generation systems if acquired by the Division. Tridimensional positioning capability to be developed to its full potential. Outputs utilizable by external users as for satellite positioning. R&D to be carried out partly in-house and partly in universities and industry through contracting out.

Gravity Field - Optimal geoid for Canada, at the 10 cm level if possible, in order to convert satellite and inertial-derived ellipsoid heights into sea level heights. Also, geoid and deflections of the vertical required for the NAD83 Redefinition project. Outputs utilizable by external users will be geoid and deflection values at discrete points and/or software packages to evaluate these

quantities. R&D to be carried out mainly in-house.

NAD83 (Horizontal reference system) - R&D related to datum parameters, astronomical corrections, software and analysis. Outputs utilizable by external users will be more accurate and reliable horizontal coordinates and software packages for integration of secondary horizontal networks. To be carried out in-house.

NAD87 (Vertical reference system) - R&D related to datum, software and various aspects of levelling theory such as refraction, error propagations, etc. Outputs utilizable by external users will be more accurate and reliable vertical coordinates and software packages for integration of secondary vertical networks. To be carried out partly in-house and partly contracted out to universities and industry.

Classical Positioning (Triangulation, traversing, levelling, etc.) - R&D on problems mostly related to technological matters such as motorized levelling, automation of field data recording and processing, design of suvey markers, calibration of instruments and baseline determinations. Various outputs will be utlizable by external users. To be partly carried out in-house and partly contracted out to universities and industry.

Others - R&D in aspects other than above, e.g., Very Long Baseline Interferometry, satellite altimetry, etc., that may have an impact on the three subdisciplines of geodesy described earlier. Various outputs may be utilizable by external users.

Since 1976, most geodetic R&D carried out by the Geodetic Survey is reported in *Collected Papers*, an annual publication of the Surveys & Mapping Branch.

CONTRACTING OUT GEODETIC R&D

The Task Force on National Surveying and Mapping recommends that Surveys and Mapping Branch R&D resources be divided equally between in-house, universities and industry in order to accelerate the knowledge transfer process. Geodetic R&D capabilities in the industry, although in a stage of development, are potentially excellent *(e.g., Hittel 1979)*. Geodetic R&D capabilities in universities are already well established. Including the new Department of Surveying at the University of Calgary, there soon will be four universities having good to excellent geodetic R&D capabilities, the three others being Laval, the University of New Brunswick, and Erindale College (University of Toronto). Geodetic Survey intends to implement the recommendation of the Task Force with respect to contracting out insofar as possible. The final resource allocation between in-house, universities and industry will depend upon various factors such as the nature of R&D projects, specific capabilities in above sectors, etc.

In the previous section, under each geodetic R&D project, an indication as to where R&D projects may take place was given. This is very tentative and based on the current situation. Possible transfers of geodetic researchers between Geodetic Survey, universities and industry could alter this situation and the distribution and amount of funds contracted out could change significantly.

COOPERATION WITH PROVINCIAL, FEDERAL AND FOREIGN AGENCIES

Cooperation with universities and industries, which is vital for a prompt knowledge transfer of geodetic R&D, will be maintained through contracting out as discussed in the previous section. It could even be enhanced by a more frequent exchange of researchers between the three sectors. For instance, the Branch Research Committee is examining the possibility of having university graduate students who are involved in departmental research agreements spend a limited period at Branch Headquarters in order to exchange knowledge and ideas with Branch researchers. In a world of scientific interdependence, it is of the utmost importance to have exchanges, both formal and informal, at all levels.

Cooperation with foreign agencies having similar interests in geodesy is maintained through scientific associations such as the American Geophysical Union and the International Association of Geodesy and through personal contacts initiated by researchers during inter-agency visits and at scientific conferences. These contacts and exchanges are very important since they can, and often do result in avoiding the duplication of R&D already carried out by foreign agencies. The status of that cooperation involving Geodetic Survey is generally satisfactory at present.

Cooperation with provincial and other federal agencies in geodetic R&D is presently carried out as above, i.e., through scientific associations such as the Canadian Institute of Surveying and personal contacts. Although such cooperation is generally good, it would seem preferable to have it strengthened by some national body. The objective of this body would be to coordinate geodetic R&D and facilitate transfer of related results between interested provincial and federal survey agencies. The importance of this proposal is enhanced by the fact that many other survey agencies are acquiring signficant geodetic R&D capabilities. The participation of universities and private survey agencies having geodetic R&D capabilities would also be desirable.

CONCLUSIONS

Geodetic R&D to be carried out by the Geodetic Survey over the next 10 years should, if properly integrated with related R&D by universities and other provincial, federal and foreign agencies, be adequate to meet needs of users. This calls for an adequate structure to plan geodetic R&D and exchange its results at the national level.

Instrumental to geodetic R&D is the geodetic researcher. Indeed, no plan nor allocation of R&D resources will produce adequate geodetic R&D without the researcher. He normally acquires his competence at the post-graduate university level, preferably with research experience in the public or private sector. It is therefore vital for the surveying and mapping community to establish policies favouring the development of geodetic researchers to fulfill medium and long range needs. This can only be done with the cooperation of universities, public and private sectors.

TABLE 1

RESOURCE FORECAST (RESEARCH AND DEVELOPMENT) - GEODETIC SURVEY

(in $ '000)

		79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Satellite Positioning	PY[1]	0.5	1	1	1	1	1.5	2	2	2	3
	OM[2]	5	5	25	25	25	25	35	40	40	45
Inertial Positioning	PY	0.5	1	1	1	1	1.5	1.5	1.5	1.5	2
	OM	50	50	25	25	25	25	35	40	40	45
Gravity Field	PY	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	OM	5	5	5	5	5	5	5	5	5	5
NAD83	PY	2	2	2	2	2	1				
	OM	5	5	5	5	5	5				
NAD87	PY	1	1	1	1	1	1	1.5	1.5	1.5	
	OM	35	30	30	30	30	30	20	10	10	
Classical Positioning	PY	1.5	1	1	1	1	1	1	1	1	1
	OM	15	12	12	12	12	12	12	12	12	12
Others	OM		40	45	45	45	45	40	40	40	40
Overhead	PY	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	OM	3	3	3	3	3	3	3	3	3	3
Total	PY	7	7	7	7	7	7	7	7	7	7
	OM	118	150	150	150	150	150	150	150	150	150
Total (in 1979$)		318	350	350	350	350	350	350	350	350	350
EMR Research Agreements in Geodetic R&D		25	25	25	25	25	25	25	25	25	25

[1] PY: Person-Years

[2] OM (in $): Operations and Materials

REFERENCES

FROST, N.H. and J.E. LILLY (1966) *Crustal movement in the Lake St. John area of area of Québec.* Technical report No. GR-5, Surveys and Mapping Branch, Ottawa.

GALE, L.A. (1970) *Geodetic observations for the detection of vertical crustal movement.* Canadian Journal of Earth Sciences, Vol. VII, No. 2.

HITTEL, A. (1979) *Research and Development Capabilities and Potential of Shell Canada.* Paper presented at National Conference on Research and Development in Surveying and Mapping, Ottawa, April 24-25.

LAPP, P.A., A.A. MARSAN and L.J.O'BRIEN (1978) *Report of the Task Force on National Surveying & Mapping.* Report submitted to Surveys & Mapping Branch, Ottawa.

SURVEYS & MAPPING BRANCH (1974) *Geodesy for Canada Conference.* Record of Proceedings, Surveys & Mapping Branch, Ottawa.

SURVEYS & MAPPING BRANCH (1977) *Activités 1977 Activities.* Annual Report, Surveys & Mapping Branch, Ottawa.

VANIČEK, P., and E.J. KRAKIWSKY (1978) *Geodesy Reborn!* Surveying and Mapping (ACSM), Vol. XXXVIII, March issue, pp. 23-26.

ZARZYCKI, J.M. (1979) *Research and Development Capabilities and Potential of the Topographical Survey.* Paper presented at National Conference on Research and Development in Surveying and Mapping, Ottawa, April 24-25.

APPENDIX M

RESEARCH AND DEVELOPMENT IN LAND SURVEYING

By

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ABSTRACT

Research and Development is required in every aspect of the land survey profession. More recently, the invention and development of new ideas and technology has come from outside agencies and has then been introduced into the land survey profession. With our very limited resources for R & D, it is important to choose our projects wisely and prevent false starts.

During the past few years, more technological advances have been made in the land survey industry than in the previous 100 years and it appears that this rate of change is accelerating. R & D in the non-technical aspect of the land survey profession has not been as fortunate and is lagging behind. In the writer's opinion, it is the non-technical area which should receive the major attention for R & D during the next few years. Fairly comprehensive lists of both non-technical and technical R & D requirements are given.

Research and Development (R&D) is required in every aspect and sector of the land survey profession. Successful application and management of the new technologies will assure our transition into the society of the future and be of benefit to our ever increasingly complex community. More recently, the invention and development of new ideas and technology has come from outside agencies and then has been introduced into the land survey profession. With our very limited resources for R&D, it is important to choose our projects wisely and prevent false starts. During the past few years more technological advances have been made in the land survey industry than in the previous 100 years and it appears that this rate of change is accelerating. R&D in the non-technical aspect of the land survey profession has not been as fortunate and is lagging behind. In the writer's opinion, it is the non-technical area which should receive the major attention for R&D during the next few years.

PART I - TECHNICAL

First, a general list in the technical area (in order of priority) where R&D is desirable to further enhance the usefulness of some of the recent technological advances to the land survey profession.

1. Electronic distance and angular measurement instruments including azimuth determination. To make them simpler, sturdier, more reliable, less expensive and more efficient.

2. Further developments in the inertial survey and/or satellite survey systems to provide automatic survey instruments that will give precise position coordinates. The expensive, large and cumbersome "Black Box" is already here - next the small inexpensive mode.

3. Modernization of land information systems through developments in data storage, data processing and retrieval systems, computer technology and computer graphics. This will allow the automatic production of maps and plans showing any selected information including the use and retrieval of any desired data in digital form.

4. Automated drafting and map production techniques, producing maps that will give three dimensional visual terrain and surface details. These details and information can then be extracted using simple and direct methods of measuring distances, elevations and slopes with inexpensive equipment.

5. Remote sensing equipment for mapping land-use and resource inventories, producing an up-to-date readily available map for a variety of users.

6. Development of long-lived portable power sources for use in instruments, computers and communication devices.

7. Development of inexpensive, high capacity communication devices that provide direct field to office, field to computer or office to office communication.

8. New ground, water and air transportation vehicles for easy and inexpensive access to all parts of the surface of the earth.

The various publications indicate that in nearly all of the above items, extensive R&D is being carried on outside the land survey community. This applies particularily to the various military defense agencies whose prime interest is defense preparedness and preserving the peace. Some of the new technology developed in these areas can, with relatively little additional R&D, be applied or adapted to civilian use. Thus, it is important to cultivate and preserve communication links to insure the transfer of information between the military and civilian fields of endeavour. R&D money spent on cultivating this communication link could produce major savings in the overall picture.

Three technical areas more exclusive to the land survey profession where R&D would be beneficial are as follows:

a) Instrument Appraisal

Instrument companies are developing and manufacturing many entirely new or modified survey instruments and devices. The large majority of the land survey firms in Canada are small and thus do not have the resources to fully judge and compare the qualities or worth of these new instruments. R&D money spent on a comprehensive appraisal on a comparative basis would assist many hundreds of land surveyors to spend their money more wisely. It would also keep the instrument companies on their toes and aid them in correcting defects. These appraisals would also be an independent check on the specifications and performance statistics put out by the manufacturer. This appraisal should include the small, simple instruments as well as the large expensive instruments such as the ISS and doppler survey systems.

b) Monuments

A long standing technical item which should receive some immediate attention is in the area of survey monuments. This includes the manufacturing, placing, preservation, finding and use of monuments in all the various survey disciplines. First should be a comprehensive review of existing literature and conditions and then research into the development of inexpensive, easy to find, long-lived, rugged, readily placed monuments for a variety of uses and users.

c) Signals

The development of a light, easily transportable, rugged, inexpensive, easily manufactured sighting rod or signal to hold prisms or reflectors. This device or rod would have to be adjustable for heights of 10' to maybe 100' and be either telescopic or sectionalized and easily erected in timbered areas. Recent developments in small sailing boat masts indicate this task may not be too difficult.

PART II - NON-TECHNICAL

The non-technical area of land surveying should, for the next few years, receive the major attention and the larger share of the funding. The land surveyor

should be assisted in every way possible to adapt to the new technologies and maintain their contribution to society. Some items (in order of priority) which should receive attention are as follows:

1. - Text Book on Survey Law in Canada

Several years ago there was considerable action made towards the development of an authoritative reference text on legal principles and practices of land surveying in Canada. Quoting from one of the reports at that time, the text would contain:

- An historical outline of surveying law.
- English Common Law and the Civil Code.
- Survey systems.
- Rights and interests in land.
- Primary and secondary surveys.
- Registry system and Torrens System.
- Boundaries.
- Drafting of descriptions.
- Rights-of-way.
- Principles of Evidence.
- Survey law in the provinces and territories.
- Survey investigations.
- The role of the land surveyor and his professional and legal responsibilities.
- Legal descriptions of rights in land.
- Use of coordinates in defining property.
- Glossary of legal survey terms.
- Statutes affecting surveys in provinces and territories.
- Survey case law.

The funding put into such a book would be repaid many times in time savings to land surveyors, lawyers, educators and persons dealing in land. With assurance of funding, I am sure the Canadian Institute of Surveying would be pleased to

take on this task.

2. - Education

With increasing urbanization, complexity of the community and the introduction of entirely new technologies, the role and practice of the land surveyor is radically changing. His place in the community will be more than that of a person well skilled in the science of measurement and survey techniques. To fulfill his professional role requires extensive university education, advanced training and much experience. The university and technical school training should keep pace with the changing conditions. Therefore, I suggest that there should be a comprehensive review made of the course content and textbook requirements in Canadian universities and technical schools which provide survey education.

3. - Restructuring

Statutory control and registration of the profession of surveying in Canada is confined to surveys to establish and locate boundaries or corners of parcels of land - *land surveying*. Today, the function and responsibility of the practising surveyor generally goes beyond this narrow field. These safeguards to the public should be extended to cover the other disciplines within the broad field of surveying and mapping. The new Canada Lands Surveys Act and the Board of Examiners for Canada Lands Surveyors have made progress in this direction. Therefore, I would recommend that a comprehensive review and investigation be made into this non-technical area of surveying. Again, the Canadian Institute of Surveying which has active committees in all aspects of surveying might be considered as a vehicle to make this study.

4. - Reciprocity

My recent study of the surveying profession in Canada indicated the remarkable homogeneous nature of the land survey industry despite the diversity of people and regions that make up the Canadian scene. Reciprocity has been talked about for many years amongst the various provincial land survey associations. The Canadian Council of Land Surveyors is actively pursuing this subject. Some R&D funds for use in this non-technical area would be beneficial to the whole industry. The CCLS would be the normal vehicle for such a study.

5. - Offshore

Offshore resources are becoming more important and will in future demand more attention. Canada is fortunate in having an offshore "exclusive economic zone" (EEZ) of some 4.7 million km^2 which will provide extensive resources in the future. I am not by any means an expert in this area, but to assure Canada's future control and sovereignty in this area, extensive surveying and mapping will be required. To quote from a recent examination made by the Research Committee of the Institute of Surveyors of Australia:

> "Maps and charts are a tangible expression of a maritime nation's ownership of its EEZ and its willingness to invest in and use its EEZ rather than merely state ownership".

R&D funds directed into a comprehensive study and review of information systems, land registration, data banks, surveying, mapping, monumentation, the private practitioner, government regulation and control, etc., as applied to the offshore, could be money well spent and should be in place well before the development of this resource commences.

Technological advances in many instances have gone ahead of the non-technical area and this fact is causing concern and perplexity in the land survey community in Canada. A review of the presidents' reports of each of the provincial associations across Canada indicates that many will support this statement. Thus, as mentioned above, it is the non-technical area which should receive the major attention for R&D during the next few years. The thinking that R&D money should go only towards the development of highly sophisticated survey instruments and systems, needs to change. It is the social and cultural aspect of land surveying that needs attention at this point in time.

APPENDIX N

L'INFORMATION FONCIÈRE

by

Gérard Raymond

President, l'Ordre des Arpenteurs - Géomètre
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ABSTRACT

This paper deals with surveyors' needs pertaining to land information in the surveying and mapping context. The gathering and the grouping together of data needed to ensure a healthier, better suited land management are discussed.

The author explains how surveyors see land information, its current and potential use as well as how they would like to see research developed.

Lorsque nous avons accepté de participer à cette conférence du Conseil de Recherche et de Développement pour lui faire part des besoins des arpenteurs-géomètres en matière d'information foncière dans le domaine des levés et de la cartographie, nous savions que ce n'était pas une mince tâche. Nous devons, en quelque sorte, présumer que les opinions que nous allons émettre de même que les principes généraux que nous allons établir conviennent de façon générale à tous les arpenteurs-géomètre canadiens. Mais puisque nous croyons que le sujet revêt un caractère d'universalité incontestable, nous avons pris la décision d'accepter de relever ce défi.

La cartographie d'un territoire constitue bien sûr, l'information de base nécessaire à la connaissance de ce territoire, son image générale, sa configuration générale, sa topographie générale enfin son altimétrie. En outre, quand on a parlé de cartographie, on a de ce fait indiqué qu'une trame géodésique convenablement fournie de points d'ordres inférieurs et de contrôles photogrammétriques constitue également une étape importante dans le processus de connaissance du territoire.

C'est un peu dans cette avenue des données fondamentales que le débat d'aujourd'hui semble vouloir nous guider et l'on peut facilement être tenté d'orienter la discussion sur la cartographie de base, les coordonnées géodésiques, alors que pour nous, l'approche est différente.

Notre préoccupation première étant d'assurer la protection du droit de propriété, nos besoins en information foncière se situent au palier attenant à celui de l'usage de ce droit. Ces grands principes étant clairement établis, voyons maintenant ce qu'il est actuellement de l'information foncière, ce sur quoi elle devrait être assise pour être réellement rentale et enfin comment nous concevons l'aide qui pourrait nous être accordée en la matière.

Par tradition, l'arpenteur-géomètre est le professionnel qui délimite les propriétés publiques et privées, en fait la démarcation, en évalue la superficie et les dimensions, c'est vrai; mais ce n'est pas tout. L'arpenteur-géomètre, dès l'instant où il pose un quelconque acte professionnel, participe à la création de l'information foncière. Certains autres groupes de professionnels participent également à cette production d'information foncière, les municipalités y participent également. Donc, l'information foncière, qu'elle soit numérique, juridique, statistique ou bien graphique elle existe et son volume est fort imposant. Malheureusement elle est aussi fort dispersée et ne peut, pour le moment, servir à grand chose justement parce qu'elle est toute éparpillée et qu'elle dort soit dans des dossiers, soit dans des classeurs.

Pour des fins purement de régie interne et surtout dans le but de faciliter et aussi d'accélérer le service aux clients, L'Ordre formait, il y a 10 ans environ, un comité spécial qu'il chargeait d'étudier la possibilité de regrouper, dans une banque à l'échelle de la province, toutes les données contenues dans les greffes des arpenteurs-géomètres. Par données nous entendons évidement les types de travaux effectuées et l'identification cadastrale de la propriété affectée. Pour toutes sortes de raisons, dont le coût de la démarche, l'hésitation des arpenteurs-géomètres à communiquer des renseignements qu'ils estimaient confident-

iels, l'instabilité même de la base d'identification des données emmaganisées, ce projet a été abandonné. Aujourd'hui, nous ne pouvons que déplorer ce manque de tenacité parce que le volume de l'information a peut-être décuplé et que toute reprise du dossier s'en trouve rendue encore plus difficile.

Cependant, compte tenu de la valeur accrue et sans cesses croissante des bien meubles et immeubles, compte tenu de l'augmentation très sensible du coût des divers professionnels, de toutes les administrations publiques, para-publiques et municipales, il nous apparaît primordial de nous pencher sérieusement sur la solution de ce problème de la cueillette, du regroupement des données susceptibles de permettre une gestion foncière plus saine, plus appropriée à notre époque. S'ajoutent à ces motifs déjà fort éloquents, les multiples lois et règlements qui viennent affecter de façon plus ou moins perceptible mais constante, l'exercice du droit de propriété. Nous les arpenteurs-géomètres en sommes conscients. C'est pourquoi nous avons décidé, malgré l'immensité de la tâche de rouvrir le dossier et d'essayer par un autre moyen d'atteindre les buts que nous visions il y a 10 ans.

Nous avons donc établi que l'information foncière existe et que son regroupement est capital. Il convient maintenant de réfléchir sur la base ou l'assesoir, l'établir.

Il nous apparaît important, à ce stade-ci de la discussion, d'énoncer clairement notre point de vue quant à cette base d'emmagasinement des données. Pour nous c'est la propriété, l'unité de propriété. Il nous apparaît très difficile de trouver une quelconque activité administrative qui ne soit rattachée à la propriété. Mais voilà. Comment identifier cette unité de propriété? Au Québec, nous avons le cadastre. Le numéro cadastral demeure, dans notre régime foncier le clé du système et comme l'indique l'article 2168 du code civil, "le numéro donné à un lot sur le plan et dans le livre de renvoi est la vrai description de ce lot et suffit dans tout document quelconque". En principe c'est vrai, mais dans les faits, la subdivision n'étant pas obligatoire, il y a un très grand nombre de propriétés qui sont assises sur des parties de lots. C'est un peu la faiblesse de notre cadastre d'être facultatif. Etant donné que toutes les propriétés ne sont pas identifiées individuellement au cadastre il nous apparaît impossible de l'utiliser comme base d'ammagasinement des données.

Reste encore la propriété cependant. Ce qui lui manque pour être utilisable, dans le cas qui nous préoccupe, c'est une identification quelconque qui puisse permettre d'éviter toute possibilité de confusion, de méprise. Un système d'identification qui est délà utilisé pour d'autres fins est celui de centroide visuel. Un système basé sur les coordonnées de certains coins de la propriété pourrait peut-être aussi servir à cette fin. Comment décider, comment choisir entre identification cadastrale dans un cadastre amélioré, rendu obligatoire, uniformisé, bien sûr, le centroide visuel, les coordonnées? Ce nous semble être un bon point de recherche.

Il convient aussi d'établir sérieusement s'il est préférable d'établir une banque des données à l'échelle d'une province, d'une région administrative, d'une division d'enregistrement, d'un groupe homogène de municipalités, de chaque municipalité.

Règle générale, l'on hésite beaucoup à confier à l'État "l'intégration" des données-des arpentages-, car de l'intégration à l'accaparement il n'y a qu'un pas à franchir et le passage de l'un à l'autre pourrait en quelque sorte créer une insécurité que trop de propriétaires ressentent déjà. C'est d'ailleurs pourquoi l'Etat s'est doté d'une politique de décentralisation et de révalorisation du pouvoir municipal.

Il est nécessaire également de penser en fonction des moins nantis, car il est indéniable que les villes peuvent se doter d'un système de collection des données sophistiqué et qu'elles s'acheminent lentement mais sûrement dans cette voie. Il importe plutôt de se tourner vers les moyennes et petites municipalités. Ont-elles besoin d'un système informatisé? Nous ne le croyons pas. Il existe déjà au Québec des municipalités de moyenne importance qui possèdent des équipements appropriés. Nous suggérons donc qu'une recherche soit entreprise en prenant comme cas type une municipalité d'environ 10 000 habitants et en s'inspirant du système des municipalités moyennes.

Voila, Monsieur le président, comment les arpenteurs-géomètres conçoivent l'information foncière, l'utilisation qui peut et doit en être faite et dans quel sens ils souhaiteraient que soit orientés la recherche.

APPENDIX O

REQUIREMENTS FOR R&D IN LAND SURVEYS

By

A.C. McEwen

A submission by the
Association of Ontario Land Surveyors

ABSTRACT

The Association of Ontario Land Surveyors generally endorses the findings in the Report of the Task Force on National Surveying and Mapping, and supports the statement of the need to apply a higher level of national resources to research and development in surveying and mapping. More specifically, the Association recommends the determination of a strategy for undertaking or supporting a series of specific projects that have been identified by its members. Projects identified are a textbook on survey law, better determination of water boundaries, distribution of case law studies, bibliography of survey literature, land information systems and testing survey equipment.

The Association of Ontario Land Surveyors welcomes this opportunity to express its views concerning the need for research and development in surveying and mapping in Canada. It is in general agreement with the findings and conclusions relating to research and development that appear in the Report of the Task Force on National Surveying and Mapping, May 1978. The Task Force recommended *inter alia* that the percentage of the Surveys and Mapping Branch's annual budget that is devoted to research and development be increased from the present 2.1 per cent to a minimum of 5 per cent and that the performance of this work be equally divided between the federal government, private industry and the universities. It is interesting to note that these recommendations are in keeping with the position of the Board of Economic Development Ministers which recently stated that the federal government

> "has announced its intention to strive for a significant increase in the share of national resources devoted to R&D and has set a target for national expenditures on R&D of 1.5 per cent of GNP to be reached by 1983. The government will be looking to the private sector to take every opportunity to increase its effort in this important area."

The above quotation is taken from the federal government's formal response to the nine specific recommendations regarding research and development that are contained in Action For Industrial Growth: Continuing The Dialogue, February 1979.

The case for applying a higher level of national resources to research and development in areas of science and technology such as surveying and mapping does not appear to call for further argument. What is required, however, is to identify specific research projects that are urgently needed and to determine a strategy for supporting and undertaking them in the most beneficial manner. It seems evident that such a strategy can best be developed through the close cooperation of members of the surveying and mapping profession in the public and the private sectors, and that its implementation requires a similar cooperative endeavour if it is to be fully effective.

By virtue of its statutory powers and duties, the Association of Ontario Land Surveyors is primarily concerned with the practice of legal surveying within the province. At the same time, the Association is conscious of its responsibilities as part of the larger Canadian survey community, and this is demonstrated, for example, by the Association's support of, and participation in, the survey science programme at Erindale College, University of Toronto, and the Canadian Council of Land Surveyors. Members of the Association are engaged in mapping, control surveys and other branches of the profession, and are frequently involved in survey operations that extend beyond provincial, and even national, boundaries. The Association's professional interests are similarly unrestricted, and it looks on research and development as a national activity that can be of benefit to the entire surveying profession in this country. To the extent that its own resources permit, the Association will continue to support suitable research projects, and it regards the present

conference as an opportunity for useful discussion to bring the requirements for research and development into sharper focus and to determine the manner in which they should be met.

The Association of Ontario Land Surveyors suggests that the following topics are appropriate for consideration as areas of research and development.

1. TEXTBOOK ON SURVEY LAW

There is a very real need for a comprehensive study of the legal principles and practice of land surveying in Canada. The lack of an adequate treatment of this important subject leaves current survey literature with a serious gap that is felt by student and practitioner alike. A proposal for the preparation of a textbook on survey law was made to the Canadian Council on Surveying and Mapping at its meeting in Quebec City in October, 1974. As a result, a committee consisting of representatives from the Canadian Institute of Surveying, the Canadian Council of Land Surveyors, the Canadian Council on Surveying and Mapping, and the Canadian Bar Association was appointed in early 1975 to determine the feasibility and cost of the projects.

The committee identified the various topics that should be included in the proposed publication, and also made recommendations concerning its authorship. Indications of a commitment to purchase a number of copies were received from many of the provincial survey associations, and there was an expectation that total sales would be in excess of 3000 copies. Since 1975, no further progress has been made towards the completion of this project, partly because of the problem of obtaining the necessary financial and other resources, but the interest in this undertaking remains high among land surveyors throughout the country. There is no doubt that the proposed textbook would be of great value to the surveying and legal professions in both the public and the private sectors. Closer investigation may show that a series of monographs, in a loose-leaf form that facilitates periodic updating, would be preferable to a single hardcover work. In whatever form the publication eventually emerges, it represents a research project that deserves the fullest possible support.

2. WATER BOUNDARIES

One of the more obstinate problems in land surveying is the legal determination of the location of water boundaries. In many instances, it is first necessary to establish whether or not a body of water is navigable, and the test of navigability, as provided by statute and common law, is not always easy to apply. Questions of navigability also raise jurisdictional issues, for whereas the property in the bed of a navigable river or stream is vested in the particular province through which it flows, the control of its waters lies with the federal government. An associated problem is the ascertainment of high water mark as a riparian boundary, for this also is a subject on which judicial decisions are not uniform, thereby giving rise to frequent situations of confusion and inconvenience.

Although the practical problems that occur as a result of present uncertainty regarding navigability, high water mark, and related issues can be considered as part of the overall study of survey law that is contemplated by the preparation of a comprehensive textbook, a thorough investigation of water boundaries and riparian rights is of sufficient urgency and importance to justify its treatment as a separate area of research.

The Association of Ontario Land Surveyors has recently appointed a Committee on Water Boundaries to examine and make recommendations concerning various survey and legal aspects of riparian property in the province. With existing resources, this project may take several years to undertake, but the provision of additional support from other sources could make it possible to widen the scope of the inquiry and ensure an earlier completion date.

3. CASE LAW STUDIES

As in other professions, the surveyor should keep himself informed of recent developments in the law. Usually he will be made aware of statutory amendments that relate to his work, but it is more difficult for him to remain up-to-date with respect to judicial decisions that confirm, extend or alter the applicable law. Law reports are not always readily available, nor does a busy practitioner have the time to undertake the necessary research to extract and read those cases that may affect him.

In November 1978, the Association of Ontario Land Surveyors introduced a new service of distributing to its members summaries of recent court decisions dealing with survey, real property, planning, and allied subjects. These summaries are not mere copies of reported cases; they are specially prepared and annotated for the particular needs of the practising surveyor. Since the selected cases are not confined to Ontario but are taken from the decisions of all the commow law courts in Canada, they are of value to other provincial jurisdictions. The extension and development of this useful service would be facilitated by the injection of additional resources to provide for further research and publication.

4. BIBLIOGRAPHY OF SURVEY LITERATURE

The increasing specialization in the fields of surveying and mapping, and the growing accumulation of published reference material point to the need for a complete and readily accessible bibliography of survey literature. Certain bibliographies already exist, but they quickly become obsolescent, and most of them are in a hardcover form that does not lend itself to convenient updating.

It is suggested that a study be made to determine the bibliographical requirements of the surveying and mapping community in Canada, with a view to undertaking a compilation that will serve the needs of the majority of users. Consideration should be given to securing the most efficient and inexpensive methods of keeping the published bibliography up-to-date, whether by means of index cards, loose-leaf pages, or a computer system.

5. LAND INFORMATION SYSTEMS

Many surveyors regret their apparent inability to gain or retain prominence in other disciplines, such as planning, where their particular expertise allows them to make an important contribution. The emergence of interest and activity in new or improved land information systems that depend on accurate geographical positioning presents the surveyor with a fresh opportunity to exert his professional skills and influence.

As providers of fundamental data regarding the spatial relationship of the physical and legal attributes of land parcels, surveyors are vitally concerned with the way in which their information is stored, retrieved and used. The pattern of future development in land information systems can be largely shaped by the awareness, interest and direct involvement of the surveying profession.

It is recommended that research be undertaken to investigate existing and contemplated land information systems in Canada and elsewhere, with a view to determining the present and future role of the surveying and mapping profession in the introduction, development and improvement of such systems.

6. TESTING SURVEY EQUIPMENT

Rapid advances in the development of survey instruments and equipment over the past two decades mean that the practising surveyor is confronted by a bewildering array of choices as to the most suitable make or model for his particular use. Too often he has to depend on the advertising literature produced by manufacturers, rather than on impartial performance reports.

The publication of results of periodic and comparative testing of survey instruments, such as EDM equipment, theodolites and levels, would be of value to the practising surveyor. It is suggested that these tests should be undertaken by a government agency that has the necessary facilities, and that sufficient resources be made available as part of a continuing research and development programme.

APPENDIX P

EXPERIENCES AND SUGGESTIONS FROM A REPRESENTATIVE PRODUCER OF R&D IN LAND SURVEYS

By

W.F. Roberts

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Fredericton

ABSTRACT

The Land Registration and Information Service (LRIS) of the maritime provinces is both a user and producer of R & D for land survey purposes - at the regional level of activity. As far as LRIS is concerned, the major requirements for R & D are in the areas of property surveys, land registration and land information systems, at the regional level. This paper presents details of past research done and future research requirements on all facets from field surveying and mapping, through to the land titles system.

ROLE OF REGIONAL AGENCIES IN LAND SURVEY RELATED R&D

A regional agency plays a much larger and different role than a federal agency in research and development for land surveys. The problems are different and the user is different. Much of the research that a regional agency undertakes must be compatible with the local land information system. There is a responsibility to assist the professional associations in updating members, and to help fill the gaps in their training created by fast moving technology. A regional agency must assume some responsibility for ensuring that society and the consumer get good value. The regional agency must ensure that existing technology is used efficiently for the benefit of the consumer. Research must thus be directed into software compatibility, procedures and systems, rather than in developing or modifying equipment. And this research must assist the local economy, encouraging the development of surveying and mapping industries.

WHAT HAS LRIS DONE IN LAND SURVEY RELATED RESEARCH AND DEVELOPMENT?

The section on past research lists the research areas that LRIS has been involved in over the last six years. As can be seen from the list, the work has involved a lot of the transforming of modern technology to a form usable in the region. The projects demonstrate that research and development at the regional level is substantially different than at the federal level. Our research is necessarily pragmatic, usually short term and related closely to land tenure and land information needs, and to the role of private surveyors in these activities. The decision on which projects should be undertaken has been made on the basis of our own perceptions of where in these areas, potential problems or improvements can occur in the next few years.

WHAT SHOULD BE DONE IN FUTURE IN LAND SURVEY R&D?

There are important areas of research and development over the next five to ten years in surveying and mapping, and of the three topics discussed at this conference, land survey is the one with the most critical need. The R&D that is necessary in operating a land information system and the surveyors and resource engineers part in it should represent a significant portion of our national R&D expenditures. We stress that it is important to encourage research that will address the areas of large scale mapping, legal surveying and land tenure. The field is large, and has been to some measure ignored until now. The user is complaining. How effectively these problems are addressed depends on what portion of the research budget can be directed towards them and how these funds are administered.

The section on past research includes such things as investigations into long term mapping needs, research into geodetic options for the Maritimes, accuracy specification for the guarantee of boundary, policies and procedures for property mapping and investigation of different approaches to monitoring. Research needs shift continually. Research must be devoted to improving the land titles system, making surveys more cost-efficient and continuing the exploitation of current technology for the benefit of the users. By comparison, the section on future research lists the research projects that LRIS feels will be important during the next few years. Also included in the section of future research are

applications of digital technology, applications of inertial systems for second and lower order surveys, analysis and testing procedures of survey and other related equipment and, vertical control and monitoring procedures.

Unfortunately, these important research requirements come at a time when we have funding problems that no doubt other regions throughout Canada have as well. Even while the total regional funds available for research are small, the fact that they are dispersed makes the likelihood of satisfactory resolution of these problems remote.

No one is suggesting that projects of a federal nature are not important. They certainly contribute to providing Canadians with more efficient and better survey products. But, we must not forget that an optimum balance between efforts devoted to federal-type projects and efforts devoted to regional projects must be established.

CONCLUSIONS

Hindsight has shown us that:

a) there are strains and weaknesses in the links between federal initiatives and the national needs. This is seen in both technological applications and in federal versus regional compatibility.

b) the user who spends the bulk of the national funds is left to fend for himself in a remote environment with little likelihood of a satisfactory solution to his problem.

c) the needs are changing from a macro to micro requirement for information collection, filing and distribution requiring additional knowledge and expertise in the land survey field for positional information and its application to the resource industry.

RECOMMENDATION

That in the allocation of federal funds for R&D for the next few years, recognition be given to the fact that there are national as well as federal needs to be met.

PAST RESEARCH

Long term Mapping Needs

Investigations into the type, scales and content of maps that would be needed in the Maritime region in the next 10 to 20 years, with some suggestions as to the best ways of meeting these needs. This research spawned three other investigations.

- Digital mapping techniques - the best way to apply digital mapping technology in the Maritime region.

- Remote sensing in the Maritimes - determine the appropriate level of involvement in remote sensing in the Maritimes.

- Modifications to block adjustment programs - changes made in block adjustment programs to make them more suitable to our environment.

- Metrication and the medium and large scale map series.

Geodetic Options

Investigations into the options that the Maritimes had with respect to the primary nets and the secondary nets and the best way to accommodate the coming changes in these nets. This research spawned two other projects.

- Densification - investigation into methods of compensation for discontinuities in the federal primary networks so that they could still serve as the basis for the secondary networks.

  - investigation into and experience in determining the level and accuracy of the secondary networks to meet the needs of users in the Maritime provinces.

- Redefinition - decisions on the scope and detail required of the Maritime project to redefine the secondary networks, and algorithm selection and programming to accomplish the project aims.

Integrated Survey Area Concept

Various investigations into the integrated survey area concept. Some of these investigations were formal, others were not. The informal investigations were mainly on procedures that developed over the years to handle the integrated survey area established in Saint John. Some of the formal investigations included:

- Accuracy Specifications - investigations into level of accuracy that could be guaranteed for parcel boundary definition.

- Pre-analysis - preliminary work on an interactive system to help surveyors use accuracy estimates resulting from the redefinition project, so that they can plan survey projects to achieve optimum accuracy and minimum cost.

- Education of Surveyors - preparation and sponsorship of courses related to coordinate system usage, and to accuracy calculations and transformations.

Property Mapping Approach

Aside from some initial research done before the LRIS program was begun, most of the property mapping research was done during implementation of the property mapping program, and most of the results of this research are thus fully tested in the field. Some of the documents that resulted from this implementation study were:

- Policies and procedures - manuals were written to explain in detail various procedures that must be followed during the property mapping process.

- Contract specifications - as the program progressed, it became possible to safely contract out much of the property mapping work to private survey companies. Very detailed specifications for these contracts were prepared.

- Property mapping plans - the process of preparing a region for property mapping is an important one, and one that can save a lot of money and confusion if done properly. Various plans exist for different areas of the Maritimes.

- Software development - computer programs were written to process the ownership information that resulted from the property mapping initial lift and update activites.

Land Titles System Implementation Approach

In the process of preparing the Maritime land titles system for implementation, various different kinds of research were undertaken. The research consisted of three types:

- Legislation development - legislation and associated regulation to go with the legislation were developed for the Maritime region. The legislation is common to the three provinces.

- Procedures development - several documents exist that explain in great detail the working of various aspects of operating the land titles system.

- Sofware development - computer software was prepared for a central Maritime installation to support the land titles legislation.

Monitoring

Since the LRIS program was novel, and so highly federally funded, there was much effort devoted to monitoring the program and its benefits. Three major studies are important here:

- The original feasibility study of H. Larsen - this was the blueprint for the LRIS program that rationalized an integrated approach to development and implementation and documented the inadequacies of the existing system.

- The P.S. Ross Benefit Cost Study - this was an independent look at the program to see if it merited further federal funding.

- Larsen McLaughlin Study - this recent study looked at the benefit-cost approach to evaluating LRIS-type programs and proposed a different approach to evaluation methods.

FUTURE RESEARCH

Base Mapping

- Efficiencies through digital mapping and automation - the most appropriate way to exploit digital mapping technology for our region should be investigated.

- Efficiencies through federal/provincial cooperation - the most appropriate means of data transfer between the region and federal agency, and a realistic funding arrangement to support this data transfer should be found.

- User education - since many current and future map users have little background in mapping, effort must be extended to keep these users abreast of current technology and the options available for meeting their mapping requirements.

Secondary Networks

- Vertical network densification and adjustment - a thorough investigation into requirements for appropriate standards for, and suitability of, existing networks for vertical control; stability studies on monuments for horizontal vertical networks.

- Application of inertial systems for second and lower order surveys - satellite technology currently used in positioning for offshore and remote areas may have applications in network densification.

- Mathematical maintenance of the geodetic system.

- Regional activity in hydrographic work - recent moves by provincial authorities to assert their jurisdiction over the offshore may require a provincial capability in hydrographic surveying, and hydrographic surveying may expand to include additional mapping coverage not currently mapped by federal authorities.

Integrated Survey Areas and the Private Land Surveyor

- Ways of making surveys cheaper for the consumer - investigating such things as:
  - improved survey techniques;
  - use of para surveyors for some legal work;
  - analysis of survey and other related equipment, and testing procedures.

- Implementation of integrated survey areas - further research into the best way to implement the integrated survey areas, improved survey regulations for integrated survey areas, specifications for application of and implementation of guarantee of boundary.

- Continuing education for surveyors - getting surveyors prepared for changes implemented to take advantage of research results.

Approach to property mapping

- Integrating property map updating activity and integrated survey area checks with other government checking procedures to streamline the approval process.

- Land ownership information as a by-product of the property map updating process - its most efficient use.

Land Titles System Implementation Approach

- Land Titles Act development - to provide a comprehensive, readily accessible ownership registry.

- Identification of overriding interests (including zoning restriction) - to enable them to be researched with respect to a subject property.

- An overriding interests data bank (including zoning restriction) to allow overriding interests to be correlated with parcel description.

- Short forms and standardization of forms in use - to simplify legal transactions and prevent misunderstandings.

- Boundary guarantee - to explore the implications and methodology of its implementation from the point of view of cost to the public and the most efficient means of implementation.

- A survey of boundary problems to attempt standardization of their solution - to introduce uniformity in legal and survey approaches to this problem.

- A comprehensive study of roads and highways - to identify and isolate legal and surveying problems relating to this topic.

- To study survey accuracies both on the ground and photogrammetrically - to determine the degree to which guarantees of location are possible and the manner in which vast tracts of woodland can be surveyed most economically.

Monitoring

- Further studies on results using the Larsen McLaughlin Method.

APPENDIX Q

REPRESENTATIVE OF CANADIAN INDUSTRY

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ABSTRACT

A brief summary is given on the Canadian Marconi Company, what the company is doing and why. Reference is made to the company's recent shift toward including the manufacture of geodetic and photogrammetric instrumentation in its scope of activity.

I've promised to spend only 10 minutes speaking, so I'll have to do it fairly quickly and what I will try to do is give you some idea of who we are, what we are doing, and why such things seem suitable for us to do. I'll try to compress some 76 years of history into the first three minutes, to give some idea of how we came to be doing these things.

Canadian Marconi was founded in 1903 by Guglielmo Marconi, with the general purpose of exploiting his patents relating to wireless telegraphy. Thus, it started out as an operating company, providing communications between Canada and the rest of the world and between ships at sea and shore stations. It went on like this through World War I, where we got into the business of long-range radio communications equipment. After World War I, we were in the business of making mantel radios and running a radio station, probably about the first public broadcast radio station ever to operate commercially. And, with World War II, the company got into radar and mobile communications. In 1950, the Operating Division was sold to the Canadian government by a forced sale, and became what is today Teleglobe today. After World War II, we also got into the T.V. station operating business and the manufacture of television sets. The television station has been sold and we don't make television sets any more. Following the radar developments of World War II, the corporation branched out into things like Doppler navigation systems, ship radar, taxi radios, and a series of more modern products like solid-state Doppler Radar and Omega navigation systems, the manufacture of computers, which is still going on, international telex exchanges and the equipment that goes with the computerized business of communicating data around the world. More recently, the corporation has entered the satellite positioning system market, where we have a big commitment, and in G.P.S., where we also have a large commitment.

About a year ago, in assessing this position, we realized that we had developed a very large computer manufacturing and a real-time software expertise, and we had also developed a great deal of geodetic expertise, including software and marketing. It was then realized that as the photogrammetric instruments became more electronic and required more software and real-time computer expertise, it would be a worthwhile idea to exploit the synergy offered by the market and by the tremendous back-up that we had built in this general area in the technical region, and to consider making photogrammetric instruments.

To this end, we purchased the license rights to the work that had been done by the Photogrammetric Section of NRC in their ANAPLOT development. We have at this time a development program going on based upon the work that was done at NRC to produce a cost-effective instrument that could be mass-produced, that will be a sort of universal type of man/machine interface, to make it easy for an operator to produce a meaningful statement about the territory of which he has a picture with all the help he can get from a computer. It would enable him to use his eyes and brain as they were intended to be used, and the computer would then take over all the routine tasks and all the analytical tasks.

I don't want to go into a detailed discussion of the design now, because it's not ready for formal announcement. What I'm really talking about here is who we are and what are we doing and why. The main objects in the design of this photogrammetric machine, the stereo-plotter, are that it be fast in all its

operations, that it be very modular, because it's intended as a base for a line of products that are related to this work, and that it have long term stability so that it does not require frequent repairs or calibration. So I guess that is more or less says what we are doing, and why we are doing it.

APPENDIX R

THE POTENTIAL FOR RESEARCH AND DEVELOPMENT IN THE AERIAL SURVEY INDUSTRY

By

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ABSTRACT

For reasons stated, the member companies of the Canadian Association of Aerial Surveyors have had to limit their activity in the field of R & D, with some outstanding exceptions. However, the industry is ready to meet any new challenge that will improve its competitiveness in world markets. A resumé of the capabilities of the aerial survey industry is given, and some current R & D requirements are listed.

An examination of the performance of the Canadian Aerial Survey Industry by international standards shows conclusively that the Canadian industry is second to none in the world. To have reached this plateau, the industry has had to be innovative and aggressive. To maintain this position, however, substantial resources will have to be channelled into new research and development over the next critical five to ten years.

I believe that the industry is ready and able to meet this challenge.

Of greatest concern to the industry over the years has been the adaptation of state-of-the-art technology to commercial activities. Our expenditures in research and development must lead to improving our competitiveness in world markets and ultimately to sales. For this reason, and because the domestic market for surveying and mapping has not permitted us to generate sufficient funds, our activities in pure research and development in this field, with some outstanding exceptions, have of necessity been limited.

This has not been the case in airborne geophysical surveying where procurement practices have permitted the generation of sufficient funds to cover the costs of a relatively high level of research and development, particularly in the design of high quality data acquisition systems for recording and first-stage processing of geophysical data from various sensors, together with positioning information and ancillary data. There have been a number of other important developments in the geophysical field pioneered by the Canadian Aerial Survey industry which have undoubtedly helped keep us at the forefront of this field internationally.

Fortunately, these activities have permitted us to build up teams of research scientists, programmers and other research technicians, as well as to acquire the essential hardware - computers and flatbed plotters being prime examples - to engage in research in other fields, primarily surveying and mapping. Many of the firms have employed research photogrammetrists for some time and more are being added every day.

If I give the impression that surveying and mapping research takes second place in the industry I need only point to our achievements in this field over the years. Our record in the application of airborne profile recording, electronic positioning systems, the horizon camera and Doppler satellite technology to commercial surveying and mapping is well known.

Our work in the development of faster, more accurate and more comprehensive programs for bridging and block adjustments is recognized. Not so well known possibly is our expertise in railway and highway route location and engineering, the development of graphical cross-sections and our extensive use of satellite imagery in project planning.

I said earlier that one of the restraints to more research and development in surveying and mapping is our inability to get proper prices for the services we provide. Let me give you a classic and very basic example: anyone in the business of compiling topographical maps is aware that the quality of the photo acquisition flying as well as the physical quality of the photographic imagery can

make a difference of between 20 to 30 per cent in the ultimate cost of compiling a map. In a typical case of 1:10 000 topographical mapping from 1:30 000 photography, the photography may cost approximately $5.00 per square mile - and the map compilation including aerial triangulation, in a rural area, approximately $250.00 per square mile. Given a relatively small area of 1000 square miles, the photography would cost $5000 and the mapping $250 000. In the case of substandard aerial photography, for whatever reason, the cost of the map compilation could easily increase to $300 000.

There is a system available in Canada, developed and assembled by a firm here in Ottawa as a matter of fact, based on the use of Decca Doppler and a navigation computer and, tying-in automated drift and camera stabilization features, which results in a more accurate flight path, a reduction of crab, a minimization of camera inclinations and more accurate forward overlap. In other words, it can virtually assure optimum photography acquisition. The system costs approximately $100 000. installed. Over a year's operations this would add about 10 per cent to the cost of photography obtained by an aircraft equipped with this system. In the example I am giving, the cost of the photography would increase to $5.50 per square mile or $5500 for the one thousand square-mile block, but it could save $50 000. on the ultimate cost of map compilation. In other words $500 saved on the aerial photography can add $50 000. to cost of the map compilation.

You would think that all mapping clients would be happy to spend the extra $500 on the aerial photography if the photography is ultimately to be used for mapping purposes. Unhappily, this is not the case. Aerial photography is often procured separately from the mapping and the contract goes to the lowest bidder. The firm that can produce high quality photography at a 10 per cent premium would lose the contract.

I have given you this incredible but true example to emphasize how difficult it has been for us to generate the necessary funds to devote to research and development. This is a case where the technology is already available but we can only use it where we are responsible for both the photography and the mapping.

Automated processes in surveying and mapping are no longer in the far distant future. The Canadian industry is faced with acquiring working competitive systems not in 10 years time but in my estimation in less than five years. The highly labour-intensive systems of the present, which have not changed basically in the post-war years, will just not be good enough if we are to maintain our position internationally where we are up against some formidable opposition from the highly subsidized industries of Europe, particularly from France and even some of the communist countries.

It is in the development of commercially acceptable and competitive systems that the Canadian Aerial Survey industry can play its most important role. We are both blessed and cursed in Canada by the number of highly competent government agencies engaged in mapping research and development, both federally and provincially. In Bill Morton's words, we are akin to the African heathen in the days of the European colonial expansion having to listen to four or five different

Christian denominations all telling us that this is the way to salvation. As a first step we must have a much higher degree of collaboration between industry and government research scientists and I would urge a similar attitude between the various levels of government activity in this field if we are not to dissipate our efforts in all directions.

Returning to the theme of this paper, the potential for research and development in the aerial survey industry, the record speaks for itself. There have been few major developments in Canada in recent years in which the industry has not had a hand. Within available resources, work is in progress on a number of projects. Among those considered urgent at the moment are the following:

- Further development of fully integrated aircraft guidance and aerial photography acquisition systems.
- Development of advanced airborne profile recording systems.
- Development of a digital terrain model generator.
- Development of software for complex airborne data and for producing new forms of graphic output for both cartographic and geophysical applications.

There are obviously many other requirements including the development of techniques leading to the acceptance of photogrammetric processes as legal documents in cadastral surveying. However, it is the broad problem of the development of commercially adaptable automated mapping systems that has us looking over our shoulders at this time. Because of the tremendously high cost of the hardware involved in the research of automated mapping systems, the field has of necessity been left largely to government agencies. However, it is in precisely this field that a high degree of collaboration should exist between industry and government so that we can assure that the product of this research is commercially viable.

We firmly believe in industry that we have the potential to contribute to this vital research and we are more than willing and able to play a role.

We must first, however, find the means of generating the necessary funding. Too often in the past, funds have had to be raised by the injection into the industry of new capital. This means that we have been forced to make extremely difficult judgement calls on whether the injection of new capital would ultimately result in an increased return on a now higher level of investment. Traditionally, return on investment in the aerial survey industry has been low, and in many cases non-existent.

On the other hand, the benefits to the Canadian economy resulting from the activities of the aerial survey industry are inordinately high. To go into that statement in detail, however, would be the subject of another paper.

Historically the industry has not been the recipient of grants for research and development. In fact, the industry is one of the least subsidized in Canada and we have liked it that way. However, because of the critical years ahead, this

may be the time for a change. Given a reasonable return for our services and a modicum of support in research and development, we are ready to fight the world.

APPENDIX S

PLACE-RELATED INFORMATION SYSTEMS

By

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ABSTRACT

Several examples are given of the fast-multiplying array of information files and data bases, covering many areas of interest. It is suggested that a place-related information system could be set up and used to supply, in an effective manner, all the relevant information about any particular site. The system does not imply centralizing the data itself, but rather that all data will be accessible, in whole or in part, as required.

THE ADVENT OF THE INFORMATION SOCIETY

Before discussing place-related information systems, it would be helpful to review briefly some relevant trends in our society.

The term *post-industrial society* first appeared about 1959. It was introduced in the United States when it became apparent that very soon more people would be employed in services than in agriculture and in industry. In 1800 approximately 87 per cent of the work force was employed in agriculture (including forestry, fishing and trapping); now the figure is 4 per cent and still declining. Twenty-five per cent of the work force was in industry in 1960; in 1977 it was down to 22 per cent. Although the above figures are from U.S. records, it is safe to assume that the trends in Canada are similar. An analysis done for the U.S. Department of Commerce Office of Telecommunications in 1977 showed that 46 per cent of the G.N.P. was generated in the information sector. For all intents and purposes, in the U.S., the post-industrial society has become the information society; in Canada, as usual, we are not far behind.

John Kettle, in an article entitled "The Information Society" (June, 1977 issue of Executive), said:

> "The worldwide information grid is ... a vision that has gripped the imagination of thousands in the knowledge industry: a worldwide network that would allow everyone to reach every bit of knowledge that is available to anyone, or ever has been. Any book, any newspaper article, any speech in any legislature, any movie or TV program, any photograph or painting, any airline schedule, any catalogue or index, any thesis or research study, any intelligence, any lecture, any radio program, any patent, any data base..."

This is mind-boggling but it is the way we are going. Let's think of a few examples.

- Airline reservations: the airline clerk is in almost instant contact with the reservation files of not only his airline but of most of the major world airlines.

- Police records: if you've been stopped for a traffic offence recently, you may find that while one officer is distracting your attention with rather trivial questions, the other officer has taken your driver's licence to his car and is checking your record on the data base.

- Banking: there have been several articles recently indicating that soon we will no longer be able to kite cheques. The deduction from our account will be made at the instant a cheque is presented for payment anywhere.

- Libraries: there is a system called INFOMART in Canada linked to another one called ORBIT in the U.S.: ORBIT provides access to a score or more of American data bases, including access to two million books in the Library of Congress each by author, title and subject.

There are countless specialized data bases in every field of activity. As yet, none of them is quite as easy to work with as theory says they will be but they do become more *convivial* with familiarity.

We are all being drowned in paper, overwhelmed with data, bombarded from every side by radio, T.V., newspapers, journals. When you get back to your desk after this conference, how much of the paper on it will be welcome?

In spite of the enormous volume, how often do you get what you want when you want it? Rarely. This information pollution has given rise to the concept of demand publishing i.e., the creation of data bases from which you would be able to get what you want when you want it. Think of the filing cabinets we could discard if we were confident that we could get the information that we need when we need it!

There are already proposals for TV programs on demand. Yesterday, George Zarzycki concluded his talk with a scenario in which you could dial into the digital map data base and immediately get the map you want on your TV screen; then, select a section for enlargement, make a hard copy and take it over to your private bar to plan a fishing trip while you finish your scotch and soda. It is not that unrealistic. This is a glimpse of demand publishing, and there are predictions that it will eventually dominate the publishing scene.

PLACE-RELATED INFORMATION OBJECTIVES

The following is a list of several tasks that were discussed yesterday:

- Completion of the 1:50 000 topographic maps series as Gerry Arnold indicated.
- Providing the geodetic framework as described by Gérard Lachapelle.
- Creating an up-to-date cadastre as described by Gérard Raymond.
- Completion of the hydrographic charting as described by Steve MacPhee.

However, at this stage it is important to distinguish between tasks and objectives. The two major objectives for a place-related information system can be readily identified.

1. A place-related information system can provide the *big picture*, i.e., it can serve as a base for aggregating and for identifying broad distribution patterns and trends. For example:

a) Topographic maps tell us very quickly where the mountains are, where the plains are, where there is a watershed.

b) Property maps tell us very quickly where the Crown land is, where the subdivisions are and where the ribbon development is.

c) Forest-cover maps tell us where there is merchantable timber.

d) Soil maps tell us where there is Class 1 or Class 2 land.

2. A place-related information system can provide *all* the relevant information about any particular site. There are many examples where this is already being done:

a) The oil industry: Alex Hittel tells me that his survey office is responsible for pulling together all types of place-related data for Shell Canada. When the exploration manager is making the decision to drill a hole that is going to cost millions of dollars, he wants *all* the geological and geophysical data for the vicinity of that site and he may want hypsographic, bathymetric, climatological, infra-structure, and land tenure data also.

b) Environmental impact studies. These are mainly a collection of all the information relevant to a specific site.

c) Land use studies. When decisions to change the use of land are being considered, all the information pertaining to a specific parcel is needed. Regretably, far too many decisions are taken without all the relevant information.

By and large, the surveying and mapping community has done a good job in meeting the first objective but it has virtually ignored the second objective. In fact, in a paper-bound technology there was little more that could have been done in providing integrated site information. However, with the advent of digital data bases, the potential exists to meet all the needs of the users of site information.

The most promising scenario is a distributed network of data bases linked so that all the data on file anywhere that is relevant to a particular site can be retrieved quickly and economically. This won't happen tomorrow but it could happen by the year 2000! This isn't too far ahead to plan. We should remember that the 1:50 000 map series was started much more than 21 years ago and it hasn't been completed yet.

At first glance we may think of our place-related system as relatively static, but if we reflect a moment we realize that it is anything but that. Although many of the features may be relatively static, the state of our knowledge about them is not. In the past, because we have been tied to paper, we have pretended that changes were not significant - we have willfully ignored new data. This has had the effect of putting blinkers on us and preventing us from even trying to define an ideal system.

Here, I want to stress that the model does not imply centralizing the data itself. Each data base must remain proprietary to the discipline that is the primary collector and user of it. What we can foresee, and it is already beginning to happen, is that survey engineers/scientists will be recruited to manage or to assist in managing the place-related data bases of the various disciplines. This is because in positioning, in quality control, in presentation, there are problems for which the survey engineer/scientist is trained. Let's face it, we are the only group that find coordinates exciting; to all other disciplines they are a necessary evil.

Thus, just as the statistician with his bag of statistical tools forms the central corps of Statistics Canada's socio-economic data base management team, so the survey engineer/scientist with his bag of coordinate tools will form the central corps of the place-related data base team.

It may not be coincidence that at the national level, the budgets for surveying and mapping and for Statistics Canada are of the same order of magnitude; in some countries they are, in fact, sister units under one Cabinet-level official. Is that a model we should aspire to?

To sum up, we can foresee a dynamic network of place-related data bases such that with relative ease, *any* or *all* of the known information about any site in the country can be retrieved. Most of the data exists; the necessary hardware can be acquired. The shortfall is in the expertise and in the systems to do it effectively. If we accept this as our main objective, many of our R & D sub-objectives will become clear.

Clearly there is a need for the hardware and software as discussed earlier by Al Daykin, Brian Giles, Paul Caden, Ted Blachut, and Alex Hittel, but essentially, as Doug Kendall said in his introduction, we need to give a lot of attention to that 90 per cent of the effort that is spent on operations.

Mr. Chairman, I hope that in addition to my assignment to present a scenario on place-related systems, I may be permitted to take a minute to be a spokesman for survey educators. In that capacity there are three points I want to make:

- Educators are in the knowledge transfer business. Governments are not. Industry is not. When we do research, we transfer knowledge to students; when they graduate they take it with them to their employer. I won't make any claim that academics can do research better than others but I want to emphasize, in the clearest possible terms, that because academic research is done largely by students, we transfer it much better than either of the other groups. We have the case histories to prove it.

- I'm glad that you didn't list me as either a user or a producer of R & D. Teachers are both producers and users. We produce R & D because it is an integral part of good teaching. Similarly, we use it because using it is also an integral part of good teaching.

- As a user I would make a plea for a solution to a specific problem. As a profession, we do not understand the business we are in. None of us. This is not too surprising! Many other professions are in the same situation. We're all well aware that economists don't understand their business either. When I say we don't understand our business, I don't mean that we don't know how to perform the tasks of our business, I mean that we don't know how our business relates to society. So I make a special plea for R & D to help in understanding the interaction of our business with society.

To sum up:

- We are already living in *the Information Society*.

- I propose that our objective should be the development of a place-related information network, such that any relevant item of information about any site can be retrieved quickly and economically.

- One of our higher R & D priorities should be to achieve an understanding of the interaction of our business with society.

APPENDIX T

AN OVERVIEW OF R&D IN CANADA

By

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ABSTRACT

An overview is given of the rise and fall of the national R & D effort over the past few decades. Some of the main problems in achieving desired benefits are outlined, and a model is described that might be useful for the broader level, that is, the national level - of R & D planning. Two main principles should be adhered to in the conduct of applied R & D; firstly, that R & D should be performed as near as possible to the source of application and secondly, that the beneficiary of the R & D should be responsible for the funding.

It is a pleasure to be here to speak to you on what has been a favourite topic of mine for a long time. What I would like to do this morning is to very briefly give a general overview of the R&D or science and technology picture in Canada - as it stands at the present time, and to talk a little bit about what I think are some of the main problems in achieving the benefits that maybe we should be achieving from R&D. I will also be presenting a bit of a framework or model that I think is useful for R&D planning, particularly at the broader level - the national level - as well as within organizations.

In Canada, certainly last year, we deplored the state of R&D. I think we have to concede that overall, Canada has not been particularly successful in using technology as a basis for economic development.

But having said that, I think that Canadians, as much as any other people in industrial countries, have long believed that technology is an important instrument. You can go back in the development of this country and find that we set up the Geological Survey in 1842 and developed R&D in the area of mining, agriculture and fisheries. The NRC was created to assist the secondary area in the 1920's, and in these early years the emphasis was on government performance of R&D to help advance the country technologically.

We had DRB and AECL in that era, but starting in the 1950's, we became conscious of the need to get more R&D performed outside of government, and we saw the development, in the late 50's, of a variety of R&D incentive programs for industry and increased support for university research. These programs did have an impact in the 1960's. In 1965 while we were looking at this, there was an industrial laboratory being created almost every day in Canada. There were five each week being created in 1965 on the average, so there was some response. The university programs began to build up and I think we built up a very good, respectable R&D capability in Canadian universities.

In general, these efforts in R&D have paid off - have paid dividends in some areas. In geology, I think the work that was done early in the GSC has been responsible for the state of rapid development of the mining and mineral industry in Canada. In agriculture and in mining we have, by and large, good productivity. In forestry we do quite well. It is really in the secondary area that we have not had the same kind of success, and we have had a relative lack of success in the secondary area that was perceived to occur from 1960 onwards. This has resulted in a kind of "on-again, off-again" loss of confidence in R&D as an instrument of economic development and as a means of achieving some of our goals. I think that is very unfortunate because I do not believe that the problems were due to R&D - perhaps a little later I will talk about what I think have been some of the impediments - but certainly the answer is not to reduce the amount of work that we do. More recently too, we have seen a very strong push to move R&D out of government laboratories. We have seen the resurgence in the tax incentives and in grants, and certainly the intent to support research in the private sector. It might be useful to consider some of the numbers. In 1960, the level of R&D performance in Canada was about 0.9 per cent of GNP - less that 1 per cent.

Under the impetus of the various government programs that rose quite rapidly in the 1960's, by 1967 we were at 1.3 per cent of GNP, which was quite a respec-

table increase. Then, in 1967 there seemed to have been some disenchantment both in the private sector and at the level of government support. R&D has dropped in Canada from 1.3 per cent down to 0.9 per cent of GNP. So essentially, on that basis, we are where we were in 1960.

A shift has occurred since 1960. I do not have the numbers for 1960 but in 1963, government represented 41.7 per cent of R&D. In 1977 it was down to 31.4 per cent. So, there has been quite a drop in the percentage performed by government. Business was at 38.7 per cent - it is now up to 44.8 per cent - so there has been quite a relative increase in the business sector and quite an increase as well, always on a relative basis, in the university sector. But I think one has to caution against these relative increases; the fact that the share has increased does not mean that the net level has increased anywhere. In fact, if you look at the performance in the industrial sector in constant dollars, you find that, in 1971, we were doing 405 million in 1971 dollars in industry and in 1977, taking inflation into account going back to 1971 dollars, we are still essentially at 404 million. So there has been no change.

Of course, as a percentage of GNP, that has meant a reduction in the industrial sector and an even greater reduction of course in the government sector, from 0.47, 0.43 to 0.33 per cent of GNP in industry.

Now how does that compare with other countries? It is always useful to look at that, although I do not think that should be the basis of our decision-making. There have been sizeable and comparable drops in the performance of R&D in that same period in two countries, Great Britain and the United States. There have been significant increases in that period in Japan and Germany; and the majority of other countries have, by and large, remained about constant - that is, the percentage of GNP.

The U.S. drop has been, in large measure, due to cutbacks in the defense R&D and relative cutbacks in the space program. In Canada we did not have that to cut, so that the reduction, the relative reduction, has taken place in some of the sectors that have an economic objective as opposed to a prestige objective or a military objective.

What does it mean in absolute levels then? I said a moment ago that the industrial R&D in Canada is 0.33 per cent of GNP. That compares with industrial R&D in the U.S. of 1.4 per cent; in Japan, 1.1 per cent; Germany, 1.2 per cent. In other words, we are off by roughly a factor of 4.

Now having said that R&D is low, it is my conviction that some of the activities that follow R&D, the post-R&D activity that leads to commercialization and the utilization of the results, are still significantly lower in Canada, on a comparative basis. It is very hard to get data in this area. We have tried. As was pointed out earlier, I am a member of the National Design Council and Chairman of their Innovation Committee. So as part of the exercise there, we have looked for information.

A study was done in 1973, which looked at how much money was spent again by the private sector in R&D, in marketing, product design, engineering, tooling and in

some of the other post-R&D activities. The results were rather surprising. Conventional wisdom has it that R&D is really a small part, and the big dollars are spent further downstream in putting in a product. In fact, it was found that R&D operations accounted for 54 per cent of the total. Marketing accounted for 2 per cent; product design and engineering, 13 per cent; tooling and industrial engineering, 5 per cent; manufacturing start-up, 7 per cent; other current ones in capital, 18 per cent. Much of the capital was in fact in R&D, so that the R&D was actually greater than 54 per cent.

That contrasts with, as I indicated earlier, the conventional wisdom that says that R&D is really a smaller factor than engineering and design. As a matter-of-fact, there was a task force formed in the United States, around 1970, which published a report - the so-called Sharpley Report. In their estimation, they felt that R&D should be about 1/10 of the new phase of the engineering and design and manufacturing start-up. I think that study was a little extreme in its views; other work done in the U.S. would indicate that R&D would be maybe about the same, as near as we can tell, as the engineering design functions, marketing functions, that are necessary to bring a product forward. Of course in Canada they are about 1/4, so that if R&D is low, then that activity is very low.

In some ways we can understand why it is lower than R&D, since R&D has been made the object of support of government programs. Firms have been told that they should do R&D. Multi-national firms that are not really interested in bringing products forward in Canada nevertheless want to be good citizens, and they want to be seen as good citizens; so they build R&D laboratories along the route leading into Montreal or Toronto where a lot of people see them. R&D has had a kind of artificial stimulus beyond what is in fact intended - or what people intend to use it for.

As part of the work at the Design Council, we tried to examine how large, successful, technology-based firms operate, and this is largely based on U.S. experience rather than Canadian experience. But basically, most of these firms have an R&D laboratory which is a corporate lab that does much of the R&D. That operation produces design parameters, patents, prototypes, inventions and know-how which feeds into the divisions. The picture I am drawing is a bit ideal, in fact it is not as simple as that. It feeds into the divisions which in fact have the responsibility for the design and engineering of the product. They use what they get from the R&D. They also use what they can purchase anywhere, and what they acquire from outside sources through various agreements and technology purchasing. Their products are engineering drawings, product specifications, materials and parts specifications, production procedures, quality control procedures and all of that tremendous engineering paper work that you need to build a sophisticated product in a manufacturing plant.

Having done that, that information can go to the variety of plants where manufacturing takes place and from the manufacturing of course comes the product. Within that system is the marketing system which feeds in market information and customer reaction. That information feeds back to the manufacturing level and also feeds back to the design stage and the R&D stage.

Organizationally, in a typical firm you would have a president, a divisional president, who has a responsibility for a product line and under him a vice-president engineering, (or research and engineering), vice-president marketing, vice-president finance and the vice-president manufacturing, who is in charge of all the manufacturing plants.

The particular example that I have taken is in fact the organization at Mallory. There is an R&D laboratory at the corporate level which does a number of things. Sales is separate from marketing in that particular instance, with regional sales offices. Each of these vice-presidents has a role which is of equal importance, of comparable importance, in the technology-based firms and you will note that the manufacturing is but a small part. It is the most visible, and it is the part that has all the hardware, all the plants. In terms of real importance to industrial strength, the other functions are of comparable strength. The resurgence in Germany and Japan after the war is an indication of the importance of the non-hardware, of the non-plant strength, because in the case of those countries, most of the plants have been wiped out. But in fact they have the rest. You can build them and you can buy the equipment.

Where is the technology carried on? In practice, you get technology developed in the R&D lab of course, in the engineering plant. You need a technology function in the manufacturing plant itself to adapt to regional needs - but that is relatively small. You need a technology capability in your marketing, because in technology-based products, you do not just sell, you have to understand customer needs and react to them.

What has happened in Canada in many instances is that we have a large number of manufacturing plants that are not companies, and the fact that you attach R&D somewhere does not always give results - because we are really weak in that other link that you need - that engineering step. In fact it may not be in the company's interest to do that. There are many drawbacks in fact in doing separate engineering, if you are in a multi-national firm in Canada: a product is produced that is not as easily exported because it is different; it cause problems of maintenance, and you do not get the benefits of the economies of scale.

The result of this inherent weakness in Canada is reflected in our industrial performance. When I was at MOSST, we initiated a statistical series with Statistics Canada to extract the 19 technology-based industrial groups, and we followed the net trade balance in each of these 19 groups. Using net trade as the measure of strength, if you were able to export more than you imported you were strong; if you imported more than you exported you were relatively weak.

Looking at the 19 groups, and taking the last year for which I have data, which is 1977, out of the 19, there were two where we had a positive trade balance and in the other 17 we had a negative trade balance. Among those two for which we had a positive trade balance were petroleum and coal products. This was refined petroleum, but nevertheless it has a very high technology base. The reasons for our performance had very little to do with technical strength; it had to do with first, the U.S. wanting to buy refined petroleum during the energy shortage (at that time relative shortage) and the second reason was the aircraft parts.

In total we had a net deficit within those product lines of 7.7 billion in 1977, and that has gone up. I think it was about 9 billion in 1978 and it is improving a little bit now with the Canadian dollar having been lowered.

There are other consequences that occur from not having this strength and from the effect of not having design in Canada has on your suppliers. There is a link between that aspect and where you do the design; that can be seen in the architectural area. If you have an architect design your building, he is going to specify an elevator. If he is doing it from a base and he knows of an elevator that someone else has installed, then that is likely what will be put in. When you are bringing in drawings, and building from drawings, it has a tremendous impact on where you get your materials.

Well, why push this technology? Why is it important to have technology-based industries? I would like to give you some data on why I think it is important. These data are the results of a recent work that the MOSST produced. Industries were classified under three groups: the research-intensive, which was more that 3 per cent - that is, percentage of turnovers; the medium research, 1 to 3 per cent; lower research, less than 1 per cent; and, essentially no research. Now if you look at the annual rate of growth of different factors within those three groups, the first factor is employment. How fast does employment grow in these industries? In the "no" research it was 0.7 per cent per year; in low research, 1.6 per cent; in medium research, 2.7 per cent and in research-intensive, 2.4 per cent. In terms of growth in real output, per person, the growth was 3.8 per cent in "no" research; 5.2 per cent in the low research; 6.6 per cent in the medium research and 6.4 per cent in the high research.

In terms of productivity, the figures are: 3.1 per cent, (always going from "no" to high research) 3.5 per cent, 4 per cent, and 4.5 per cent. In terms of price increase of the products, "no" research was 3.2 per cent; low research, 3.1 per cent; medium research, 1.6 per cent and high research only 1.4 per cent increase. I think this tells you quite a bit about what the impact is on the economy of fostering research-intensive industries.

It is pretty clear if you look at it in terms of inflation, employment and productivity, no matter what measure you use, these are the areas that have performed. So I think it is important and I thought I would put that in because sometimes we find people saying "why bother". As a result I think it is a little disheartening to have seen that drop-off in R&D as a percentage of the GNP. The question of course is how much do we do. Well, it is very difficult to come out with numbers, but I think these international comparisons have some validity. Progressive countries do about 2 per cent as opposed to 0.9 per cent in Canada.

In industry - how much do you do? Again it depends, but I think that the task force on surveying and mapping said that high technology industries do from 5 to 10 per cent (those are very high technology industries - things like aircraft and electronics). Anything over 3 per cent tends to be research-intensive or technology-based industry. If you put 3 per cent in your industry, I guess that would be quite large. I do not know what the total production is of the surveys and mapping industry - I am quite sure it is well below that.

There is a framework that I would like to describe before concluding that I find useful as a tool for R&D planning and for thinking of resource allocation. The framework really assumes that R&D is a tool - it is an instrument to give technical capability to a firm, country or industry which in turn is used to improve the service or productivity and improve products - but really has a well defined end product.

Looking at the different areas of science and technology that you would be interested in, there are different levels of technical or scientific capability that you would want to achieve: the first one being scientific awareness; the second level could be the ability to exploit the technology - know enough about it to be able to use it; a thid level would be to become good enough so that you could start getting some industrial participation; and fourth would be to develop a full capability within the country and a level that would allow you to really shine and say "this is where we are tops in the world", i.e., international excellence.

Necessarily, as you go up the scale, costs go up and the vertical scale, if you were to put it in terms of cost, might almost be an exponential scale. The greatest amount of effort is expended at the scientific awareness level and the total participation decreases as you move up the scale.

We can look at each of these in succession. The first one is scientific awareness. The objective that one would seek here is really to provide a knowledge base that would give you a perception of the opportunity and options and also provide a scientific base for policy purposes and decision-making - either within government or industry - whatever way you are going to go. It also should be there to provide a base which would allow you to receive freely available information from outside sources because there is a fair amount available and if you do not have some capability you do not even get that. I am thinking now about the material you would buy, not technology that you would get through agreement to purchase.

Finally, scientific awareness provides a base to move to the higher level. In this field, the areas you cover would not necessarily follow your policy of saying we are going with this kind of technology at the present time - it would be much broader than that and it would in fact be used to help direct policy. It should cover all of the important areas of technology in which you have an interest. You need not be so selective here. It would be centred, I think, mainly in government and universities, but the decision here to atain this level would be the responsibility of the agency that is doing the work. You would not really want to go to greater consultation.

The next level is the ability to exploit. Of course, you want something that could meet all the objectives. In addition it would provide a knowledge base that would guide you in actions associated with the use of the technology. For example, purchasing equipment, supervision of construction, training of operators, management of the facility, setting standards and regulations if you are in government and that would cover a fewer number but still quite a wide number of technologies centred again, in this case, in the agency doing the exploitation.

That is where you need it. Again the decision of where you go really is up to whoever is doing the exploiting.

At the third level, you would want to increase the Canadian content to give some leverage and access from the principal source of technology. The decisions that go to these levels become, I think, to some extent, lengthier industrial policy, because it is not always the user who is benefitting from that. You are stimulating downstream industry. This is where you would also look for more support from government and I think it should be applied; first of all, the capability that should be in industry, primarily is whoever produces the activity.

The fourth level is intended to meet all of the objectives of the others, to give you a stronger industrial participation which would provide a balance in trade. As you go up the scale, the capability is primarily in industry. It starts to require the use of more instruments of various government departments, i.e., incentive programs and what have you in order to achieve this. Because as you go up the scale, the goals become progressively more difficult to achieve and tied more to inudstrial policy.

Then finally, the third is really the ultimate that you might want to achieve; looking for a very strong industrial benefit where you would look for some prestige. All countries do activities during certain times directed towards that, and it also would give you independence. For example, I had in mind here the supply of energy. You may want to have a full capability in the country that can almost independently develop your oil sands or whatever area you feel is essential to the economy.

Well, I think that sort of sets a kind of framework that we could talk about and with this sort of thing you would, I think, be able to concentrate the effort a little better. We cannot do everything, there is not enough money to go around to satisfy all the needs, so some selection has to be made and the process is always a difficult one.

There are thoughts that I would like to leave you with; two principles that I think are useful to apply. One is that technology should be developed nearest the source of application. If the main thing is awareness and giving you a base from which to move later, then certainly that kind of thing is well placed in universities; it is also useful in government for policy purposes. Universities are the best place to disseminate, the best place from which to initiate. As you get to other levels, the people applying a technology and using it, need some level but if your object is to develop a piece of hardware, then I do not think that kind of thing should be done in government. I think that should be done in the firms or in the areas where they will be producing the hardware.

So I think this principle of applying it nearest the point of application is useful. The other useful thing is that the beneficiary should be responsible for the funding, or at least for part of the funding. Well, the beneficiary should pay, I guess that is right. The beneficiary is not always the performer, not in total. You can see where the development of a technology really creates opportunities for people downstream who are not in effect performing. Certainly, when Northern Electric set up the Research Laboratories in Ottawa, it was a high

cost to them. They captured some of those benefits and I think they are capturing many of them now. But there were benefits that were transmitted to the component people, who then had an apportunity to work with the equipment designers. I know I was in the components industry at the time and Northern Electric was a tremendous stimulant to us in R&D. So in order for that level to be optimum, the only people who could in fact balance that off are those in some kind of support system. And that is where I think the role of government comes in.

But on the other hand, I am really doubtful that we should pay 100 cents on the dollar to a firm that will be the beneficiary, or in part the beneficiary of the product of the research. If they do not have some interest, they do not put in dollars; they tend not to have a great deal of interest. Again I can talk to a certain extent from experience. When I was at Mallory, we were pressured, so to speak, by a government department that will remain unnamed, to develop a product that in their view had great potential. We looked at it and did not think it had great potential, we were not interested in putting in money. They kept upping the ante until it in fact paid us a profit to do the research and we did the research. However, even if it had been good idea, we were so biased by that time that I do not think it had a chance of succeeding and it did not. So I would like to see the firm that is going to benefit put in a buck.

APPENDIX U

List of All Recommendations Made

LIST OF ALL RECOMMENDATIONS MADE

(In some instances, the general tenor of like recommendations has been consolidated into a single statement).

1. Improvements must be made in productivity in the survey business in Canada, particularly in the areas of data acquisition, management and display.

2. An expenditure on R & D of five per cent of the budget of the Surveys and Mapping Branch, Department of Energy, Mines and Resources, should be targeted for 1985. However, the federal Surveys and Mapping Branch can not be expected to carry the entire R & D load. Other levels of government and industry should also contribute funds.

3. R & D work must be monitored so that duplication of effort will be avoided, so that research will not be done for the sake of research alone and, so that the best possible dissemination of information on projects and results will be accomplished.

4. R & D is required for the development of digitized information systems, especially in the areas of development of standards, systems compatability, transfer or geo-referenced data, systems for digitizing and editing, and digital data management and display.

5. Research funds should be spent on improving geodetic procedures and instrumentation; specifically, on an improved method of high precision levelling and, on improvements in the inertial survey system and doppler satellite methods of horizontal and vertical positioning.

6. Development work should be directed toward the design and production of cadastral information systems that are simple and economical.

7. Research should be conducted toward the development of more cost-effective procedures for map revision, including an examination of the use of digitized data, and some sort of automated detection, from the air, of changes in man-made features.

8. R & D should be directed toward the development of fully integrated aircraft guidance and aerial photo acquisition systems.

9. Funds should be found to cover the cost of researching and publishing a reference book on Canadian Survey Law.

10. There is a need for improved aerial photography specifications for photography intended for orthophoto production and, for R & D in photomap reproduction processes.

11. A research project is required to develop a series of standard monuments which would fit the various field conditions to be found in Canada.

12. R & D is required for the application of satellite remote sensing data to land-use and resource inventories.

13. Improved instrumentation is required for hydrographic data collection in bathymetry.

14. Improved navigation and offshore positioning systems are required.

15. There is a need for a central surveying and mapping institute, as a central agency of expertise, and one that could, for example, provide unbiased evaluations of new instruments and procedures.

16. Some R & D is required on the comparison of the costs and problems of metro and municipal regions converting to the 1983 North American readjustment versus the costs and problems of not converting.

17. Development of position determination systems that are accurate enough and economical enough to be employed for large scale (1:20 000) mapping purposes.

18. An investigation is required of the usefulness of satellite altimetry for the determination of the shape of the geoid at sea.

19. Automated map production techniques are required which will supply selected information on such things as slopes, distances and elevations.

20. R & D is required for the definition and legal determination of locations of water boundaries, and of positions under large bodies of water.

21. Better ways should be developed to incorporate socio-economic data in geographic information systems.

22. Better methods of cartographic presentation are required so that a wider field of map users can be satisfied, and so that the users can better understand the information depicted.

23. R & D should also be directed toward smaller, everyday requirements of the small practitioner, such as small programs for conversions betwen different coordinate systems.