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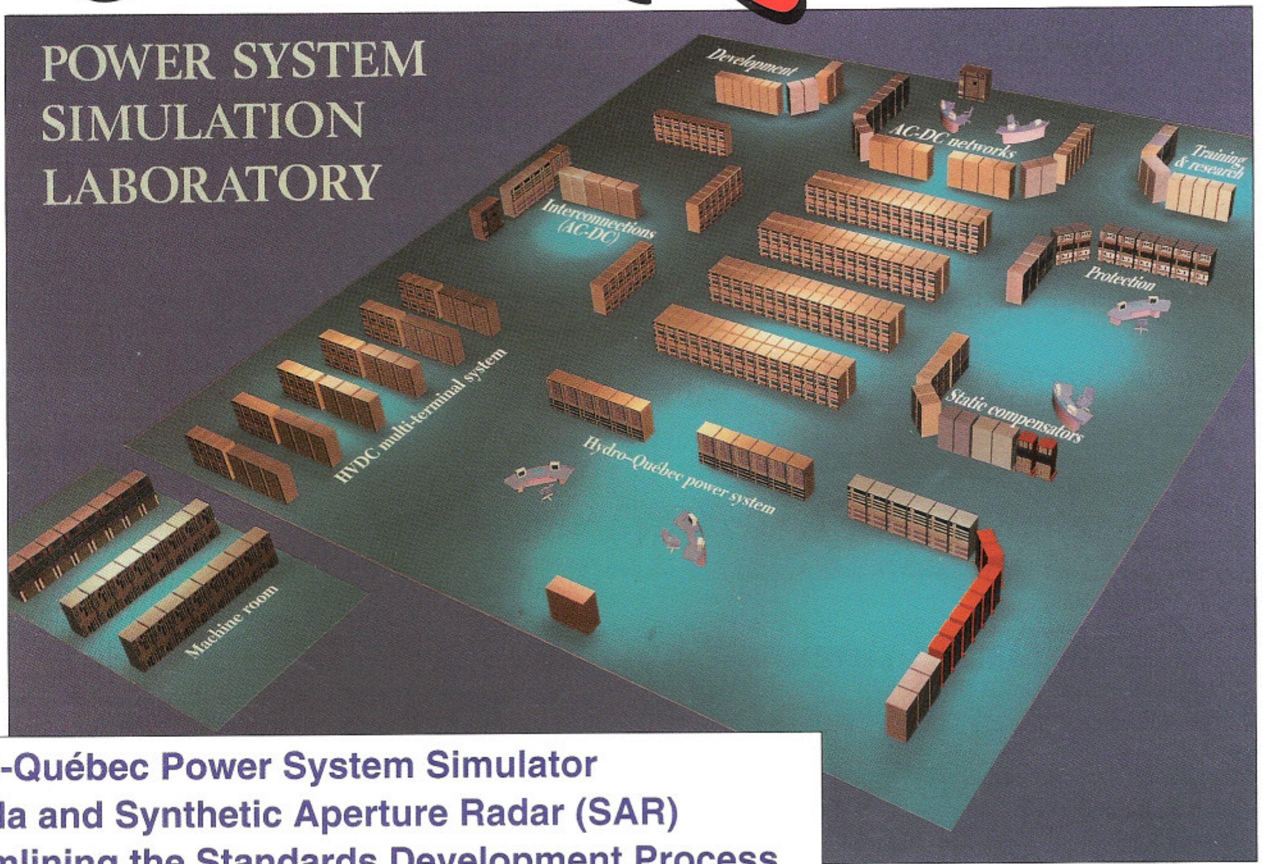

- Hydro-Québec Power System Simulator
- Canada and Synthetic Aperture Radar (SAR)
- Streamlining the Standards Development Process
- Newfoundland and Labrador Hydro's Wind and Ice Load Monitoring Test Facility

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IEEE Canadian Review General Information

The ***IEEE Canadian Review*** is published three times per year as follows: Winter (to appear in early March); Spring/Summer (to appear in early July); Fall (to appear in early November).The ***IEEE Canadian Review's*** principal objective is to project an **image** of the Canadian electrical, electronics, communications and computer engineering professions and their associated academic and business communities to :

(i) Canadian members of IEEE;
(ii) Canadian members of the profession and community who are non-members of IEEE;
(iii) the associated academic (i.e. universities, colleges, secondary schools), government and business communities in Canada.

To ensure that the ***IEEE Canadian Review*** has the desired breadth and depth, Associate Editors are responsible for identifying issues and screening articles submitted to the ***IEEE Canadian Review*** according to the following general themes :

1- National Affairs	4- Education	6- Communications
2- International Affairs	5- Power	7- Computers
3- Industry		

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Information for Authors

Authors are invited to contribute to the ***IEEE Canadian Review***. Submissions in electronic form are especially welcomed. Please contact one of the Associate Editors or the Managing Editor.

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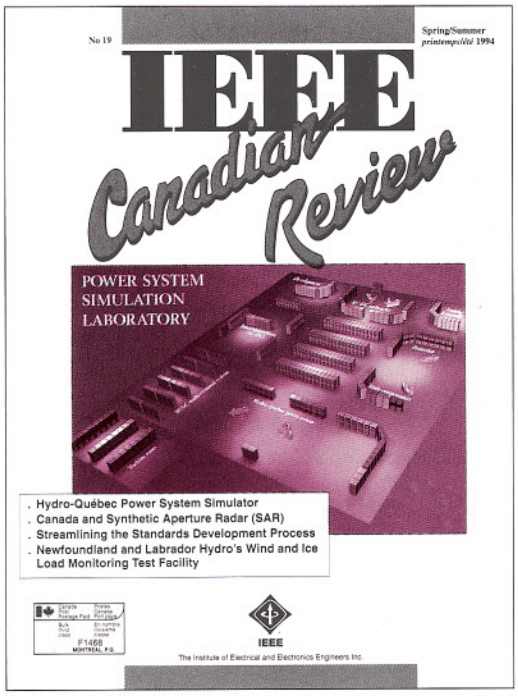
Cover picture

The photograph shows an artist's 3-Dimensional overview of the new Hydro-Québec Power System Simulator at IREQ which has been extensively used for the study of power system related transients on Hydro-Québec's network.

Tableau couverture

La photographie présente une vue en 3 dimensions du nouveau laboratoire de simulation de réseaux d'Hydro-Québec à l'IREQ. Le simulateur sert aux études des phénomènes électro-dynamiques apparaissant sur le réseau d'Hydro-Québec.



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DIRECTOR'S REPORT

by Ray Findlay
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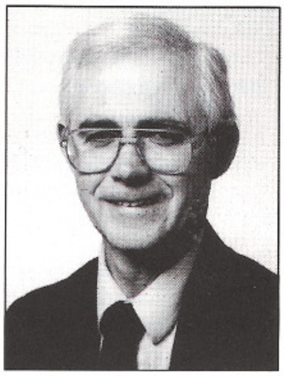

Some of you have raised concerns with me about the quality and level of service from the Operations Center in Piscataway. I, and other members of the Board have the same concerns. We are working to improve things. We are concerned that your requests to the Customer Service Center meet with swift, accurate responses. We have made some changes this year, which should result in a substantially improved member service.

But I need your help to ensure that it does happen. Keep records on dates of receipt of your renewal, date of return, check date (or credit card information), etc. If your renewal is not processed and returned within a month, let me know, and I will take action. Similarly, if you have problems ordering products or obtaining information, please tell me. In order to improve service to our members, we need to know where the glitches are.

In other news, I had my first Region meeting in Ottawa on the weekend of April 30 as your Director. I was very impressed. Ibrahim Gedeon and his Ottawa cohorts put on a truly amazing show. They arranged a reception for us on parliament hill, with a chance to talk to a few of our elected leaders. The Ottawa Section was presented with a hand-sewn banner to commemorate the Fiftieth Anniversary of its founding. Later, the Ottawa Section was again our host for a celebration to honour the Ottawa Valley Pioneers, those remarkable people who have developed the industrial and research base for Ottawa's success in the communications and computer industries. Troy Nagle, our IEEE president found time in his busy schedule to attend not only the Region meeting but also the Monday evening celebrations.

Some of the important issues at the region are:

1) Status of proposed Merger between the Canadian Society of Electrical and Computer Engineers (CSECE) and IEEE-Canada: Letters Patent of CSECE have been amended to be consistent with the legal opinion obtained by IEEE. This change has now been accepted by Consumer and Corporate Affairs. The possible incorporation of IEEE Canada as a non-profit organization is under review by IEEE Inc., and by the executive committee of IEEE Canada. The final step will be to transfer the assets of CSECE to IEEE-Canada, hopefully before our target deadline of January 1, 1995. We are also considering according IEEE membership to all full CSECE members during the interim (who are not already IEEE members). Legal expenses for the entire process should be less than $5,000. As to the possibility that IEEE-Canada might incur some liability for outstanding debts accruing to CSECE through the Engineering Institute of Canada (EIC), that threat has now been effectively removed. EIC has resolved their debt and restructured to run a much more efficient office in Ottawa. I also hope to have a line item added to the renewal form for IEEE-Canada members about subscribing to the Canadian Journal of Electrical and Computer Engineering at a base rate of $8.00 per annum (four issues per year).

2) The Region Committee also considered some modifications of the current Region 7 bylaws to bring them into line with those from other regions.

3) The Canadian Conference on Electrical and Computer Engineering will be held in historic Halifax 25- 28 September at the World Trade and Convention Centre. I hope that anyone who can support the conference will do so. We will be holding our second region meeting on September 24-25 at the Delta Hotel and any IEEE member who might wish to observe the proceedings is welcome.

4) Through the excellent efforts of Dr. Jacek Chrostowski, our Region e-mail coordinator, IEEE-Canada has been awarded a grant of $85,000 from CANARIE - The Canadian Network for the Advancement of Research, Industry, and Education, to develop advanced electronic services for our members. The grant will be used to purchase a computer server with modem/fax cards for each Section in Canada. Three part time computer specialists, augmented by enthusiastic volunteers, will be working to establish uniform electronic services across Region 7, including bi-directional fax/email communication. We will also be organizing a fall workshop for volunteers from each Section.
The Vancouver Section has already implemented a distributed communications and information architecture for the 1600 IEEE members in the Vancouver Section, through the inspiration and dedication of Pieter Botman. The Hamilton Section is also working to establish a Freenet system for its members with a Gopher service.

5) We have been working closely with the IEEE Canadian Foundation, incorporated as a charitable institution in Canada, so that IEEE-Canada members may make charitable donations or bequests more easily in Canada for the benefit of IEEE-Canada. Please direct all your inquiries to the IEEE Canadian Foundation, c/o Luc C. Matteau, 456 Rogers Street, Peterborough, ONT, K9H 1W9, or contact Luc at l.matteau@ieee.org or by Fax 705-741-0466, or phone 705-745-2431. In addition, we are asking permission to have an additional line added to the dues renewal form to enable such donations as part of dues.

6) Finally, with the agreement of the Region Committee, I have hired an Administrative Assistant to help with the organization and the paperwork of the Region. She has a mail drop, fax number and an email address (c.lowell@ieee.org). She is working from her home.

Finally...

Both Eastern and Central Canada Councils celebrate 25 years of active service this year. On behalf of the Region I send them anniversary greetings, and wish them every success for the future.

RAPPORT DU DIRECTEUR

Certains d'entre vous ont manifesté quelques inquiétudes quant au niveau de qualité du service du Centre des opérations de Piscataway. Des membres du Conseil et moi-même partageons vos préoccupations. Nous travaillons présentement à l'amélioration du service. Nous souhaitons que les réponses à vos demandes soient faites avec promptitude et exactitude. Nous avons effectué quelques changements cette année qui devraient améliorer considérablement le service auprès de nos membres.

Afin de poursuivre notre objectif de qualité, j'aimerais m'assurer de votre collaboration. En ce qui a trait à votre renouvellement, il serait important que vous gardiez tous les renseignements tels que la date et le reçu de votre renouvellement, la date de votre chèque (ou votre relevé de carte de crédit), etc. Si votre renouvellement n'a pas été effectué dans le mois qui suit, faites-le moi savoir afin que je puisse remédier à la situation. De même, si vous avez de la difficulté à obtenir l'information recherchée ou à commander certains produits, il est important que vous m'en faisiez part. De façon à améliorer le service aux membres, nous devons savoir à quel niveau se situe le problème.

D'autre part, j'ai participé, pour la première fois à titre de Directeur, à la rencontre régionale du 30 avril dernier à Ottawa. J'ai été très impressionné par l'extraordinaire organisation d'Ibrahim Gedeon et ses collègues d'Ottawa qui ont orchestré cet événement de façon remarquable et même qu'une réception sur la colline parlementaire nous a permis de rencontrer certains de nos élus nationaux. La Section d'Ottawa a été honorée d'une bannière pour commémorer le 50e anniversaire de sa fondation. Dernièrement, la Section d'Ottawa a aussi été l'hôte d'une célébration en l'honneur du "Ottawa Valley Pioneers", ces gens remarquables qui sont à l'origine du succès du marché industriel et de la recherche en matière de communications et d'informatique à Ottawa. Malgré un horaire chargé, le président d'IEEE, Troy Nagle, a assisté non seulement à notre rencontre régionale, mais aussi aux célébrations spéciales du lundi soir.

Voici les principaux points qui sont ressortis de cette rencontre :

1) L'état actuel de la proposition de fusion entre la société canadienne de génie électrique et informatique (CSECE) et IEEE Canada. Les lettres patentes de la CSECE ont été amendées de façon à être consistantes avec l'opinion légale obtenue par IEEE. Ce changement a maintenant été accepté par Consommation et Affaires Commerciales Canada. L'incorporation possible de IEEE Canada comme organisme à but non-lucratif est présentement à l'étude par IEEE Inc. et par l'exécutif de IEEE Canada. La dernière étape sera de transférer les avoirs de CSECE à IEEE Canada et ce, avant notre date limite cible du 1er janvier 1995. Nous envisageons également la possibilité d'accorder une adhésion à IEEE à tous les membres à part entière du CSECE durant la période d'intérim (ceux qui ne sont pas déjà membres de IEEE). Les frais légaux de cette procédure devraient s'élever à moins de $5,000. Quant à la possibilité pour IEEE Canada d'avoir à endosser certaines dettes accumulées par la CSECE à travers l'Institut des ingénieurs du Canada (EIC), elle ne se pose plus. L'EIC a résolu ses difficultés financières et a restructuré son bureau d'Ottawa. Je souhaiterais aussi ajouter une précision dans le formulaire de renouvellement des membres IEEE Canada pour leur abonnement au "Canadian Journal of Electrical and Computer Engineering" à savoir que le taux de base sera de $8 par année (4 numéros).

2) Le comité régional a discuté de quelques modifications concernant les règlements de la Région 7 afin de les harmoniser avec les autres régions.

3) Le congrès canadien en génie électrique et informatique aura lieu dans la ville historique d'Halifax du 25 au 28 septembre prochain au "World Trade and Convention Centre". J'espère que tous ceux qui le peuvent apporteront leur support à cette conférence. Nous tiendrons notre deuxième rencontre régionale les 24 et 25 septembre à l'hôtel Delta et tous les membres IEEE qui désirent y assister à titre d'observateur y seront bienvenus.

4) Grâce à l'excellent travail de Jacek Chrostowski, notre coordinateur régional pour les communications électroniques, IEEE Canada s'est vu octroyé une subvention de $85,000 de CANARIE (Canadian Network for the Advancement of Research, Industry, and Education) pour le développement de services électroniques de pointe pour nos membres. Cette subvention servira entre autres à l'achat d'un ordinateur avec cartes modem/fax pour chaque Section du Canada. Trois spécialistes en informatique ainsi que de fervents volontaires travailleront, à temps partiel, à l'établissement de services électroniques uniformisés pour la Région 7, incluant la communication par fax/messagerie électronique bi-directionnelle. Nous organiserons à l'automne des ateliers pour les volontaires de chaque Section.
   La section de Vancouver a déjà implanté un réseau de communication et d'information pour les 1,600 membres d'IEEE de leur section grâce au dévouement de Pieter Botman. La section d'Hamilton travaille aussi à établir un réseau «Freenet» avec un service «Gopher» pour ses membres.

5) Nous avons travaillé étroitement avec la fondation canadienne de IEEE, incorporée comme corporation charitable au Canada, de telle sorte que les membres de IEEE Canada puissent faire des dons plus facilement au Canada au profit de IEEE Canada. Veuillez faire parvenir vos demandes à la Fondation canadienne IEEE, a/s Luc C. Matteau au 456, rue Rogers, Peterborough, Ontario K9H 1W9 ou par courrier électronique à : l.matteau@ieee.org, ou encore par télécopieur au (705) 741-0466, ou par téléphone au (705) 745-2431. De plus, nous recommandons d'ajouter sur le formulaire de renouvellement d'adhésion IEEE que les dons fassent partie du montant total des redevances.

6) Finalement, avec l'accord du comité régional, nous avons engagé une assistante administrative qui nous secondera dans l'organisation matérielle du bureau régional. Vous pouvez la contacter par la poste, par télécopieur ou par courrier électronique (c.lowell@ieee.org.). Elle travaille depuis son domicile.

Finalement ...

Les conseils de l'est et du centre du Canada fêteront leur 25e anniversaire cette année. De la part de la Région, je leur offre mes meilleurs voeux et leur souhaite beaucoup de succès pour l'avenir.

HYDRO-QUÉBEC POWER SYSTEM SIMULATOR

by C. Gagnon, V. K. Sood, J. Bélanger. A. Vallée, M. Toupin, P. Mercier, and M. Tétreault

Over the past 20 years, IREQ (Institut de recherches d'Hydro-Québec) has built up a strategic simulation facility for the design and commissioning of power transmission systems. This real-time simulator has been extensively used by Hydro-Québec and other utilities for the verification and optimization of real controls and protection equipment.

Au cours des 20 dernières années, l'IREQ (Insititut de recherches d'Hydro-Québec) a developpé des moyens stratégiques de simulation pour évaluer la conception et pour mettre au point avant la mise en route, les équipements de réseaux électriques. Le simulateur de réseaux de l'IREQ a été largement utilisé par Hydro-Québec elle-même et plusieurs autres sociétés de gestion de systèmes électriques pour la vérification et l'optimisation des équipements de régularisation et de protection des réseaux, assurant ainsi une meilleure sécurité et fiabilité de ces équipements.

The complexity of power transmission systems has increased dramatically over the past 20 years as a result of economic and environmental constraints. Multiterminal HVDC (High Voltage Direct Current), SVCs (Static VAR Compensator), series capacitors, FACTs (Flexible AC Transmission Systems) as well as sophisticated protection and control schemes have ever greater impact on modern power system performances. Utilities that face these problems must therefore have access to real-time simulation facilities in order to cope with any problem not recognized at the design stage, but detected at the commissioning or operating stages.

During the sixties, Hydro-Quebec made extensive use of transient network analyzers (TNAs) for the design and commissioning of the world's first 735 kV transmission system interconnecting the 5000-MW Manicouagan hydro electric plants to the main power grid. Recognizing, on the one hand, the strategic importance of such tools for the development of its power transmission system, and, on the other hand the limited capability and excessive losses of commercially available TNAs, IREQ (Institut de Recherches d'Hydro-Québec) designed and built a real-time power system simulator capable of simulating large high voltage transmission systems.

First commissioned in 1973, the IREQ simulator (cover picture) has undergone continuous upgrading and evolution over the past 20 years to keep pace with technological advances. The simulator was used extensively for the design and commissioning of Hydro-Quebec's James Bay transmission system as well as by several other utilities around the world for the simulation of their own systems.

Simulation Technology

The simulator uses well proven and reliable analog, electronic and digital technologies for the simulation of power system elements by lumped reactors, resistors and capacitors, saturable cores, etc. Its rated operating voltage of 100 V phase-to-phase and maximum short-circuit current of 5 A were selected to minimize the losses and increase the precision of EHV (extra high voltage up to 400kv) and UHV (ultra high voltage, above 735kv) system simulation.

The simulator operates in real-time at the nominal system frequency (60 Hz or 50 Hz). Real-time behavior permits the verification and optimization of real controls and protection equipment which can be connected to the simulator, much as in the field, by special interfaces and models. The performance of the controls can thus be evaluated under realistic operating conditions, including very severe but probable contingencies that are difficult and often impossible to duplicate in the field.

Another advantage of the real-time capability is the speed of test execution. The simulation of a phenomena lasting 1 second takes 1 second instead of several minutes or hours as with conventional simulation software operating in deferred (non real) time. This makes it possible to perform detailed optimization studies that may include random variation of parameters such as circuit-breaker switching instants. Rapid interaction with the user is vital in investigations of complex phenomena and controller trouble shooting. Such studies involve a "what if" type of analysis for which it is very important to minimize the simulation time, since the next test or actions depend upon the conclusions of the previous test.

The key features of the Hydro-Québec Power System Simulator are:

- Real-time simulation capability;
- Hybrid technology that includes passive and electronic analog models and also real-time digital models;
- Large numbers of low-loss analog models for the simulation of complex EHV networks;
- Large numbers of SVC and HVDC system models (Figure 1);
- Interconnection with commercial protection and control systems;
- Sophisticated software and computer system for test automation, data recording, on-line analysis, post-processing and report editing;
- Central-computer-controlled interconnection panels for control of network configuration from computer terminals;
- An integrated database for results and input data used for the real-time simulation and conventional off-line simulation software packages;
- A unique layout allowing system studies, control and protection validation tests, research projects and training sessions to be conducted simultaneously.

Passive analog components such as reactors, capacitors and resistors are used to model transmission lines, transformers (with saturation), shunt

Figure 1 : Photograph of HVDC controllers.

reactors, constant-impedance loads, series and shunt capacitors and filters, etc.

System voltage levels are scaled down to a nominal 100 V phase-to-phase on the simulator and an impedance scaling factor is selected to keep the fault current below 5 A. This scaling factor makes it possible to study all practical phenomena within a dynamic range of 10 A to 50,000 A with the same setup. The frequency bandwidth of the simulator components is limited to approximately 20 kHz, although the bandwidth of the simulation will also depend upon the complexity of the models used.

This basic analog technology is well known and proven, having been used around the world since the earliest days of the electrical industry. The main difficulty with the use of real but small inductors and transformers operating at low voltages are the copper and core losses, which are usually higher, as a percentage, than the losses of real components operating at high voltages. Consequently, special care must be taken to minimize these losses yet still maintain acceptable inductance linearity.

Electronic components are used to simulate arresters, circuit breakers and thyristor valves. Negative resistances are also available to reduce the copper losses of reactors and transformers when required.

Real-time digital models are used to simulate synchronous machines with their regulation systems as well as SVC and HVDC controls and dynamic loads. Complex transmission lines are under development. Real-time computers are also used to generate all the voltage waveforms of the more than 100 three-phase simple equivalent sources available to establish the load flow. Circuit-breaker switching sequences and closing resistor parameters are likewise computer-controlled, allowing automatic execution of complete series of random switching tests for statistical and optimization studies.

Computer-controlled network interconnection panels are conveniently located in each test area. Each terminal of each model is connected to these panels via computer-controlled switches. The network status thus always conforms to the study database information and is controlled automatically for each test. Any voltage or current can be easily measured, since the input and output terminals of all models are available from the front panels of the interconnection system. This concept has been found to be very useful over more than 20 years of experience with the simulation of large complex networks.

The computer recording system of each test area comprises at least one A/D converter with 128 13 bit analog multiplexed input channels (Figure 2) and 64 digital multiplexed input channels, for a total of 192 input channels. The maximum data transfer rate is 1 mega-samples per second. A 12-Mb memory is dedicated to each A/D and since it is connected directly to the VME bus of the main computer, the time that would have otherwise been required for data transfer is eliminated. This speeds up result analysis and reduces the total execution time of large statistical and optimization studies.

Recorded waveforms can be visualized in "nearly real time" from any graphics workstation located in the test area or anywhere in the laboratory.

A waveform playback system has been developed and is used for protection system verification with previously recorded waveforms obtained from the simulator or EMTP (Electro-Magnetic Transients Program) simulation. Field test data can also be played back. This has been found to be very useful in checking corrections made to protection systems after the simulation setup is dismantled.

The computer system is based on a network of Sun workstations and file

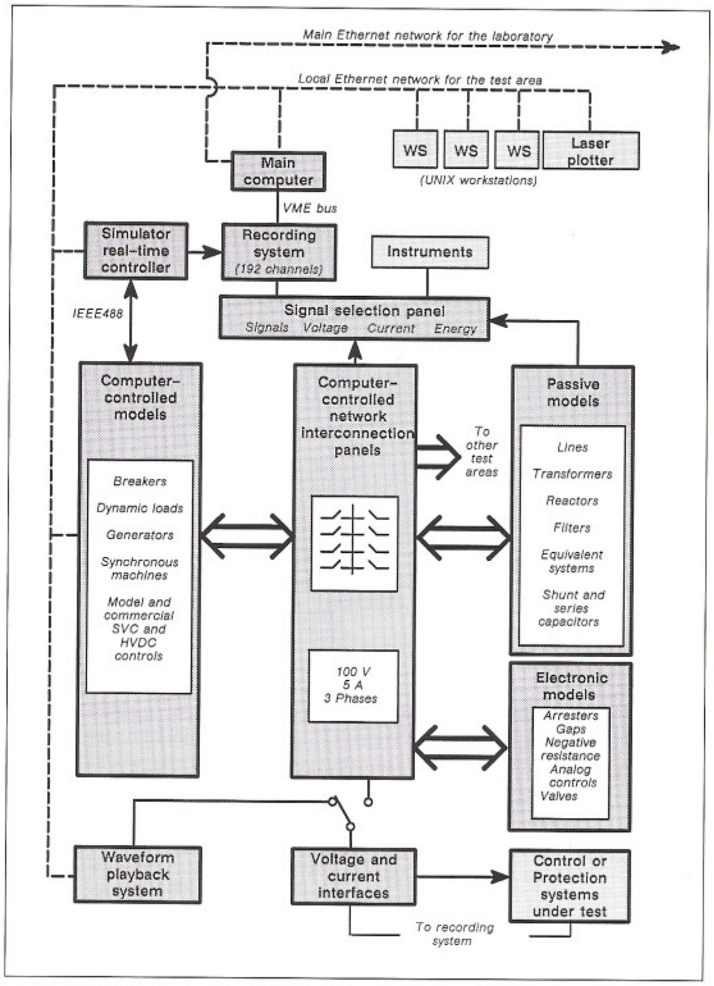

Figure 2 - The block diagram of a typical test area of the Hydro-Québec simulation laboratory.

servers running UNIX, capable of handling and storing large amounts of data. Each workstation can control the simulator models and display the test results and waveforms as well as executing many other simulation and analysis programs. Figure 3 shows the general organization of the software library which includes the study data input and processing, network reduction, verification of the simulation precision, test execution, results and waveform analysis, post processing and report production.

Most of the software is written in C, with some older programs written in FORTRAN. VxWorks[tm] tools are also used to manage real-time elements of the simulation. The main user interface is developed under X Windows on the SUN workstations. New user interfaces for the network schematics and numerical models are under development in C++ using object-oriented techniques. It is expected that CASE tools will be introduced at a later date.

In fact, most of the software programs developed over the last 20 years are independent of the simulation tools and are also used to perform studies with conventional off-line simulation program such as EMTP, when the real-time simulation capability is not required.

An essential feature is the use of a common database for the system data. Specialized interface software automatically generates the connection list of the simulator models, configuration files for control of the network status, and input files for conventional simulation and steady-state analysis programs. This is important for an efficient and reliable validation of the simulation which sometimes is the most challenging task of the study! This common data base ensures the integrity of system data, results and test description, and facilitates production of the test reports.

Conclusion and Future Developments

Hydro-Quebec has commissioned a new simulation facility that incorporates its many years of experience with the development and operation of simulation tools. This facility combines the advantages of different proven and state-of-the-art technologies, including analog, electronic and digital simulation techniques, to achieve the best compromise between the simulation precision, capacity, operating flexibility, cost and delivery schedule.

Hydro-Quebec is now completing the development of a fully digital real-time simulator to further improve the precision and operating flexibility of real-time simulation techniques. It believes that, due to the increasing complexity of power transmission systems, including their protection systems and control strategies, other utilities will recognize the advantages of these simulation facilities for the design and optimization of their transmission systems meant to cope with increasing difficult economic and environmental constraints.

Acknowledgments

Many members of IREQ's "Service Simulation de réseaux" contributed to the development of the simulator described here and it would be difficult to name them all. Thanks go to the entire team.

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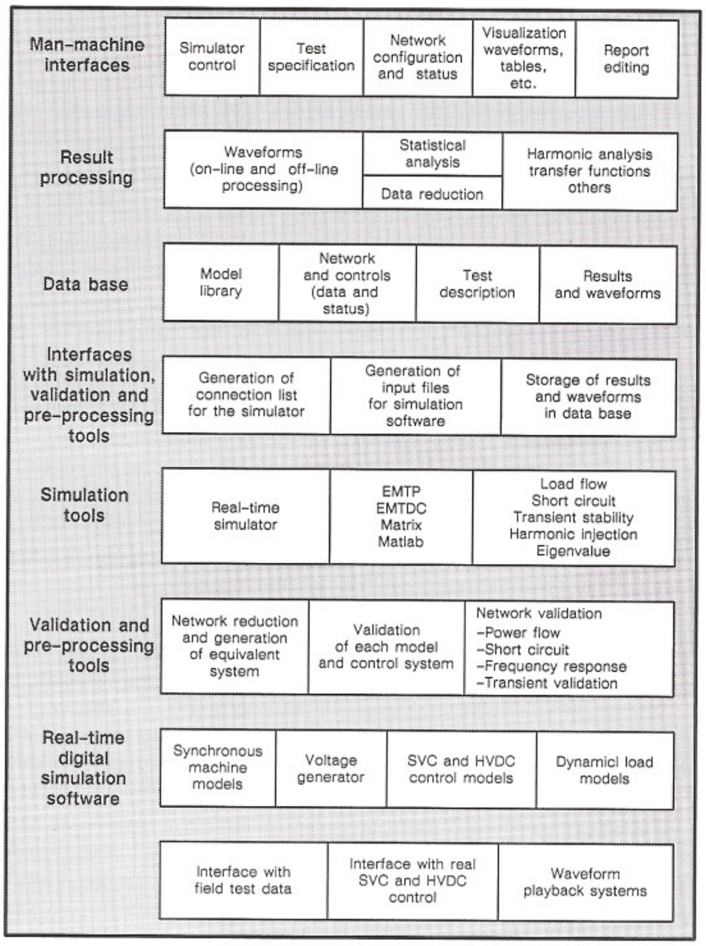

Figure 3 : General organization of the simulator's software library.

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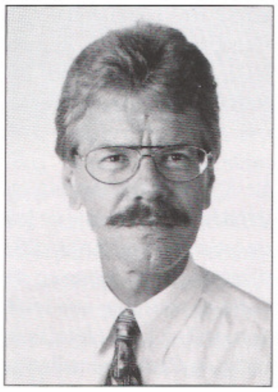
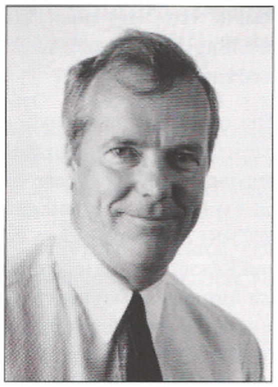
About the authors

Michel Toupin



He was born in Champlain (Québec) in 1951. He received a Specialized Baccalaureat in Applied Science (Electrical Engineering) in 1974 from Université du Québec à Trois-Rivières. He joined Hydro-Québec after graduation as a Commissionning Engineer for exciter system and speed regulators of large hydraulic synchronous generators. In 1986, he received a Master's Degree in Power Systems Engineering from Ecole Polytechnique (Montréal). After two years with the Power System Planniing Department of Hydro-Québec, he joined, in 1987 the Power System Simulation Department at IREQ where, for the past four years, he is the Manager of the Power System Control Studies Group.

Alain Vallée



He was born in Montréal (Québec) in 1953. He graduated in Operations Research in 1976 from Université de Montréal and obtained a Masters degree in Operations Research from the same university in 1981. He worked for two years as a research assistant at Alcan Smelters and Chemicals before joining Hydro-Québec in 1979 as a mathematician in the Operations Planning Department. In 1986 he joined the Power Systems Software Department as a researcher, and became Manager of this department in 1992. He is presently the Manager of the Power System Simulation Department at IREQ.

Charles Gagnon

He graduated in Electrical Engineering from Université de Sherbrooke (Québec), and joined IREQ in 1985 in the Department of Network Analysis Software. In 1987, he worked with Brown Boveri for a year in their System Protection department. In 1988, he returned to IREQ in the Department of system Simulation where he is, since 1990, head of the team for AC and DC system studies.

Vijay Sood

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Michel Tétreault

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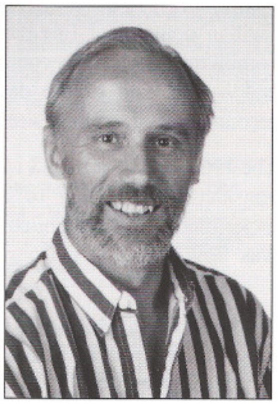
Pierre Mercier



He graduated in Engineering Physics in 1971 from Université Laval (Québec). He obtained a Masters degree in Nuclear Engineering from École Polytechnique (Montréal) in 1973. He worked for 15 years in the Hydro-Québec nuclear programme devoting his time to analytical work supporting nuclear safety. In 1988, he joined the Power System Simulation Department at IREQ where he is presently Manager of the Simulation Techniques Group.

Canada and Synthetic Aperture Radar (SAR)

Canada has become a major force in the area of fine resolution imaging radar systems.

by *Major Pushkar E. Godbole, Dr. Charles Livingstone, Dr. Raymond Lowry, Anthony Luscombe*

Canada has taken a leadership role in radar and radar remote sensing and will, with the launch of RADARSAT next spring, further solidify that leadership role. This introductory article reviews recent Canadian activities in radar, and forms an introduction to a series of four full length articles planned to cover this area in greater depth. The articles will cover commercial radar remote sensing, research on radar at the Canada Centre for Remote Sensing, the work at the Department of National Defence on Spotlight SAR, and finally the complete RADARSAT development.

Le Canada est devenu un leader dans la technologie radar et la télédétection. Ce rôle de leadership s'accentuera davantage à l'occasion du lancement de RADARSAT, prévu au printemps prochain. Cet article d'introduction passe en revue les dernières activités en technologie radar et constitue une introduction à une série de 4 articles qui seront consacrés à la télédétection commerciale par radar, à la recherche sur le radar au Centre canadien sur la télédétection, aux travaux effectués au Département de la défense nationale sur le ROS spotlight, et enfin à toutes les phases de RADARSAT.

Canada and Canadians have become well known in the international imaging radar community because as a nation, we have been responsible for more than our 'share' of developments in recent years. *IEEE Canadian Review* will feature in the next 4 issues, a series of articles describing four areas of development which have contributed to this international reputation. This article is meant as an introduction to these four articles.

Synthetic Aperture Radar or SAR is a type of imaging radar that has become particularly important in Canada. Both the "all weather" capability of SAR and its ability to provide fine spatial resolutions independent of range have been particularly valuable for military reconnaissance and for a wide range of civilian terrain mapping / monitoring applications. This has been especially true for support of marine operations in the Arctic which in turn has been a very formative influence on the development of SAR in Canada.

Canada covers large areas in the Arctic with very limited resources for surveillance and control. Since the Arctic has long periods of darkness and frequently is cloudy, radar has long been seen as the best sensor for reconnaissance in this region. During World War II, airborne search radars were developed to the point where small targets such as icebergs could be detected, and plan position indicator (PPI) displays were developed which gave a crude picture of the terrain or ocean surface being imaged. During the 1940s and 1950s, a number of long-range surveillance aircraft were deployed, equipped with sensitive search radars. Although these were military systems, they were used to provide information on targets of general interest such as floating sea ice. The information so obtained began to be used to support not only naval operations, but also civilian shipping through agencies such as national Coast Guards.

In the 1950s, radar technology advanced rapidly and gave rise to practical Side Looking Airborne Radar (SLAR)[1] systems, which were tested for ice reconnaissance on a research basis. By the 1960s, substantial operational trials of SLARs for ice reconnaissance were being organized by the U.S. and Canadian Coast Guards, by the International Ice Patrol, and, in the former Soviet Union by the Arctic and Antarctic Research Institute (AARI) in St. Petersburg (Leningrad). The 1970s saw the introduction of operational SLAR ice reconnaissance systems and the trials, in the civilian domain, of fine-resolution SAR systems. By the early 1980s, commercial SAR ice reconnaissance data were being collected routinely and by the end of the decade, comprehensive SAR and SLAR ice reconnaissance systems were being flown operationally.

The 1969 sailing of the SS Manhattan through the Northwest Passage was considered something of a success for ice reconnaissance. On an experimental basis, a Philco-Ford AN/UPD-2 Ku-band (16.5 GHz) radar was flown on a U.S. Coast Guard (USCG) C-130 ice reconnaissance aircraft. The purpose was to determine if ice concentration, floe size and number, ice-surface topography, age, and deformation could be identified from the imagery. A detailed analysis of these data was made (Johnson and Farmer, 1971) and the results were compared with surface data taken by scientists on board the SS Manhattan and the Canadian Coast Guard (CCG) ice breakers John A. MacDonald, and Louis St-Laurent. The results were very encouraging as most of the objectives were realized, resulting in increased interest in imaging radars for tasks such as ice reconnaissance.

The conditions in Canada during the late 1970s and early 1980s were particularly favorable to the development of an operational sea ice remote sensing capability. There were tax incentives in place that made frontier oil exploration very attractive. The Canada Centre for Remote Sensing (CCRS) of the Canadian Government's Department of Energy, Mines, and Resources was leading research into radar remote sensing. Canadians are fortunate in having close proximity to the USA, where a great deal of civilian sensor development and scientific research, in substantial part stimulated by National Aeronautics and Space Administration (NASA), was taking place. As a result of these and other circumstances, Canadians were well placed to develop a substantial industrial ice reconnaissance capability.

A federal government Interdepartmental Task Force study in the mid-1970's recommended that Canada develop a satellite surveillance capability. This resulted in the establishment of the Surveillance Satellite

1. SLAR systems rely on the movement of the platform to provide the second axis of a two dimensional image. The antenna is pointed perpendicular to the flight path, and the data are recorded as a strip image. The across strip dimension is radar range, and the along strip dimension represents aircraft position.

Project, (SURSAT) Project (VanKoughnett et al, 1980) which led more or less directly to three of the four of the initiatives to be described in this series of articles. The SURSAT Program had, as a prime objective, the development of user requirements for radar remote sensing in Canada. There were two main parts to the SURSAT program, an airborne SAR and a spaceborne SAR.

The airborne SAR was developed by importing an existing experimental radar and installing it on the CCRS Convair 580 aircraft. The radar used was, at the time, the best available nonmilitary research radar: developed by the Environmental Research Institute of Michigan (ERIM) a dual-polarized X-and L-band SAR (Rawson and Smith, 1974). The combination of the CCRS aircraft and the ERIM X/L SAR became known as the SAR-580 system (Inkster et al., 1979). This system played a crucial role in the SURSAT Program by generating large amounts of quality SAR data which were used by a wide variety of researchers to develop applications for radar data.

The spaceborne SAR which became part of the SURSAT program was the NASA SEASAT SAR. The Canadian contribution to the program included the development and operation of ground receiving facilities in St. John's, Newfoundland and Prince Albert, Saskatchewan, and the development of digital SAR data processing facilities to convert the raw SAR data to imagery. This program provided a wealth of data and experience both on the applications side, and on the engineering side, thereby laying the groundwork for the development of RADARSAT.

The remote sensing community in both government and commercial sectors became involved in the analysis of SAR imagery for a variety of applications including geological mapping, forestry, agriculture, hydrology, Search and Rescue, sovereignty surveillance and ice reconnaissance. Numerous experiments were planned and conducted throughout Canada including the Arctic. These experiments demonstrated the advantages of SARs finer spatial resolution and improved radiometric resolution as compared to SLAR systems then commonly available. A number of groups studied the data from these and other experiments and reported on the results in the SURSAT Final Report. Much of the activity at the time was centered on the petroleum exploration effort in the Arctic, which was taking place due to the Middle East Crisis of the early 1970's.

Although the Department of National Defense (DND) participated fully in the SURSAT program, it has always had sufficiently different requirements compared to civilian users to justify a separate research and development program. An imaging radar is extremely well suited to military applications because of its long stand off range and its inherent ability to operate at night and through clouds. In a large sparsely populated country such as Canada, territorial surveillance of the land mass and surrounding oceans can be very difficult and costly. An imaging radar acts as a force multiplier since it allows a single aircraft to observe a much greater area than would normally be possible with visual sensors alone. As a result of these benefits, DND embarked on a SAR development program in the early eighties known as the Spotlight Synthetic Aperture Radar Project. An experimental prototype version of the Spotlight SAR system was developed at the Defense Research Establishment Ottawa and flight tested on an aircraft operated by the National Research Council's Institute for Aerospace Research. The technology behind the Spotlight SAR system is uniquely Canadian and will be exploited in future phases of the project.

A number of lessons for future civilian SAR development were learned from the SURSAT program. The result demonstrated that although SAR was well suited to a wide range of civilian remote sensing needs, the instruments available at that time were neither sufficiently precise nor sufficiently stable to realize the potential of the technology. In 1979, CCRS initiated a program to establish civilian SAR technology and to develop Canadian SAR systems that could provide the quantitative measurements needed to support the evolving radar remote sensing requirements. This program led to the construction of the current CCRS C and X band SARs by MacDonald Dettwiler Associates (MDA) in Vancouver and provided the technology base needed to build Canadian, commercial SARs. It also led, more or less directly, through the Canadian Space Agency (CSA), to the development of a national remote sensing satellite system, RADARSAT, which will be launched in the spring of 1995 (RADARSAT, 1993). Continued effort at CCRS, DND (Defense Research Establishment Ottawa, DREO) and at MDA and Intera have helped Canada gain international recognition for excellence in airborne SAR remote sensing.

The first article in this series (next issue) will describe the STAR-1 radar, the world's first commercial remote sensing SAR digital system. This system has now expanded from ice reconnaissance into many other areas of remote sensing including mapping and tropical forest monitoring. It remains, to this date, the only fully commercial SAR in service, with all other airborne SARs being developed for remote sensing research or for military reconnaissance. The system, which is constantly being upgraded, represents the state of the art in operational systems. It is routinely used to provide fine resolution imagery, Digital Terrain Models, forestry and other land use maps, over very large areas on a routine basis.

The second article in the series will describe the current CCRS airborne radar activities. CCRS has continued to develop SAR remote sensing technology, based in large part on a rebuilt SAR-580 system. The current system is a dual frequency (X-band, 3 cm and C-band 5 cm) dual polarized system (H or V transmit, H and V receive). The C band radar is capable of operating in full polarimetric mode[1]. In addition, it has an interferometric mode[2] that can be used to measure terrain height with single pass data. This system has, for many years, been a world standard for SAR research, since it has provided a large number of users, world wide, with quality SAR data with sufficient flexibility in frequency, polarization and other radar parameters to allow significant research to be conduced.

The third article in the series will describe DND's Spotlight Synthetic Aperture Radar (SSAR) Project. The aim of this project is to develop an all weather, long range target classification and surveillance capability for Canada's fleet of CP-140 Aurora Long Range Patrol Aircraft. The Spotlight SAR project will provide DND with one of the most sophisticated SAR systems in the world and will help establish Canadian Industry as a world leader in this area of surveillance technology.

The last article in the series will describe Canada's most ambitious undertaking to date, the operational radar remote sensing satellite, RADARSAT. Starting from the Canadian base of experience obtained from airborne systems, the RADARSAT system development was initiated with Arctic ice monitoring and ship routing as primary applications. The final design for the radar now incorporates a versatility of operation which allows the system to provide a variety of image products which is unprecedented for a satellite SAR. The various modes of the system offer a wide choice of swath width, resolution and imaging angle, making the data valuable in many different applications. The satellite will also be unprecedented in its ability to achieve radar imaging of the Antarctic continent. In order to ensure that its potentially valuable

1. Polarimetric radars are capable of receiving the entire range of like and cross polarized signals (HH, VV, HV and VH) and recording their phase and amplitude in near real time. The resulting data set can be used to reconstruct the entire Stoke's scattering matrix of the terrain imaged with the radar (Ulaby and Elachi, 1990).

2. Interferometric radars have the capability to record the phase and amplitude of the returns from all pulses, simultaneously at two antennas on the same aircraft. By measuring the phase difference at the two antennas, the height of the terrain above the reference datum can be calculated. In this way a true Digital Elevation Model can be constructed, (Graham 1974).

worldwide application can be realized, a Canadian ground segment has been developed for reception, processing and distribution of data. The satellite is due for launch in 1995 and seen as the first in a series of Canada-led advanced radar remote sensing satellites to be developed by the CSA from their offices in St. Hubert, near Montréal.

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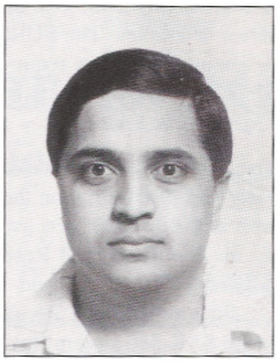
About the authors

Ray Lowry

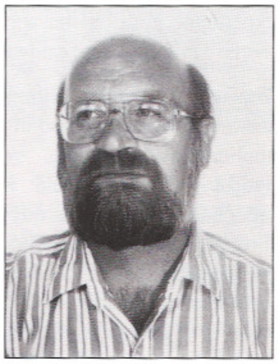
With a background in Electrical Engineering from the University of Saskatchewan, and Imperial College, London, his work has been in radar and related remote sensing areas. Since 1978, he has been an industrial scientist with Intera Technologies of Calgary working on the development of Synthetic Aperture Radars and their application to a variety of remote sensing problems.

Major Pushkar E. Godbole



He is an Aerospace Engineering Officer with the Canadian Airforce. He graduated from the Royal Military College in 1983 with a degree in Computer Engineering and was stationed with 407 Maritime Patrol Squadron in Comox, British Columbia until 1987. He subsequently pursued post-graduate studies at Carleton University and graduated with an M. Eng. degree (Electronics) in 1989. Since that time Major Godbole has been employed on the Spotlight SAR project at National Defence Headquarters in Ottawa and he is currently the Engineering Manager for the Spotlight SAR project.

Charles Livingstone



He received the B.Sc. degree in physics in 1965 and the M.Sc. degree in geophysics in 1967 from the University of British Columbia. He received the Ph.D. degree in physics in 1969 from the University of Western Ontario. He joined the Canada Centre for Remote Sensing in 1976 and is currently a senior research scientist at this institute. He has conducted a number of research and engineering programs in sea ice and oceans remote sensing and in the development, extension and calibration of airborne synthetic aperture radars. He is curently completing calibration work on the CCRS SAR polarimeter. Dr. Livingstone is a member of the IEEE Geoscience and Remote Sensing Society and is registered as a Professional Engineer in the Province of Ontario.

Anthony Luscombe

He received his B.A. and M.A. degrees in mathematics from St.-John's College, Cambridge University (Englang) in 1976 and 1980. From 1977 to 1984 he was with the Marconi Research Centre at Great Baddow, England working on a variety of remote sensing projects. During this period, he undertook work in synthetic aperture radar system design and performance analysis, including a number of studies for the European Space Agency for ERS-1 and advanced SAR systems. Since 1984, he has been a SAR Specialist and Staff Scientist at Spar Aerospace in Sainte-Anne-de-Bellevue (Québec).

STREAMLINING THE STANDARDS DEVELOPMENT PROCESS

by Wallace S. Read and Jay Iorio

The IEEE Standards Process Automation System[tm] is an integrated computer and telecommunications application of state-of-the-art technologies to facilitate and automate standards development and other processes involved in information exchange. System users will be able to access draft, current and archive standards as well as draft documents of newer technologies in progress without respect to their hardware or software platform.

The project has been under development for over 6 years through interaction with IEEE members from industry, government and other standards bodies interested in the application of technology to improve the present process of information development,dissemination and exchange.

Le SPAsystem[md] (pour Standards Process Automation System) de l'IEEE est un système d'application intégré de technologie de pointe en matière d'informatique et de télécommunications visant à faciliter et à automatiser la mise au point des normes ainsi que les autres processus reliés à l'échange d'information. Ses utilisateurs pourront notamment avoir accès aux projets de normes ainsi qu'aux normes actuelles et archives de même qu'à des projets de documents touchant des technologies en voie d'élaboration, peu importe le matériel ou les logiciels dont ils se servent.

Cette initiative est en voie de préparation depuis plus de six ans dans le cadre d'un processus de collaboration entre des membres de l'industrie, des gouvernements et d'autres organismes de normalisation intéressés à se doter d'une technologie permettant d'améliorer les modes actuels de préparation, de diffusion et d'échange de l'information.

IEEE Standards, like other standards-developing organizations, has a two-way information flow. Working Groups write the Standards, the completed Standards are distributed both to end-users and back to the Working Groups to serve as the basis for the next iteration of the Standard, and the staff members act as facilitators to the process all along the line.

The technical quality of an IEEE Standard and its expeditious delivery to the user community are the responsibility of highly competent professionals, working in committee,to achieve those results. In a way, these goals are competing forces. Rushing a Standard by sacrificing quality is unacceptable, yet it is equally unacceptable to miss a market niche by delivering a Standard too late. That is why the IEEE, as the best equipped standards developer in the electrotechnology field, must continue to strive for improvements in our processes.

A number of years ago, the IEEE Standards Department set about designing a user-friendly, automated system which would speed up the standards development process.

We are now committed to this project which we have called the Standards Process Automation System or SPAsystem[tm] for short. When fully implemented, we expect it to introduce economies, shorten schedules, lighten the load on our volunteers and expand international participation.

We started with certain assumptions:

- Standards developers and end-users have a variety of computer hardware and software, and always will.
- Users, potentially freed from the single view of the data that characterizes paper distribution, might want to use and perceive the provided information in any number of ways.
- High-quality electronic products must be affordable to produce.
- No additional labour can be demanded of the volunteers who write the standards or of the staff who manage the process.

To a large extent, these assumptions have determined the solutions we are developing.

The Standard Generalized Markup Language (SGML) offers one means by which to accommodate these assumptions, and so has been an important piece of the SPAsystem[tm] from its inception. In short, the Standard Generalized Markup Language (ISO 8879-1986) is a standardized computer language for describing the structure of information, without regard to how it might be visually rendered on a screen or a printer and without regard to the specific hardware being used. From a user's perspective, a well executed SGML system offers the ability to handle text, graphics, and other data types as though they constituted a structured database instead of free-flowing word-processing files. Such a system allows the user to apply the full range of searching and navigation techniques against such a database.

SGML is the best available solution for our needs, in part because it can be used to add genuine electronic value to information without regard to platform and without regard to how it might be rendered geographically. Information will always have to be presented in some form, but how that is done is a separate issue from the underlying nature of the information, just as it is with a relational database. In a sense, every body of information is a database and so should be handled with that in mind. To use database terminology, what a user wants in a given session is not a book, but a database report. In effect, SGML helps us do this.

So, with SGML as the basis of the data, and with the Internet, the phone lines, and perhaps cable TV as available tools, several problems are solved immediately. There is one data file for all platforms, yet that data file contains information that by any other scheme would be platform-specific. Users equipped with SGML compatible software of any type (word processor, database browser) can purchase only the data file, just as they do with paper. The entire computer-using marketplace is covered. Inexpensive browsers for major platforms could be provided as part of the purchase. Network users would see the information through the prism of an SGML compatible database manager.

If the Standards Working Group at the beginning of the production line starts with word-processing files of every type, and the goal is to create SGML files for public consumption, the territory in between becomes a data-conversion battlefield. Not only does information have to go back and forth constantly, but going from WordPerfect to SGML is like going from apples to oranges. They imbue their respective files with different kinds of information, there is no consistency to the way in which word-processing information is added to a file, and so a straightforward mapping is impossible. Furthermore, quality control becomes a major problem, especially with standards and other legally significant documents, where the wrong byte out of place can be problematic. In many cases, the typesetting files are incomplete, to boot. The result is that often rekeying is the most economical route when proofreading and other costs are factored in, and rekeying is expensive. As an ongoing expense, this is untenable for most publishers. In many cases, this has led to a stalemate with regard to electronic publishing while at the same time, the understandable requests from the end-users multiply.

The only point in the production process where it makes sense to add value is at the point of origin: during the authoring process. If the authors (i.e. the Standards Working Group) can be set up in such a way that the time they now spend formatting a document for printout can be redirected to formatting a document for database use (from which a printout can be derived), then writing an IEEE Standard, for example, would become an exercise in adding to a huge, interrelated body of information instead of producing a printout that represents a narrow, atomized view of the overall database. In addition, added value is best added by the subject-matter experts -- the authors.

IEEE Standards has therefore decided that the key to publishing our information electronically in a useful, economical form is to change the authoring process, but without placing additional burdens on the Standards Working Group members or anybody else. The point is redirection of existing work to greater benefit, rather than adding labour to the process.

Users of such software will think they're just using a state-of-the-art document processor with unusually helpful stylesheets, but behind the scenes very rich information will be created and manipulated in a standardized, platform-independent fashion. When this comes to pass, the SPAsystem™ will become a clear pipeline from creator to end-user.

The marketplace suggests that within a few years it will not be unusual for popular document-processing software to adopt the SGML approach to information management.

Until then, the challenge is to finesse the tools available to most of our authors -WordPerfect, Microsoft Word, troff - in a way that makes automatic conversion to a suitable SGML form possible. It won't be creating documents in SGML exactly, but it will have virtually the same effect.

Eventually, authors will routinely create SGML files without knowing it, which undoubtedly is for the better, and access to network services will be as casual as ordering a pay-per-view movie. Video and audio will be added to the information mix, and beyond that onecan only speculate about virtual conferencing systems and new modes of authoring.

None of this can be predicted, nor can the specifics of the hardware and software that we will be using which will support these future capabilities. Therefore, all a publisher can do is protect its data -- by decoupling it from platform, by imbuing it with added value, by ensuring it will still be usable and integratable with any future developments by relying on platform-independent, information-rich formats that embody electronic rather than paper assumptions. After all, the hardware and software will be replaced at least every five years, while the data will be just as valuable in 10 years, 20 years, 100 years. Standards-developing organizations are information-processing businesses: information is their essence, and it must be protected fro the ever-shifting ground of the computer world yet still be able to take immediate advantage of technology advances.

From all this, we distilled the basic principles that continue to guide the development of the SPAsystem™ :

- The authors of a document should create the ultimate electronic products as part of the authoring process.
- The system must be open, built on interlocking standardized formats and protocols instead of proprietary or platform-specific solutions.
- The information -- the Standards themselves as well as the related administrative and procedural data -- should be looked at anew before specific technological decisions are made, without preconceptions derived from paper as the historical distribution means.
- Networks are the best, though not yet the exclusive, means of access to the system for both developer and end-user.

In a sense, the SPAsystem™ designed itself. Once the problems were laid out and the desired services listed, there was only one narrow path to sail between the rocks. We are in the process of navigating that route.

The SPAsystem™ implementation schedule sets June 1995 as the time when any IEEE Standards Working Group will be able to make use of the authoring system, which will assure valid SGML input to the process. About a year after that, standards users will be able to make use of the growing database created by the authors.

Those wishing more information about the SPAsystem™ and its application may contact: Mr. Jay Iorio at the IEEE Standards Department at 445 Hoes Lane, P.O. Box 1331, Piscataway, New Jersey 08855-1331, tel: (908) 562-3837, fax: (908) 562-1571, e-mail j.iorio@ieee.org.

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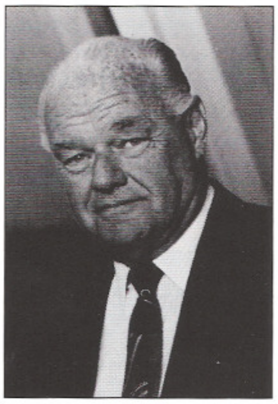

Dr. Read is the IEEE Vice President for Standards Activities, a member of the Standards Council of Canada and President of the Canadian Electrical Association in Montréal.

He has been nominated by the IEEE Board of Directors as a candidate for the 1995 President-Elect of the Institute.

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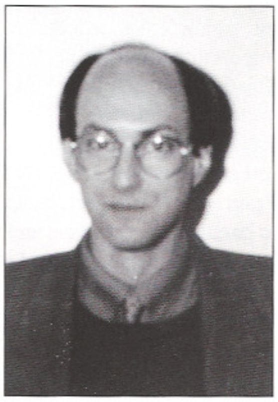

Mr. Iorio is Director of Research and Development in the IEEE Standards Department at Piscataway, New Jersey, with specific responsibilities for development of the SPAsystem™.

NEWFOUNDLAND AND LABRADOR HYDRO'S WIND AND ICE LOAD MONITORING TEST FACILITY

by A. K. Haldar, M. A. Marshall, W. J. Nugent, B. C. Hemeon, and T. J. Gardiner

This paper is an overview of a recently commissioned test site to monitor wind and ice loads on a test transmission line near St.-John's Newfoundland. Data obtained from the site are being used to validate several mathematical models that provide design parameters for transmission lines.

Cet article présente un aperçu d'un banc d'essai mis sur pied récemment près de St. John's, Terre-Neuve afin d'étudier des conditions d'opérations difficiles des lignes de distribution électrique (vent, glace, etc.). Les données ainsi obtenues servent à valider les modèles mathématiques utilisés pour générer certains paramètres de conception.

Several structural failures, causing power outages, have occurred on Newfoundland's Avalon Peninsula because of heavy wind and ice loads. In 1984, many failures were concentrated in an area where two major high voltage lines cross Hawke Hill[1]. These failures were attributable to the dynamic effects of high winds on the top of the hill resulting from wind speedup effects combined with severe ice accretion (ice growth by means of gradual additions) on the transmission lines.

To understand such problems better, Newfoundland and Labrador Hydro (NLH) constructed a full-scale test site at Hawke Hill in 1993 to monitor wind and ice loads on a non-energized transmission line. This research project is also part of a national study to improve existing design codes for transmission lines in Canada.

The objective of this project is to collect loading data and related meteorological parameters on a test line that has been constructed on Hawke Hill. This test site is designed to serve as an instrumented monitoring station to continuously record: wind speed, wind direction, temperature, precipitation, ice accretion, load along the insulator string, swing angles in both directions (transverse and longitudinal) on the conductor at the insulator attachment point, conductor tension, strains in selected members of the tower, load in the guy wires and finally, the vibration of the conductor with and without dampers.

Data collected from the test site will be used to validate several ice accretion models, wind models, vibration models, and NLH's model of how the tower structure might/will deform based on wind, ice accumulation, etc.

Planning and developing of the overall monitoring study included:

- the design and procurement of various meteorological and load sensors
- design of a PC-based data acquisition (DAQ) system
- implementation of a DAQ program using the C programming language
- development of a data analysis and presentation (DAAP) program using MATLAB(tm), a high-performance interactive computer language, for scientific and engineering numeric computations [1].

Sensors

At the test site, there are three structures: A central guyed steel V-tower (the main structure), and two wooden end structures. A single conductor (795 26/7 ACSR "Drake") is strung from one wooden end structure through the middle phase connection of the central tower to the other end wooden structure. These three structures form a straight line in the east-west direction, with the end structures approximately 213.4 metres from the central tower. Refer to Figure 1.

Each end structure is instrumented in an analogous fashion. A conductor load cell is installed to measure the conductor tension. In addition, a guy support load cell, to measure guy tension, is connected in-line with the conductor. Each end structure load cell has its own signal conditioner housed in a small junction box that is attached to the load cell. Both load cells and their associated electronics are connected to a larger junction box, which is attached directly to the pole approximately 15 metres from the ground level. These junction boxes are equipped with an ambient heater and two line drivers to drive the d.c. signals over the 213.4 metre distance to the control panel in the equipment shelter. Both end structures are connected directly to a control panel via one power and one signal cable.

Most of the sensors are installed on the central tower. The central tower is supported by four guy wires (9/16 inch thickness, 7 strands, grade 180). A load cell is connected in series with each guy to measure the tension. Further, there are two swing transducers and an axial load cell installed between the insulator string and the centre of the tower bridge. Bracing members on the bridge provide an ideal location for most of the meteorological sensors. These include: a heated anemometer (wind speed indicator) and an ice detector. All these sensors (except the anemometer and ice detector) are connected to a large junction box located in the centre of the upper bridge of the tower. This junction box provides a shelter for a signal conditioner, line drivers, and an ambient heater. The box is also connected to the ground control centre housed in the equipment shelter, by a power cable and a signal cable. Strain gauges have been installed on selected members at the base of the tower to measure the loads transferred to the foundation by the tower.

At two locations near the equipment shelter, there are six meteorological sensors: two temperature gauges (dry thermistors), a dew cell and relative humidity sensor, housed in a Stevenson's screen[2], and two precipitation

1. Hawke Hill is located on the Avalon Peninsula, approximately 55 kilometres west of the St. John's Airport, at an elevation of 274 metres.

2. A Stevensosn's screen is a shelter which houses the two dry thermistors, a dew cell, and the relative humidity sensor. Its main purpose is to protect the sensors from direct sunlight and rain, but it is designed to allow air to flow through freely.

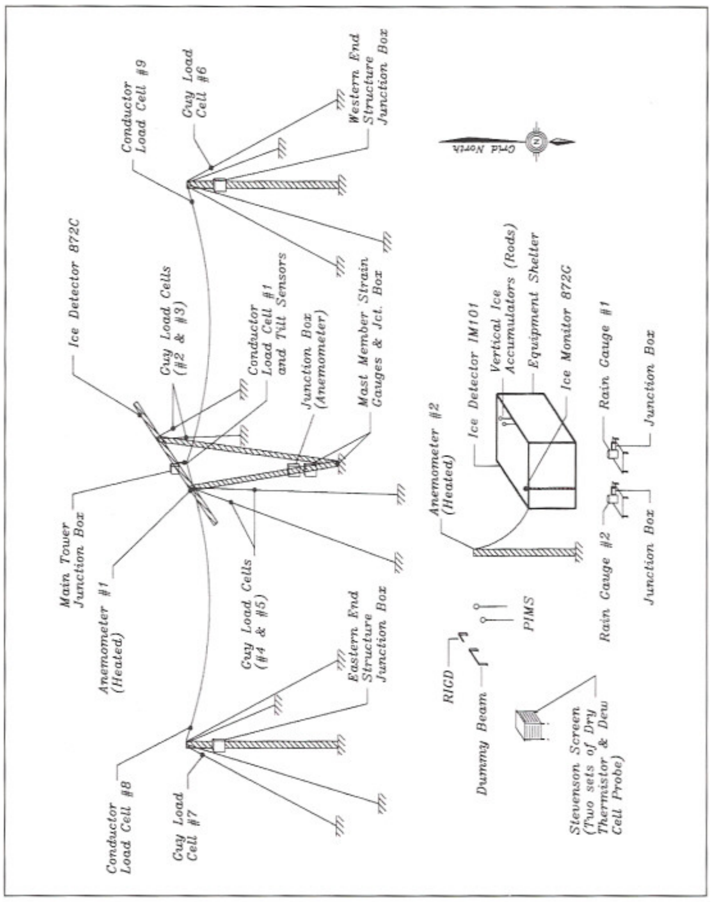

Figure 1 : Equipment Layout and Designations.

gauges. Additionally, there are two passive ice meters[1] (PIMs), an experimental remote ice growth detector[2] (RIGD) [2], and a *dummy beam* to manually check the accumulated ice mass reported by the RIGD.

These devices are installed at positions near the equipment shelter, but not too close to obstruct accurate data collection. Two different ice detectors are installed on the roof of the equipment shelter. Also, in the immediate vicinity, a second anemometer is installed at the top of a power service pole. Each sensor is connected to the control centre in the equipment shelter by the appropriate signal and power cables.

PC-Based DAQ System

Figure 2 presents the DAQ system configuration. Three types of DAQ boards are used in the PC-based system:

1) analog-to-digital (A/D) boards (quantity 3)
2) counter board (1)
3) communications digiboard (1).

Each A/D board can handle sixteen single ended or eight differential inputs. These boards provide twelve bit resolution. Besides the analog input channels, there are two digital-to-analog channels, and eight digital inputs and output channels. The three A/D boards are configured to provide 16 single ended and 16 differential channels.

A counter board is used to interface with the wind sensors (anemometers), which supply a pulse whose duration is proportional to the wind speed. This board also provides eight digital input and eight digital output channels. Only the counter channels are presently used for this investigation.

Eight additional serial ports are made available to the DAQ PC via a digiboard. These ports are used to interrogate the three ice detectors, and the four signal conditioning modules located on the end structures. (Refer to Figure 2.) This board also provides the communication channel to the NLH head office in St. John's (Hydro-Place).

DAQ Software

All the data from the site are transmitted to Hydro-Place via a modem over a dedicated lease line. A DAQ program, written in the C programming language, was developed to meet the following objectives:

- each sensor should have a dynamic sampling rate induced by the existing wind and ice conditions at the site;
- a report by exception algorithm should be set up to provide real time relay of the data to Hydro-Place.

To simplify the compliance with these objectives, the DAQ program loads a configuration file at start-up. Defined in this file is the sampling frequency and deadband assigned for each channel, based upon the existing wind and ice conditions.

The DAQ program also controls the communication of the data stored directly on the PC at the site at Hawke Hill to Hydro-Place. There the data are archived on NLH's main frame computer. If the dedicated telephone line linking Hawke Hill and Hydro-Place is lost for any reason (e.g., power outages at Hydro-Place), limited emergency storage is available on the Hawke Hill computer. Later, when the communication is restored to Hydro-Place, the stored data are transferred to the Hydro-Place computer. (For more details about the DAQ program, refer to Reference [3].)

DAAP Program

A DAAP program is used to extract meaningful information from the binary coded data that are transmitted from the remote site by the DAQ program. These data are transmitted continuously, and are subdivided into hourly files. Depending upon the weather conditions at the remote site (e.g., wind speeds during critical periods), an hourly data file could be as large as 22 MB. This file consists of 58 channels (33 are presently active), and each channel can be sampled at up to 20 Hz. For this phase of project, conventional programming languages (e.g., FORTRAN or C) would have been very cumbersome, particularly regarding dimensioning, type declaration, and storage allocation. Also, to carry out data analysis quickly and frequently was a critical requirement of the project.

For these reasons, MATLAB[tm] was an appropriate choice, because its basic data element is a matrix. It does not require dimensioning, type declaration and storage allocation. The DAAP program in MATLAB[tm] is written in a menu-driven, interactive environment, and it communicates with the user in a clear unambiguous manner [4]. Figure 3 provides a compendium of the roles played by the DAQ and DAAP programs.

Concluding Remarks

This paper presented an overview of the project. which required the coordination and cooperation of various groups at NLH (e.g., structural, electrical, software, etc.). The Hawke Hill test site has been operational since January 1993. It took approximately nine months to develop the first phase described in the paper. The project is expected to run for another three years. Analysis is underway of the voluminous amount of data

1. A passive ice meter is a device consisting of 12 tubular rods forming a rectangular frame. After an icing event, the thickness of the accumulated ice on the rods is measured manually with a step of vernier calipers.
2. The remote ice growth detector is a sensor which transmits an electrical signal proportional to the weight of accreted ice on a 1 metre long cantilever beam. This device is being developed by NLH's Technical Support Group.

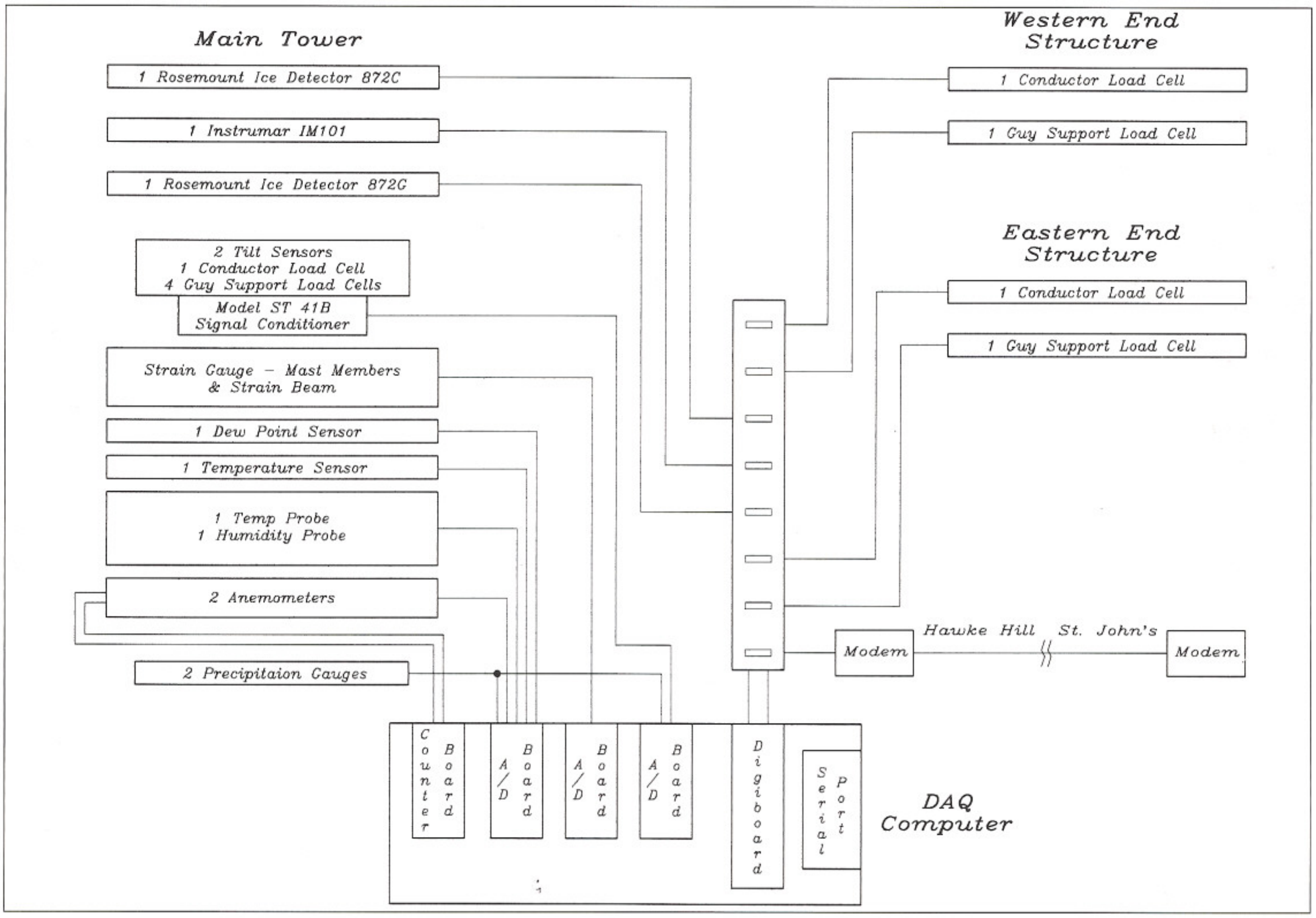

Figure 2 : Schematic of the data aquisition system.

acquired thus far.

Because of the nature of the project, and the research benefits of such a site, many other projects may be developed in the future. Presently, plans are on the way for future expansions. This includes the addition of trapezoidal conductors to investigate the wind drag on such conductors.

Acknowledgments

We wish to express sincere gratitude to Mr. Dave Reeves (Vice President of Engineering and Corporate Services), and Mr. Harvey F. Young (Director of Engineering Design) for their encouragements and support. A special word of thanks is extended to NLH's operations personnel, eastern region, and to Mr. Roger Van Couwenberghe (Atmospheric Environmental Services, Technology Division, ON) for his many helpful suggestions.

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[1] MATLAB, The Math Works, Inc., Natick, MA, U.S.A.

[2] M.A. Marshall, A.K. Haldar, T.J. Gardiner & C.J. Young, "Hydro's Remote Ice Growth Detector (RIGD)", NECEC'94, sponsored by the IEEE, St. John's, Newfoundland, Canada, April 29, 1994.

[3] J. Nugent & B. Hemeon, "Monitoring Wind and Ice Loads on a Test Transmission Line II: Data Acquisition System", NECEC'93 Workshop, April 1993.

[4] M.A. Marshall & A.K. Haldar, "An Application of MATLAB to Monitor Wind and Ice Loads on a Test Transmission Line", NECEC'94, sponsored by the IEEE, St. John's, Newfoundland, Canada, April 29, 1994.

About the authors

A. K. Haldar

Dr.Haldar, P. Eng., received his B. Eng. (Civil), M. Eng (Structures) and Ph.D. in 1969, 1977, and 1985, respectively. He is a Senior Engineer, Technical Support, in the Engineering Design Division of Newfoundland and Labrador Hydro. He is at present the Chairman of the Overhead Line Design Subsection, Transmission Section of the Canadian Electrical Association (CEA), an associate member of the American Society of Civil Engineers (ASCE), a working member of the ASCE Ice Load Task Group and a Canadian delegate to IEC TC-11. He is also Vice-Chairman of the CEA R&D Committee on Transmission Systems. He has published more than 40 papers and reports in the fields of vibration, reliability-based optimization, and wind and ice loading on transmission lines.

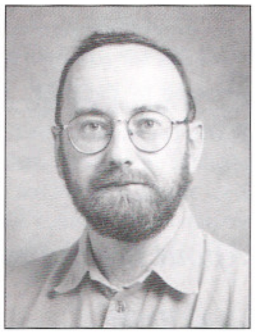
T. J. Gardiner

Mr. Gardiner, P. Eng., is a graduate engineer and member of the Association of Professional Engineers of Newfoundland. He joined Newfoundland Hydro in 1987 as a Transmission Line Design Engineer. He has been extensively involved in the design and construction of various transmission lines, including the construction of the Hawke Hill Test Site. He is currently involved in carrying out the monitoring of vibration on transmission lines, including the evaluation of five state-of- the-art vibration recorders.

Mervin A. Marshall

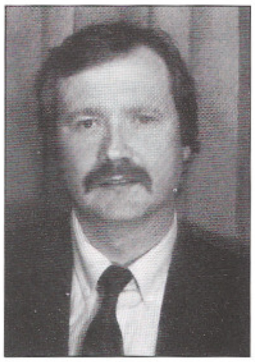
Dr. Marshall is a native of St. John's, Antigua, West Indies. After completing his Ph.D. at Memorial University of Newfoundland (MUN) in August 1990, he taught graduate and undergraduate courses at MUN. His area of expertise is Structural Integrity Monitoring using random vibration techniques. In May 1992, he joined Newfoundland and Labrador Hydro's Technical Support Group as a Development Engineer. Besides being a key member in the current Wind and Ice Load Monitoring research, he developed the PC-based, menu driven DAAP program used to analyze the field data.

Brian Hemeon



After serving 10 years with the Communication Command of the Canadian Armed Forces, Brian Hemeon worked for three years designing and maintaining data acquisition systems for the Earth Sciences Department of Memorial University of Newfoundland. For the last three years, he has been employed as a Control Systems Programmer with the Energy Management System of Newfoundland and Labrador Hydro.

W. J. Nugent



Mr. Nugent, P. Eng., graduated in 1987 from Memorial University of Newfoundland with a Bachelor's degree in Electrical Engineering. As an employee of NORDCO Ltd. he was involved in the design of a marine radar data acquisition system, as well as working on the design of a force moment sensor for Space Station Freedom under sub-contract to Spar Aerospace. Since joining Newfoundland and Labrador Hydro, he has participated in a variety of projects, including the Wind and Ice Load Monitoring research.

Perspective / *Perspectives*

A few words from the Managing Editor

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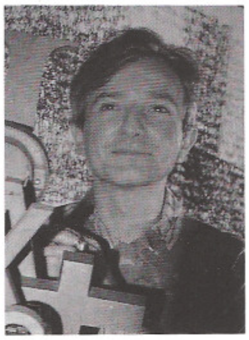

This issue, more than any other, has come about thanks to the new Associate Editors I appointed last fall. Three of the four articles are destined to become the first in a continuing series designed to be topical, technically informative, and somehow Canadian. And if you suspect that your work might be a suitable subject for a future article, please don't hesitate to contact any of the Associate Editors or myself. We are all reachable via electronic mail.

Behind the scenes, more changes are taking place. We have ironed out some lingering problems with delivering the magazine electronically to the printer. I am also trying to finalize negotiations with an advertising agency based in Ontario to work with volunteer «advertising coordinators» across the Canada to attract *Spectrum*-like advertising. Some contacts here in Québec will also be pursued.

And for those readers with Internet access (see Ray's comments in this issue), I hope to make our magazine articles available electronically in PostScript form sometime soon.

But despite all of these encouraging signs, membership size remains the best indicator of the relative health of IEEE Canada and the *IEEE Canadian Review* itself, since the cost per issue increases as the number of members decreases. Indeed, as of this issue, we have yet to climb back up to the Fall '93 membership mark. This has more than financial implications for us all. I therefore invite you to encourage your colleagues to consider joining (or re-joining) IEEE as one good way to promote electrical and computer engineering in Canada.

And one final note : any change in address must be sent directly to Piscataway, since our mailing list is created from their database.

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THEME
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PROGRAM OF EVENTS / PROGRAMME DES ÉVÈNEMENTS

Sunday, September 25, 1994 - Dimanche le 25 septembre, 1994

1400-1800	Registration and Cocktails/Inscription et cocktail

Monday, September 26, 1994 - Lundi le 26 septembre 1994

0800-1700	Registration/Inscription
0900-1015	Opening Session/session d'ouverture
	Plenary Session/session plénière - Software Engineering Maturity, David K. Shier Software Quality Assessment Group Manager, IBM Canada
1030-1200	Technical Session/session technique
1200-1400	PEI Luncheon - The Honourable Jon Gerrard, MD, Secretary of State for Science, Research & Development
1400-1700	Technical Session/session technique

Tuesday, September 27, 1994 - Mardi le 27 septembre 1994

0800-1700	Registration/Inscription
0830-0915	Plenary Session/session plénière - Alternate Energy, Carl Brothers Site Manager, Atlantic Wind Test Site
9020-1200	Technical Session/session technique
1200-1400	New Brunswick Luncheon, C. F. Baird, Sr Executive VP NBEPC
1400-1700	Technical Session/session technique
1900-1930	Cocktails/Cocktail
1930-2200	Nova Scotia Banquet, Ivan Duvar, President and CEO MT&T

Wednesday, September 28, 1993 - Mercredi le 28 septembre 1994

0800-1400	Registration/Inscription
0830-0915	Plenary Session/session plénière - Communications Systems
0920-1200	Technical Session/session technique
1200-1400	Newfoundland Luncheon - Frank Davis, VP Newfoundland Tel
1400-1700	Technical Session/session technique

SYMPOSIUM

September 26	-	Software Engineering
September 27	-	Alternate Energy
September 28	-	Advanced Technologies in Search & Rescue

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Blocks of rooms have been reserved at 3 downtown hotels in close proximity to the WTCC. Reservations must be made individually by attendees; please mention that you will be attending the CCECE '94.

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o Prince George Hotel, $100/day + taxes, available 'til Aug 12
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o Citadel Inn Halifax, $95/day + taxes, available until Aug 10
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