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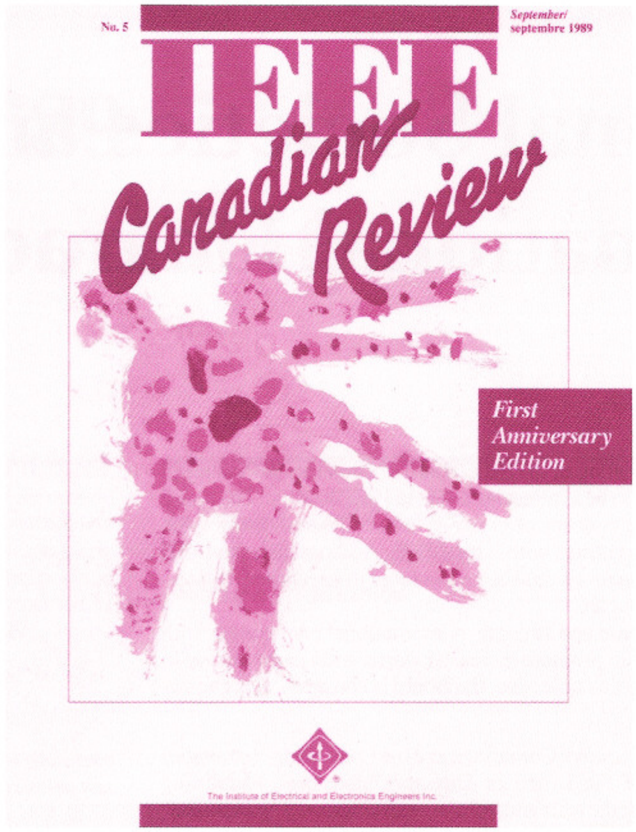

The Managing Editor's four-and-a-half year old daughter Aude was commissioned to paint the cover of the First Anniversary Edition of the IEEE Canadian Review. When asked what would be most appropriate for a first anniversary, "A single candle" she replied, "as bright as the sun.:."

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National Societies and a New International Character for IEEE

The August meeting of the IEEE board of Directors in Pittsburgh may turn out to be a milestone event in IEEE history. The board approved the concept of creating, where desired, geographic area-specific entities within the IEEE. Additionally, the IEEE Board of Directors would be restructured to strengthen its international character.

The objective is to increase and strengthen international cooperation with sister organizations and to promote increased world-wide participation in the Institute. To achieve this objective, the Board is considering organizational changes.

For several years, the Executive Committee and the Long Range (strategic) Planning Committee of the Board of Directors have been examining potential changes to both the staff and volunteer structure. *"The Institute"* has reported regularly on these proposals and, in fact, the staff reorganization is presently being implemented. At the June meeting, President Pugh established a committee to review the many proposals for volunteer restructuring and present recommendations to the Board at its August meeting.

These recommendations could result in the creation of a U.S. society (IEEE U.S.A.) with headquarters in Washington. The Canadian Region could become the Canadian society (IEEE Canada) with headquarters in Thornhill. I expect that others will also be formed. The creation of such societies would facilitate national activities and increase autonomy for members of such societies. It would also separate national activities from international technical activities.

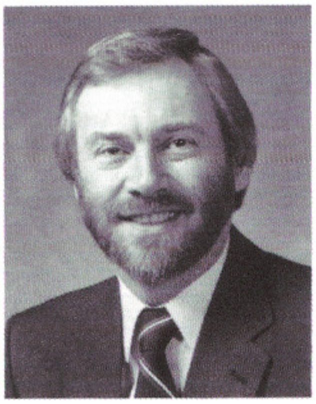
From a Canadian perspective, the implementation of these concepts would have definite advantages. The Canadian region of IEEE has acted as a responsible and respected Canadian technical entity for many years. However, there has been a perception in many quarters that we were part of a U.S. organization. This view has severely limited our capability to act as a Canadian society. There is now a real possibility that this limitation will be removed.

For many years, IEEE has attempted to be a transnational technical institute with its 35 Technical Societies while it conducts professional activities which are U.S.-specific. Non-U.S. members join primarily to participate in Technical Society activities. However, there is a possibility that the U.S. professional activities may impact negatively on non-U.S. members. Because these U.S. activities have been carried out in the name of IEEE Inc., its worldwide character has been viewed as less than international.

The creation of IEEE U.S.A. as a national society and the removal of U.S.-specific activities from the parent organization will do much to allow IEEE to become truly international. For members in countries that do not have a credible technical society activity outside IEEE, there is the opportunity to form a national society within "IEEE International". For countries that wish to maintain solely their IEEE Technical Society activity, the present Section and Region structure is well suited for such co-operation. The profile of the IEEE entity can be suitably high or diplomatically low to meet the needs of these members. A more international IEEE should facilitate increased co-operation.

It is important to stress that many things would not change. The IEEE Headquarters remains in New York. The IEEE Service Centre remains in

by Dr. Robert T.H. Alden
Director, IEEE Canada



New Jersey. All IEEE Technical Societies (Computer, Communications, Power, etc) and their memberships remain unchanged. The IEEE Board of Directors retains ultimate authority over all IEEE entities. The Board continues to directly control those activities and services that meet the global needs of the membership. These are Regional and Technical Activities, Publications, Educational Programs, and Awards.

There are a number of critical issues and mechanisms that need to be carefully considered before any changes are made. Should accreditation and/or standards activities be part of international or national activities within IEEE or outside IEEE? How would these new entities relate to other IEEE entities and other (non-IEEE) societies? The answers to these questions may vary widely from country to country. The Board of Directors is aware of the importance of these and other decisions, and has started the process to inform the membership and seek input. You can expect much discussion and debate in the coming months. Your input to me, my colleagues on our Regional Committee, your Section Executive, or the IEEE President will help us in determining our future action in this important venture. Please let your views be known.

The IEEE Board has set a direction for future growth at a time when industry is restructuring for globally-oriented trading. Electronic communication has changed the effect of time and distance. As Canadians, we must work at the forefront of our technology. We must have an international perspective of education, technical knowledge, and business practices. But we must also retain our own national sense of identity and priorities. I support the current proposal for change. I believe it to be in the best interests of Canadians, IEEE members worldwide, and the Institute itself.

IEEE Election'89 – A Unique Opportunity

by Edward (Ted) F. Glass
Westinghouse Canada Inc.
Winnipeg, Manitoba

IEEE Election'89 is different. For only the second time in 105 years, the Board of Directors of IEEE has endorsed a candidate from outside of Regions 1 to 6 as one of its nominees for the position of President Elect. Thus Wally Read, Past Director, joins two other candidates, Eric Sumner and Merril Buckley, in the race for the top leadership position in IEEE. The successful candidate will serve in the position of President-Elect during 1990 and will become the President in 1991.

Apart from the fact that a member of IEEE Canada is in the running, so what?

What is the impact of this election in real terms on the membership at large?

One may remember that, in last year's election, one of the issues discussed was IEEE's transnational role. In fact, one of the candidates, Irwin Feerst, was particularly vocal on this point. His view, by and large, was that IEEE operations outside the United States were a financial burden to the Institute and should be discontinued.

To put it very simply, IEEE Canada happens to fall in the category "outside the United States". I'm not sure what he meant by "financial burden". I'm also not sure what a "discontinuation" of these activities would have meant in practical terms. But what I do understand is that a candidate to this very important position clearly received enough support to bring home the point that IEEE's transnational role is neither well understood nor appreciated by a significant portion of the membership.

One could treat the merits of transnationalism far more than is the intent of this article. But it should be said that IEEE, with its commitment to transnational priorities in Electrical Engineering imbedded in its Constitution and By-Laws, has been light-years ahead of its time. The concepts of *Global Community* and *Free Trade* are not new to IEEE. And there is no doubt that, in the decade of the nineties, this emerging reality to others will impose new and significant forces on our volunteer leadership.

A clear understanding of the IEEE as it exists today, taking into account the needs and aspirations of the various memberships, in the U.S.A. and elsewhere, is not only timely for the IEEE "top job", it is more than ever a *requirement*. There is no other way to counter what must be seen as a significant threat to the existence of the IEEE and the seminal role that it plays worldwide in the advancement of humankind.

Whoever takes the helm of the IEEE in the future, the forces of change are already at work. IEEE will necessarily evolve. The man at the helm will either be going along for the ride, in which case it may be rough for all of us, or he may want to channel those forces along a direction that corresponds to a clear vision of where we *should* be going. I believe that only a "transnational" candidate will feel this viscerally and will be willing to throw his energy, if not his heart and soul, in this endeavour.

The Board of Directors is obviously aware that, at the very least, a "transnational" candidate had to be on the ticket this year. They may be trying to tell us something.

I believe that a "transnational" candidate *must* be elected to the "top job" at this crossroads of our history. But it will only happen if all of us "transnationals" in IEEE Canada care enough to vote.

About the IEEE

The Institute of Electrical and Electronics Engineers, Inc. (IEEE), with headquarters in New York, is a transnational organization with 300,000 members in 137 countries. The world's largest engineering society, its objectives are technical, professional and societal.

The IEEE's technical objectives center on advancing the theory and practice of electrical, electronics, communications and computer engineering and computer science. To meet these objectives, it sponsors conferences and meetings, publishes a wide range of professional papers and provides educational programs. In addition, the Institute works to advance the professional standing of its members. It also has a mandate to enhance the quality of life for all people through the application of its technologies, and to promote a better understanding of the influence of these technologies on the public welfare.

Today, the IEEE is a leading authority in areas ranging from aerospace, computers and communications to biomedical technology, electric power and consumer electronics. When it began its second century in 1984, it rededicated itself to Innovation, Excellence, the Exchange of information and the quest for improved Education. In so doing, it underscores the initials IEEE.

IEEE Canada is the Canadian entity of this transnational organization, with approximately fifteen thousand members. The Canadian Region is divided into twenty Sections, each centered in a Canadian city, from Victoria, B.C., in the west, to St. John's, Newfoundland, in the east. For information on whom to contact in your area, the many IEEE products and services available, or how to join IEEE, write, phone, or fax our IEEE Canada office (page 3).

Free Trade: A Telecommunications Perspective

Opportunity has arrived, but we have to work at it.

by R. Charles Terreault
Assistant Vice-President,
Network Technology
Bell Canada, Montréal

More than $400 million a day. Every day. That's the value of trade between Canada and the United States - and it's growing.

Each country is the other's best customer, and the Canada-United States Free Trade Agreement is already stepping up the pace. The Agreement is having a direct impact on the high technology industries of both countries.

In the telecommunications industry, all tariffs on telephones, modems and private branch exchanges (PBXs) were eliminated on January 1, 1989, the day the Agreement came into effect. Trade in this area is about even: in 1988, Canadian companies sold about $1 billion in goods to U.S. customers and U.S. producers sold about the same amount.

Status Quo Not An Option

Canada's international trade outlook is for change, challenge...and opportunity.

Change is rippling through world trade, whether or not Canadian companies recognize it, respond to it, and use it as a powerful vehicle for our future prosperity. In the past, governments have been prone to spend hundreds of millions of dollars propping up businesses that, for one reason or another, couldn't make a profit.

In today's demanding world markets, businesses must adapt, discover changing needs and fill them - or disappear. Analysts tell us that global integration - not isolation - is the pattern for the 1990s. The world is fast becoming more of a single market, and there is no place for an enterprise to hide from competition. The status quo is not an option. Many informed observers agree that it is not a question of whether Canada's trading relationships will change, but how they will change.

As Leonce Montambault, Chairman and Chief Executive Officer of Bell Canada, has declared, "If we (Canadians) wish to ensure our place in the North American economy - and the world economy - we should pursue free trade with vigour and determination."

Bell Canada is already carrying out a major transformation - from a monopoly provider to an aggressive competitor. About one quarter of Bell Canada revenues now come from competitive services.

With current world trends, every Canadian company will have to make a similar change: from occupying a comfortable position in a small, domestic, market, with little outside competition, to scrambling aggressively to capture - and keep - market shares both at home and abroad. This will require major transitions - conversions - in perception, attitude, self-image.

Telecommunications: Your Competitive Edge ?

This Agreement offers many benefits, not only for us at Bell Canada but for our customers as well. Lower, or no, tariffs mean lower prices on our purchases of U.S.-made products or those with significant U.S. content. Our customers will also benefit - indirectly from our lower costs, and directly from the increased competitiveness of U.S. terminal suppliers.

More competition at home and abroad ...

The world is becoming more of a single market. The Canada-U.S. Free Trade Agreement (FTA) means change, challenge, and opportunity for increased profits. Is Canada ready ?

Une intensification de la concurrence au Canada et à l'étranger ...

La mondialisation des marchés continue de se concrétiser. L'accord de libre-échange entre le Canada et les États-Unis (ALE) entraîne de nombreuses modifications dans son sillage, pose de nouveaux défis et donne l'occasion d'accroître les profits. Le Canada est-il prêt ?

It follows that the Agreement will necessarily increase competition for Canadian businesses, putting such efficiency and productivity tools as telecommunications near the top of the business priority list. It is anticipated that creative new applications of telecommunications will continue to develop at an ever-increasing pace. For telecommunications to take its place as an instrument for creating profits, the move toward cost-based pricing must gain momentum.

This Agreement is a pioneering trade effort, introducing the concept of international trade in services. It will serve as a model for future GATT (General Agreement on Tariffs and Trade) negotiations.

Advance Rulings on Enhanced Services a Must

The Agreement addresses telecommunications in several areas:

- monopolies
- basic telecommunications services
- enhanced telecommunications services

- research and development
- standards
- equipment

It provides for competition in some areas, and not in others.

The Agreement defines monopoly as "any entity, including a consortium, that...is the sole provider of basic telecommunications transport facilities or services."

The Agreement states that nothing shall prevent either country from maintaining or designating a monopoly, as long as the designating country notifies and consults with the other, and endeavours to minimize any effects on the benefits of the Agreement.

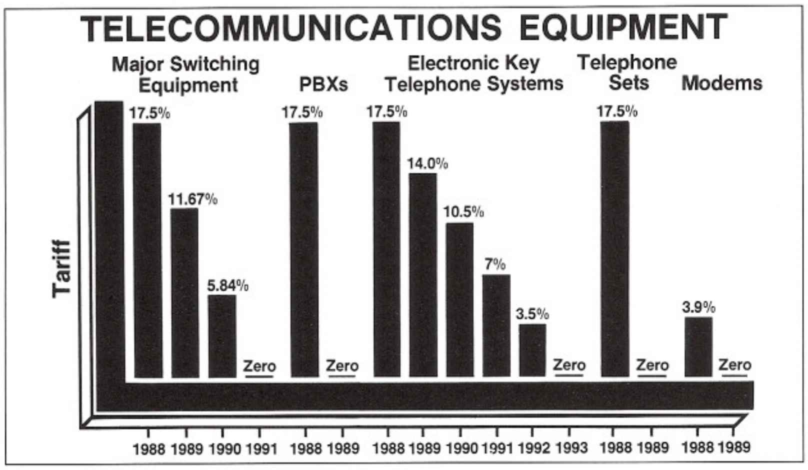


Figure 1 The progressive elimination of certain tariffs as a result of the Free Trade Agreement.

There will be little effect on basic telecommunications services - those limited to the offering of transmission capacity for the movement of information (e.g., basic local and long-distance telephone services).

The federal government has issued a policy statment, relevant to proposed legislation, which defines roles for:

1) telecommunications common carriers, i.e., those operating local and long-distance networks, and
2) providers of enhanced services, i.e., those offering customized telecommunications services that involve generating, acquiring, storing, retrieving, transferring, processing, or making information available in computerized form.

A stated objective of the Agreement is "to maintain and support the further development of an open and competitive market for the provision of enhanced services."

These services are facilitated through the enhancement, via computer programs, of the telecommunications network's basic transmission capabilities. Two examples are the iNet 2000* database information retrieval, and Envoy 100* electronic messaging services, both offered nationally through Telecom Canada.

According to the Agreement, each country may use its own definition of enhanced services, as defined by the regulator in that country. Canadian companies are already selling enhanced telecommunications products in the United States and anticipate excellent future markets in this field.

The Agreement heightens the urgency for our regulator, the Canadian Radio-Television and Telecommunications Commission (CRTC), to have the authority to render advance rulings on whether or not a proposed service is, in fact, an enhanced service, rather than simply a resale of basic service, which is to be offered only by common carriers.

Currently, providers may offer enhanced services without scrutiny by the CRTC until challenged. In Bell Canada's view, this scrutiny should occur before introduction of the service, not after.

Free Trade and Research and Development

Making the most of the Free Trade Agreement requires a constant, productive commitment to research and development (R&D).

Unfortunately, Canada is considerably behind major competitors, such as the United States and Japan. Canada's total spending on research and development is less than 1.5 per cent of Gross Domestic Product, compared to almost double that in the U.S. and Japan.

Canada's total is about $8 billion a year, and the telecommunications industry alone accounts for almost 20 per cent ...the largest percentage of any Canadian industry. Bell Canada's research and development investments last year totalled $123 million, nearly two per cent of total operating revenues.

Northern Telecom (our sibling company within the BCE Inc. family) spent 13 per cent of gross revenues - $860 million - in research and development in 1988. The spending by both companies was largely through their jointly-owned subsidiary, Bell-Northern Research, the leader in high technology R&D in Canada. We expect this level of commitment to continue over the next several years.

The federal government is beginning to recognize the crucial role R&D will play in our international competitiveness, but we need a much larger, stronger, accelerated commitment to stay in the race.

Standards and Equipment

The Free Trade Agreement raises another issue of mutual concern: standards.

Canada and the United States have agreed to "... endeavour to make respective standards-related measures more compatible, to reduce the obstacles to trade and the costs of exporting which arise from having to meet different standards."

Neither country is to create standards designed to keep out the other nation's equipment and services. Such organizations as the Canadian Standards Association and the American Underwriters Laboratory are to work more closely together. In telecommunications, we are already working closely on developing mutually-acceptable standards. With its Integrated Services Digital Network (ISDN), the telecommunications system of the 90s, Bell Canada is extending the scope of its international work on standards.

Regarding telecommunications equipment, as mentioned earlier, the Agreement has already eliminated tariffs on telephones, modems and PBXs. Those on major switching equipment are going in three equal annual reductions - there are two more reductions to come. Similarly, tariffs on electronic key systems will be gone in less than four years - on January 1, 1993. Further negotiations could very well accelerate this schedule as many companies have requested that the dates be moved up.

Conclusion

Bell Canada is making the transition from a monopoly to a vigorous competitor. This transformation over the last few years is challenging to our employees, beneficial to our customers, and profitable to our shareholders.

Free trade with the United States is an opportunity to do business profitably at home and abroad...a prelude to competing successfully anywhere in the world.

But every Canadian company will have to work at it.

At a rate of $400 million a day with the United States alone, the effort will be amply rewarded.

---

* TM Bell Canada

Éléments électriques pour le chauffage de l'air dans les procédés industriels

Des technologies nouvelles s'ajoutent aux équipements traditionnels

par Daniel Maure, Président, INTEK inc.
Mario Bouthillier, Vice-Président, PYRADIA inc.
Longueuil, Québec

Le chauffage résistif à la fine pointe ...

De nouvelles technologies issues de la recherche et de développements récents sont maintenant disponibles pour le chauffage de l'air dans les procédés industriels. Les caractéristiques des résistances à haute tension et des résistances à haute densité de puissance sont comparées à celles des éléments électriques conventionnels tels que les éléments spiralés ouverts et les éléments tubulaires blindés.

Resistance heating technology evolves ...

New technologies from recent progress in research and development are now available for industrial process air heating. The technical characteristics of High Voltage Elements and High Power Density Resistances are compared with those of conventional electric elements like the open coil element and the metal sheathed element.

Le principe du chauffage de l'air à l'aide de résistances électriques est bien connu puisqu'il repose sur l'application de la loi de JOULE: tout conducteur d'électricité parcouru par un courant électrique produit un dégagement de chaleur. Au-delà de ce principe physique de base, l'application industrielle du chauffage de l'air pose la question du meilleur choix technologique pour une utilisation donnée compte tenu de la grande diversité des équipements disponibles commercialement.

Dans le passé, l'électricité a souvent été considérée comme une source d'énergie plutôt coûteuse pour les procédés de chauffage industriel. Depuis quelques années, les coûts de l'électricité (en particulier au Canada) sont de plus en plus compétitifs par rapport aux combustibles fossiles et, surtout, les avantages non-énergétiques de l'électricité ont commencé à prendre une importance prépondérante dans les prises de décisions concernant tout nouveau projet éventuel. Parmi ces avantages non-énergétiques de l'électricité, on peut citer: coûts de maintenance faibles, grande facilité de contrôle grâce en particulier aux progrès de l'électronique (thyristors), santé et sécurité accrue pour les travailleurs et impacts très minimes sur l'environnement.

Très récemment, de nouvelles technologies telles que les résistances à haute tension (RHT) et les résistances à haute densité de puissance (RHDP) sont venues renforcer la position concurrentielle de l'électricité dans le domaine du chauffage de l'air pour les procédés industriels.

Les résistances électriques

Dans les applications de chauffage de l'air, la chaleur est transférée de l'élément chauffant à l'air par le phénomène de convection. En convection forcée, la puissance thermique échangée dépend à la fois du coefficient de transfert de chaleur et de la différence de température entre la surface chauffante et l'air à chauffer. Le coefficient de transfert de chaleur dépend surtout de considérations aérodynamiques et, pour une température d'air donnée à la sortie du dispositif de chauffage, l'intensité du transfert de chaleur dépend principalement de la température de la surface chauffante qui est elle-même reliée plus ou moins directement à la température de fonctionnement de la résistance électrique.

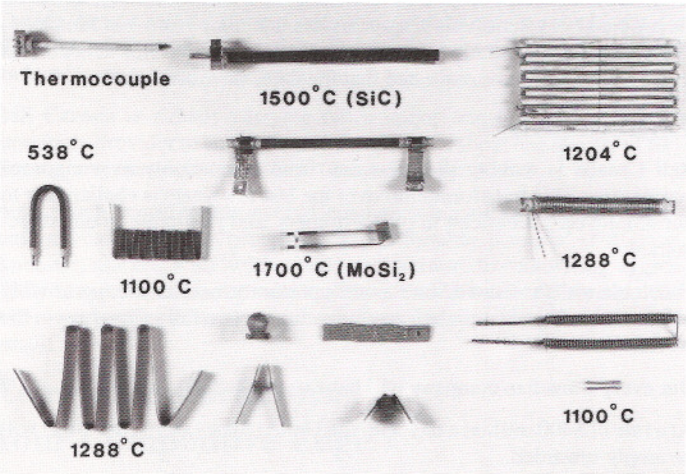


Figure 1 Quelques types d'éléments chauffants conventionnels dont des éléments spiralés ouverts (à droite), un élément tubulaire blindé (538°C), des éléments au carbure de silicium (*SiC*) et au bisiliciure de molybdène ($MoSi_2$).

La température limite d'utilisation des différents types de résistances électriques constitue donc un paramètre de première importance lors du choix d'un équipement pour un besoin spécifique. Les alliages de nickel et de chrome (nichrome) sont utilisés jusqu'à des températures de 1,000 à 1,150°C, les alliages de fer-chrome-aluminium peuvent être employés jusqu'à 1,200°C alors que le carbure de silicium est utilisable jusqu'à 1,300°C. Ces derniers types de résistances électriques sont habituellement utilisés pour le chauffage de l'air dans les applications où l'atmosphère ne comporte pas de substances corrosives. D'autres types de résistances, telles le bisiliciure de molybdène, peuvent être utilisés jusqu'à 1,700°C mais il est en général préférable de les utiliser dans un milieu non-oxydant. Les alliages de nichrome sont utilisés dans la majorité des applications parce que leur fabrication et leur installation ne présentent pas de difficultés particulières alors que les autres types de résistances électriques sont considérés comme plus ou moins exotiques et sont limités à des applications très particulières.

La température maximale à laquelle l'air peut être chauffé doit évidemment être inférieure à la limite d'utilisation du matériau constituant la résistance chauffante électrique. Il est possible d'approcher cette limite d'utilisation en augmentant la surface de l'élément chauffant et l'intensité du coefficient de transfert de chaleur. La puissance surfacique (W/cm^2) recommandée par les divers fabricants tient compte de facteurs tels la température limite d'utilisation de la résistance électrique et les caractéristiques de transfert de chaleur. La densité de puissance volumique (kW/m^3) tient compte, à la fois, de la puissance surfacique permissible, des caractéristiques physiques particulières des éléments et de leur disposition dans un volume de chauffe donné.

Les technologies conventionnelles: éléments spiralés ouverts et éléments tubulaires blindés

Du point de vue des applications industrielles de chauffage, les éléments électriques conventionnels se présentent sous différentes formes (Figure 1) dont les principales, pour le chauffage de l'air, sont les éléments spiralés ouverts et les éléments tubulaires blindés (aussi appelés éléments gainés).

Les éléments blindés consistent habituellement en un boudin (ou spirale) de nichrome disposé au centre d'un tube métallique (ou gaine). L'espace entre la résistance électrique et la gaine extérieure est rempli avec un matériau qui est à la fois diélectrique et relativement bon conducteur de chaleur. La gaine extérieure a l'avantage d'isoler électriquement la résistance sous tension du milieu chauffé mais au détriment d'une certaine perte de performance. La gaine elle-même ainsi que le diélectrique qu'elle renferme causent une résistance thermique intermédiaire entre la résistance chauffante proprement dite et l'air à chauffer.

Les éléments ouverts sont directement exposés à l'air et la chaleur produite par l'effet JOULE est dissipée sans milieu intermédiaire susceptible de réduire le flux thermique ou d'augmenter inutilement la température de la résistance électrique. Les éléments ouverts sont souvent fabriqués à partir de fil de nichrome enroulé sur un mandrin pour former un boudin (ou spirale) qui est ensuite étiré à la longueur désirée. Dans les installations de chauffage de l'air, les éléments spiralés doivent être supportés à intervalles réguliers par des bagues en matériau diélectrique (céramique). En dépit de leur forme spiralée, ces éléments chauffants ont un comportement du point de vue du transfert de chaleur qui est assez similaire à celui d'un cylindre droit qui aurait le même diamètre que celui du fil chauffant.

L'enroulement en forme de spirale ne doit cependant pas être trop serré puisque l'élément se comporterait alors comme un cylindre plein ayant un diamètre équivalent au diamètre extérieur total de la spirale (les échanges de chaleur seraient alors plus faibles). Les bagues isolantes constituent le point faible des éléments spiralés puisqu'elles obstruent l'écoulement d'air sur la résistance chauffante et limitent ainsi localement l'échange de chaleur. Dans ces bagues isolantes, le coefficient de transfert de chaleur peut-être jusqu'à 60% plus faible que sur la partie non-obstruée de l'élément. Il s'agit là d'un facteur technologique qui oblige le concepteur à surdimensionner l'élément chauffant spiralé afin de respecter la température limite d'utilisation de la résistance chauffante à l'intérieur de la bague isolante.

Tableau 1

Comparaison de différents types d'éléments chauffants

Vitesse d'air à l'approche: 2.8 m/s
Point chaud de la résistance électrique: 900°C

Éléments conventionnels:

Température sortie d'air (°C)	Blindé (600 V) W/cm^2	Blindé (600 V) kW/m^3	Blindé (600 V) T moy (°C)	Spiralé (600 V) W/cm^2	Spiralé (600 V) kW/m^3	Spiralé (600 V) T moy (°C)
150	5.1	670	610	4.9	510	420
315	4.4	630	650	3.9	490	530
600	2.4	525	765	2.1	430	715

Nouvelles technologies:

Température sortie d'air (°C)	R H T spiralé (4160 V) W/cm^2	R H T spiralé (4160 V) kW/m^3	R H T spiralé (4160 V) T moy (°C)	R H D P (600 V) W/cm^2	R H D P (600 V) kW/m^3	R H D P (600 V) T moy (°C)
150	4.9	215	420	11.9	33000	600
315	3.9	125	530	10.5	29000	660
600	2.1	120	715	6.7	18000	780

Légende:

W/cm^2 Puissance surfacique de la gaine (blindé), du fil (spiralé) ou de la plaque (RHDP).
kW/m^3 Densité de puissance volumique pour l'ensemble du chauffe-conduit.
T moy Température moyenne de la résistance électrique.

La densité de puissance (ou compacité) de l'élément chauffant spiralé est alors pénalisée par la présence des bagues isolantes et cette situation est, en définitive, assez similaire à celle des éléments tubulaires blindés dont la performance thermique est essentiellement limitée par la gaine extérieure et le matériau diélectrique qu'elle renferme (voir Tableau 1). Les pertes de pression subies par l'écoulement d'air au moment où celui-ci traverse l'assemblage d'éléments chauffants constituent un autre paramètre important dans la conception des systèmes de chauffage de l'air. En général, les pertes de pression des systèmes à éléments spiralés ouverts sont moindres que celles des éléments tubulaires blindés et bien inférieures aux pertes de pression des dispositifs utilisant des éléments blindés munis d'ailettes qui sont parfois employés pour le chauffage de l'air.

Les nouvelles technologies: les résistances à haute tension et à haute densité de puissance

Résistances à haute tension (RHT)

Les manufacturiers de résistances chauffantes fabriquent toute une gamme de produits pouvant fonctionner à tous les niveaux habituels de tension compris entre 120 et 600 Volts. Les résistances chauffantes individuelles sont habituellement combinées en circuits série/parallèle ou triphasés pour répondre aux besoins de l'application de chauffage envisagée. Dans le cas des applications industrielles de chauffage de l'air, la tension de 600 Volts triphasée a traditionnellement été considérée comme la solution la plus économique. Toutefois, des travaux récents réalisés sous les auspices de l'Association Canadienne de l'Electricité (ACE) ont montré que les résistances à haute tension (RHT) fonctionnant à 4,160 Volts pouvaient être avantageusement utilisées pour des applications industrielles de chauffage de l'air d'une puissance supérieure à 3 MW.

Les RHT sont essentiellement des éléments ouverts analogues à ceux utilisés à la tension habituelle de 600 Volts mais avec des espacements plus considérables afin d'assurer la tenue diélectrique requise à plus haute tension. Ces résistances sont aussi installées en configuration à double isolation, c'est à dire qu'elles sont isolées électriquement par rapport à un boîtier intermédiaire lui-même isolé électriquement par rapport à la masse. Compte tenu de leurs caractéristiques particulières, les RHT sont donc plus coûteuses que les éléments conventionnels mais l'alimentation à 4,160V permet une économie substantielle au niveau de la sous-station électrique de sorte que le coût total d'une installation de plus de 3 MW est moindre que le coût d'une installation complète à 600 Volts. Les résistances à haute tension sont donc particulièrement intéressantes dans le cas d'installations de plus de 3 MW lorsque la sous-station électrique doit être construite de toute pièce et lorsque les éléments chauffants sont situés relativement loin des transformateurs (150 mètres et plus).

Les RHT permettent une certaine économie du point de vue des coûts d'acquisition des équipements mais, à cause des contraintes d'espaces reliées aux impératifs d'isolation électrique, elles requièrent énormément d'espace physique pour l'installation des éléments chauffants proprement dits.

Résistances à haute densité de puissance (RHDP)

Les résistances à haute densité de puissance (RHDP) sont des éléments chauffants ouverts fonctionnant à des tensions de 600 Volts et moins (il n'est cependant pas exclu que celles-ci puissent être éventuellement blindées et/ou adaptées au fonctionnement à haute tension). L'avantage majeur des RHDP réside dans le fait qu'elles permettent de réduire considérablement le volume des systèmes de chauffage de l'air par rapport aux technologies conventionnelles que sont les éléments spiralés ouverts ou les éléments tubulaires blindés (voir Tableau 1). Cette réduction du volume de chauffe est obtenue grâce à une augmentation considérable de la surface d'échange de chaleur et du coefficient de transfert de chaleur par convection. Les RHDP sont constitués de plaques métalliques perforées, entaillées et assemblées en série/parallèle pour former une résistance électrique. L'ensemble obtenu possède une densité de puissance volumique supérieure à 18 MW/m^3 ce qui peut représenter jusqu'à 50 fois plus que les technologies conventionnelles (Figure 2).

L'arrangement de plaques perforées empilées l'une derrière l'autre à interval-

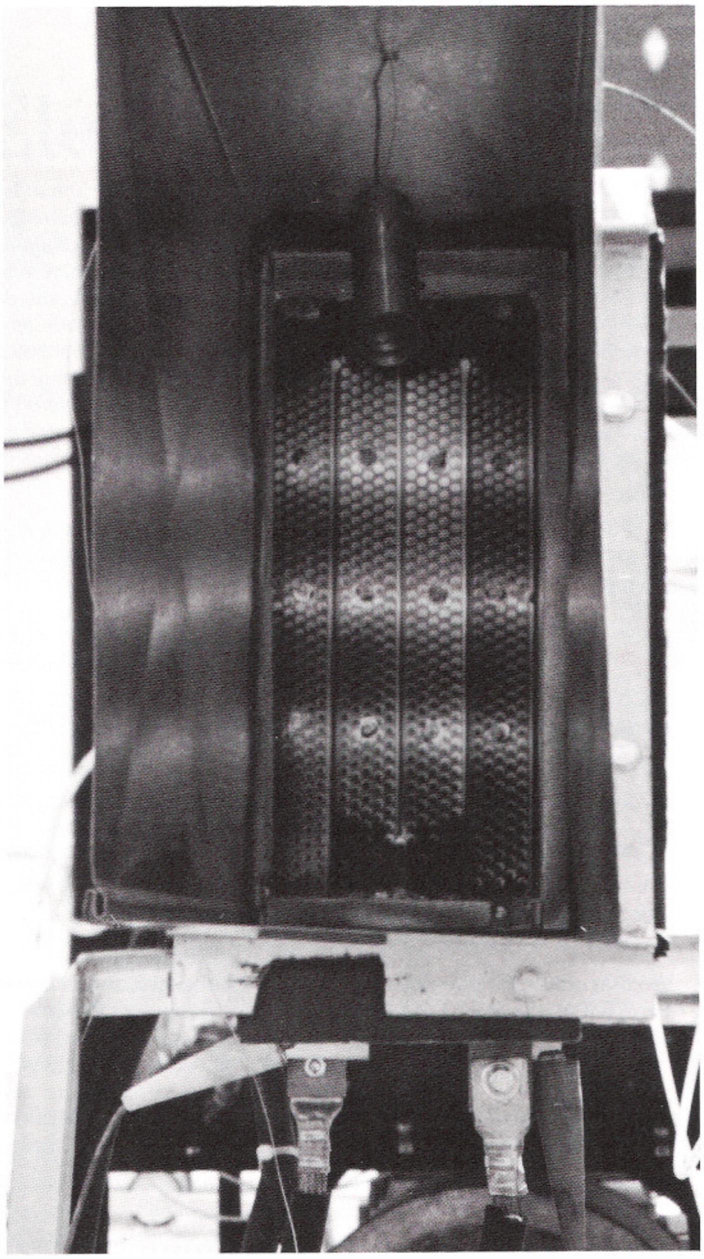


Figure 2 Prototype de résistance à haute densité de puissance (RHDP), 72kW, 600V.

les rapprochés dans différents plans perpendiculaires à l'écoulement d'air permet d'augmenter de façon appréciable la surface de transfert de chaleur en contact avec l'air chauffé. De plus, cette disposition des plaques perforées augmente de façon significative la turbulence de l'écoulement d'air et améliore ainsi le transfert de chaleur par convection. Cette dernière amélioration du coefficient de transfert de chaleur est obtenue sans trop augmenter les pertes de pression par un choix judicieux de l'espacement entre les plaques perforées et par un alignement rigoureux des perforations sur chacune de ces même plaques. Le concept RHDP étant plus performant que ses concurrents au point de vue du transfert de chaleur, il est alors possible d'utiliser des matériaux plus courants tels que l'acier inoxydable 304 au lieu du nichrome plus coûteux (l'inox 304 peut être utilisé jusqu'à des températures de sortie d'air de près de 600°C). Le concept RHDP est aussi très polyvalent et permet de réaliser aussi bien des systèmes de chauffage à très grande densité de puissance ou des systèmes de densité de puissance intermédiaire fonctionnant à des températures élevées se situant presque à la limite d'utilisation du matériau employé pour fabriquer les plaques chauffantes perforées. En effet, une des caractéristiques les plus originales des RHDP réside dans l'absence quasi totale de points chauds puisqu'il s'agit d'éléments ouverts qui ne comportent pas de composantes telles que des bagues isolantes ou des gaines extérieures qui seraient susceptibles de réduire la densité de puissance.

La réduction considérable du volume de chauffe combinée à l'utilisation de matériaux peu dispendieux (tels que l'inox 304) permettent, selon le contexte d'utilisation, de maintenir le coût des RHDP à un niveau comparable sinon inférieur aux éléments conventionnels. La robustesse et la fiabilité sont aussi des caractéristiques inhérentes au concept RHDP puisque des bandes perforées de 0.8 mm d'épaisseur et de 30 mm de largeur sont évidemment peu vulnérables aux chocs mécaniques ou à la corrosion. À cause du transfert de chaleur très intense, les éléments RHDP possèdent aussi des temps de réponse thermique qui sont de beaucoup inférieurs à ceux des autres types d'éléments chauffants. Ces éléments chauffants sont donc particulièrement bien adaptés pour les applications où la température de sortie d'air doit être contrôlée de façon rapide et précise.

Les résistances à haute densité de puissance ont été mises au point par Hydro-Québec au laboratoire L.T.E.E. de Shawinigan. Les entreprises PYRADIA inc. et INTEK inc. ont récemment obtenu d'Hydro-Québec la licence exclusive de commercialisation de la technologie RHDP.

Conclusions

Il existe de nombreux types de résistances électriques pouvant être utilisées pour le chauffage de l'air dans les procédés industriels et ce sont essentiellement le contexte d'utilisation et les impératifs thermiques qui déterminent le meilleur choix à effectuer.

En absence de contraintes particulières, les éléments conventionnels de types spiralés ou blindés peuvent aussi bien être utilisés et leurs performances thermiques seront en définitive assez comparables.

Dans les applications où la puissance totale à installer est très élevée soit environ 3 MW et plus, les résistances à haute tension peuvent être envisagées à condition toutefois que l'espace disponible pour l'installation ne soit pas trop exiguë.

Les résistances à haute densité de puissance sont très polyvalentes et peuvent s'adapter à presque n'importe quel projet. Ces dernières sont particulièrement intéressantes dans les applications où le volume disponible pour réaliser l'installation est très limité (grande densité de puissance), où les températures de fonctionnement sont trop élevées pour les matériaux usuels (transfert de chaleur très intense, donc températures d'éléments moins élevées) et où le contrôle des températures doit être particulièrement précis (temps de réponse très court).

IEEE Canada Snapshot

Mark Funkenhauser of Thompson Foss, a Toronto-based computer consulting firm, was recognized as the IEEE Computer Society's 100,000th member on May 17, at the Society's International Conference on Software Engineering in Pittsburgh. Shown above left to right are President-Elect Helen M. Wood, of NOAA/NESDIS; Funkenhauser; Past-President Edward A. Parrish, of Vanderbilt University; President Kenneth R. Anderson, of Siemens Research; and Membership & Information Vice President Barry R. Johnson, of the University of Virginia.

Managing Complexity in the Defence Environment

Methods used to integrate complex technologies in the defence environment may benefit many civilian applications.

by L. Gregor
President, Gregor and Associates
Montréal, Québec

Large electronic systems are inherently complex. Such systems, interacting with the "real world" to monitor and control large numbers of different electrical and mechanical apparati, are even more so. To bring these systems into being requires an efficient integration of these complexities.

On the one hand, the ability to do this relies on fundamental knowledge of the tactical and physical environment in which these systems will operate. On the other, it requires a thorough understanding of how the system will be called upon to perform in and react to this environment.

To achieve this, one requires fundamental expertise in software development permitting, first of all, the accurate simulation of the environment. Secondly, one requires a similar expertise to develop the computer control of all electronic and mechanical elements required to perform in this environment with the purpose of achieving the overall system objectives.

To gain a better understanding of the challenges which are inherent to the science of systems management, let us relate it to some major application such as the new Canadian Patrol Frigate (CPF) project.

The Canadian Patrol Frigate - Some Background

In the mid 1970's, the Department of National Defence (DND) recognized the need to update Canada's Navy with a fleet of the most advanced combat vessels. The decision was to concentrate on a smaller ship, a frigate, with good speed and manoeuverability and which would have the most sophisticated surveillance, navigation, defensive and combat systems available. The purpose of these ships would be to patrol Canada's coastline, the longest in the world, and to operate on anti-submarine duties with NATO forces in the Atlantic sea lanes.

Large systems management: A challenge...

In what might be called "an elaborate computer-based electronic chess game," Systems Management uses a variety of integration engineering strategies to "win the match."

The objective is to accomplish this with the minimum of moves. It requires the ability to anticipate all the variations and challenges that a complex system can present.

La gestion des grands systèmes: un défi ...

Le rôle de la gestion des grands systèmes est analogue à celui d'un joueur d'échecs qui doit mettre au point des stratégies pour "gagner la partie", en l'occurrence pour arriver à une parfaite intégration de systèmes multiples et complexes en un ensemble cohérent.

Le défi est d'atteindre ce résultat aussi efficacement que possible, c'est à dire, en un minimum de gestes. Comme un maître aux échecs, l'intégrateur doit anticiper les problèmes qui peuvent se poser et imaginer des solutions de rechange appropriées.

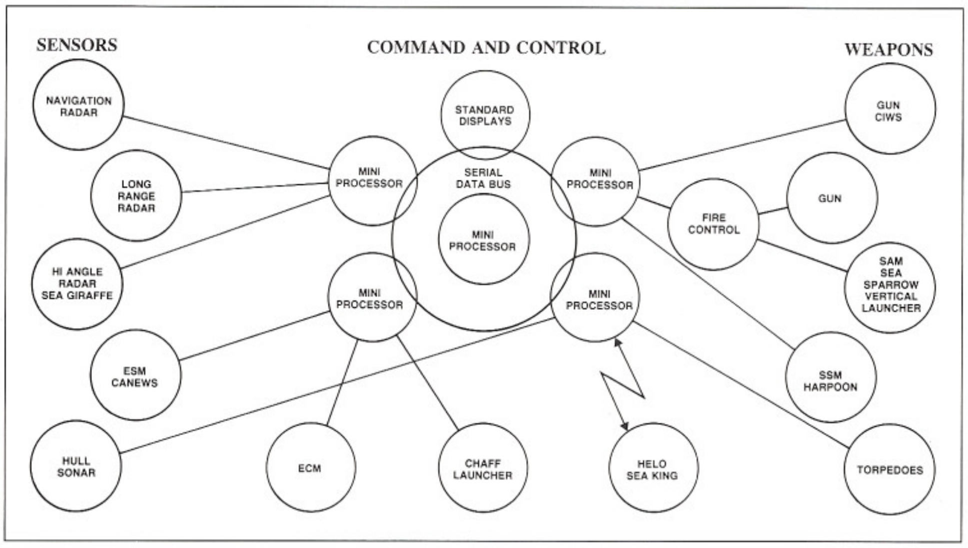
Canada, at that time, had not designed and built a new fighting ship for over a decade. During that hiatus, much of the Canadian Navy's design and engineering personnel had drifted away from the service. In addition, technology had meanwhile progressed very rapidly, most notably in the area of computer-based control. The DND consequently looked to the United States for this highly specialized technical assistance and eventually negotiated with Sperry Corp., now UNISYS Defence Systems. This led to the establishment of a Canadian subsidiary, Paramax Electronics Inc., and the subsequent construction of a headquarters building and test centre in Montréal which opened in 1985.

The Design Objective

The CPF combat system had to be designed to detect, identify and analyze multiple targets and to recommend and execute appropriate action within a matter of seconds.

Sensors, weapons and communications systems had to be integrated to provide the captain of the ship with a clear, understandable picture of his environment at all times, and the capability of maintaining control even after suffering damage to his own ship (Figure 1).

Figure 1 Canadian Patrol Frigate integrated combat system



A thorough knowledge of all subsystems in a given design is, of course, a prerequisite. In order to design surface-to-air defensive capability into an integrated combat system, for example, the systems management team must be thoroughly knowledgeable about surface-to-air missiles generally; which missiles, launch and control systems are currently available, which are most suitable to the defined task and how all of these are to be integrated with the dozens of other subsystems which are to become part of a single combined combat/defensive system on a ship.

The same thorough knowledge is required of all the varied sensor, weapon, electronic warfare and internal/external communications systems. In other words, a thorough knowledge of all parts is required before one can begin to integrate them into an operational whole. And this thorough knowledge comes together in one's capability to accurately simulate all aspects of the system's operational environment so that one can design and test all parts of the system and subsequently provide for adequate maintenance and the training of personnel (Figure 2).

One can easily understand that the building, and subsequent assembly, of large individual functional elements involves the interaction of a great variety of disciplines to achieve overall system analysis, design and engineering within an environment that requires powerful simulation capability as a prerequisite. However, it may not be so obvious that one must have a clear understanding of the integration process, including its inherent iterations and feedback loops. This means that to handle the successful integration of all elements, one must not only be capable of specifying overall system architecture as well as component requirements as a result of a rigorous and powerful design process, one must also possess the capability to verify the performance of all aspects of the integrated system as the finished elements begin to take form, and apply appropriate corrective measures when necessary.

Figure 2 Canadian navy personnel team training in a life-size mock-up of a CPF operations room. Through realistic and repeatable simulated scenarios, crew members learn to react to almost any situation they are ever likely to encounter at sea.

This philosophy extends well into the production phase, resulting in exhaustive testing procedures before the actual "on-board" installation and "prove-out" of the whole. Only in this way can one guarantee that system performance corresponds to, or exceeds, the desired result. Systems management capability is, therefore, fundamental to efficiency in the CPF program as it enables complex groups of functions to mesh smoothly into one another. One could even say that this is the essence of systems management.

The U.S. Department of Defence defines a "major" project as one which requires over 500 man-years of software development in today's environment. To put this in perspective, the CPF project required the development of over one million source lines of code (SLOCS) entailing over three million computer instructions. This effort required approximately 2000 man-years of software development, the largest such program undertaken in Canada to date. Past experience in defence-oriented projects shows that a systems management approach is likely to be beneficial for all software development projects in the general range of 500 man-years and above.

The Impact of Systems Management in Canada

Canada already had an established defence industrial base before the CPF program began in 1983. However, what the country lacked was specific capability in the electronic computer-based engineering science of systems management.

When Paramax was awarded the role of prime sub-contractor to Saint John Shipbuilding Limited on the CPF project in 1983, there began a flow of new technology to Canadian companies and attendant benefits to Canada's industrial economy. This impact is most evident in the many established companies which expanded into new areas to meet the needs of the frigate program. CAE of Montréal, for instance, best known for its flight simulators, expanded into marine machinery control systems to supply some of the CPF requirements and has subsequently developed sales of these systems to UNISYS for U.S. minesweeper applications. Computing Devices Company, of Ottawa, developed new man/machine interfaces for the CPF's command and control system. Control Technology of Montréal was established by independent businessment to supply cabling assembly requirements and wiring panels for the frigate electronic systems. SED Systems of Saskatoon was set up as a centre of excellence for exterior communications in naval applications and is responsible for the integration of all CPF exterior communications.

The science of systems management is still very young in Canada but the potential is highly promising. Systems management can facilitate automation of many manpower intensive tasks. Looking towards the future, there are many opportunities to use a systems management approach in civilian projects such as air traffic control systems, computerized road traffic control systems and utility transmission and distribution networks. One example that could readily be transposed to the civilian environment is the U.S. Navy's Warehouse Control System. One can only begin to imagine the vast array of depots world-wide and the many hundreds of thousands of individual parts and supply stores that have to be maintained with the utmost efficiency. A systems management approach was particularly useful in handling such a mammoth, complex task.

There are also opportunities for shiphandling simulators and trainers in which an extensive computer facility creates illusions of spaces and movement for tankers and freighters. Without actually going to sea, merchant marine crews could be trained to react to simulated real-life situations of navigating and piloting day or night in varying conditions of wind, rain, fog, etc. and with buoys, lights, bridges and shore features all reproduced in accurate dynamic perspective. Such training could significantly contribute, for instance, to a reduction of environmentally disastrous accidents such as that of the *EXXON VALDEZ*.

Conclusion

In review, systems management involves the combining of complex subsystems into a unified command and control system. A thorough systems management approach would also validate the physical design of system spaces, provide early identification and resolution of overall system integration problems and would demonstrate that system performance meets operational requirements through tactical and environmental simulation.

Thanks to powerful simulation capability, engineers involved in this developing field would also be able to assure the operability of system equipement and its software interfaces as the system evolves throughout its operational life. It goes without saying that maintaining configuration and documentation accuracy and the efficient managing of spares, repairs, procurement and installation are also an integral part of overall systems management objectives.

While the major applications of systems management expertise in Canada are most visible in defence-related projects, this science is applicable in almost any field which requires complex integrated systems. Canadian industries will feel the benefits of this new technology over the coming decades as they gain from the transfer of technology which began with the CPF program and the building of twelve new frigates for the Canadian Navy.

Beginning with this issue, letters addressed to the Managing Editor will, according to their interest, be published in "Readers' Corner". All readers are invited, and indeed encouraged, to make use of this forum to share their positions or concerns. Please address all correspondence to IEEE Canada, 7061 Yonge St., Thornhill, Ontario, L3T 2A6.

A National Electrical Engineering Society

Given the predominance of IEEE Canada, how can we satisfy our need for a "credible national electrical engineering society with a Canadian perspective, Canadian priorities and Canadian agenda"?

To answer this question we must first examine what we mean by Canadian perspective, priorities and agenda. Is there anything in this that, if pursued from within IEEE Canada, could put us in a conflict of interest with IEEE ? If yes, then clearly IEEE Canada cannot serve this need and we must look to ways of strengthening the alternative routes such as the CSEE. If not, then perhaps IEEE Canada can and indeed should be used for fulfilling these needs.

We believe that IEEE-Canada can play the role of the Canadian Society.

Of the many activities that could possibly fall within the Canadian perspective, we would like to suggest the following that could serve to launch this "agenda":

Review of Electrical Engineering Education in Canada

Review of Government policies on Science and Technology.

While, surely, some IEEE members must already be actively engaged in these activities, the involvement of IEEE-Canada could enhance such activities by providing a larger and more broad-based forum for deliberation.

Harbans Nakra
R. Lewis Vaughan
Varennes, Québec

PCBs

I found the article "PCBs: Myths and Reality" of great interest as it largely confirmed my own suspicions regarding these substances. I was however rather dismayed at the very last paragraph when, after thoroughly demolishing the arguments that PCBs are in any way harmful, the authors are apparently giving in to the hysteria surrounding these compounds by still talking about their destruction.

If engineers give in this easily to this type of scare-mongering, it just encourages the scare-mongerers even more. All it needs is for anybody, with however little evidence, to suggest that a substance is carcinogenic, and the next thing we know, lives are being disrupted, businesses forced into bankruptcy, and more and more oppressive legislation imposed on a suffering industry.

No substance or process should ever be legislated out of existence without the strictest of scientific proof of the same rigor that is used for the introduction of new pharmaceuticals. Had proper double-blind toxicity tests been carried out on PCBs at the first sign of suspicion, all the fuss and bother of the last few years would never have happened.

Greg Trice
Scarborough, Ont.

The article on PCBs stressed the "Myth" of what is hitting the press but the article itself admits that PCBs are indeed a problem: *"These dibenzofurans can be created when PCBs are heated."* Note the choice of word: it doesn't even require burning or incineration (complete pyrolysis being desirable).

I am told by environmental authorities that, not too long ago, PCBs were used as binders in plastics. When plastics were disposed of by burning, PCB's and, according to your article, dibenzofurans, were, and perhaps still are being released. Why shouldn't we think of St-Basile-le Grand, and no doubt hundreds of other minor incidents a day, in terms of dibenzofurans?

Since your article, I note the concern about the importing of contaminated oil from the USA. If this is disposed of in Diesel engines and home furnaces, etc. – could this not produce more toxic dibenzofurans?

If any of the above concerns have validity, then I put it to you that the motivation of the article was not on the side of right, nor on the right side!

Barry M. McVicar
Calgary, Alberta

Nuclear Submarines

I am concerned with the apparent lack of balance that the December 1988 and June 1989 *IEEE Canadian Reviews* are displaying with regard to the military use of advanced technology, with two articles expounding the virtues of nuclear-powered submarines. Both articles accept without criticism the attitudes in the 1987 Defence White Paper, that expanded military operations are synonymous with both National Defence and Security, and discount the real opportunities for progress towards true International Security through arms control, reduction and elimination treaties. It is well known that, though technically not violating the Nuclear Non-proliferation Treaty, Canadian acquisition of nuclear-powered submarines will seriously weaken the control regime of the IAEA. The treaty has problems enough with the nuclear weapons-possessing states not committing themselves, as originally agreed in 1968, to real reductions leading to eventual elimination of nuclear weapons. For Canada to exercise the "loophole" of Article 14 of the NPT, would be truly retrograde.

The military paradigm that sees the Arctic as just another theatre for war games obscures the idea that the certain detection of intruders could be a sufficient deterrent against such intrusion. With an Arctic Non-Militarization treaty, such detection would fulfill the requirement for verification. To restore some measure of balance, I believe the *Canadian Review* must solicit substantive technical contributions covering the capabilities of passive sonar arrays for submarine detections, and the opportunities for improved Arctic surveillance of military activities with RADARSAT.

Peter Brogden
Toronto, Ont.

The *IEEE Canadian Review* makes the disclaimer that the responsibility for the contents of the articles rests upon the authors and not on the IEEE. However, the *Review* cannot escape editorial responsibility for the topics chosen and general content of the articles published.

The article printed in the June 1989 issue, "The Strategic Implications of Canada's Choice of Submarine," contains no exposition of technical interest to electrical or electronics engineers. The article is nothing more than an expression of opinion on one side of a controversial subject in the public domain. Even Spectrum does not go as far as this.

Normally, engineering societies take a public stance only on issues within their domain, such as on R&D spending or on engineering education. By publishing this article, the Canadian Region of the IEEE has expressed an opinion beyond its mandate and the members deserve a clear statement from the directors regarding the IEEE's position on Canada's military policy and on nuclear arms. The current position is one I do not want to be associated with, and I will be looking for your reply.

Raymond H.P. Thom
St-Lambert, Québec

Managing Editor's Reply:

The objective of the IEEE Canadian Review, is to serve "as a forum to express views on issues of broad interest to its targeted audience. These issues, while not necessarily being technologically-oriented, are chosen on the basis of their anticipated impact on engineers, their profession and the augmented academic, business and industrial community, or even the community at large."

The nuclear submarine issue is one, among many others, where electrical and electronics technologies are used in a context that is very different than one of trade or of economics. Indeed, certain uses of technology can have consequences, now and potentially far into the future, which go beyond the scope of one's day to day contribution to a specific project. In this respect, such issues represent an opportunity for engineers to question their fundamental values in relation to that which earns them their livelihood.

In the case of the nuclear submarine, broad questions have essentially not been addressed in the mass media, let alone those that concern engineers specifically. Also, to a certain degree, perhaps the mass media is not the proper forum for an appropriately rigorous treatment. In this respect, the IEEE Canadian Review, on one hand, permits such issues to be dealt with on the correct *level. On the other hand, it enables a small but influential fraction of Canadians to be better informed and perhaps contribute more meaningfully to the final outcome of such issues.*

The key here is information: it has to be made available. In this respect, two types of information have so far been published in the Review. First of all, we have seen a description of the different technologies that go into one specific submarine, with a focus on those that interest IEEE members more particularly. Secondly, we have had an article that describes the strategic reasoning one would use to justify the choice of nuclear submarines for Canada. At this point, having made a certain amount of information available, it is up to the readership to take position, and perhaps to react. Making information available to the readership is not synonymous with taking a stand on any given issue and it is not the intent, in this case or any other (for instance PCBs), to substitute articles for editorial policy. It only means that the Review will not shy away from controversial subjects as we see it our responsibility to stimulate discussion on such topics.

To be sure, in the case of highly controversial issues, all sides should be brought to the fore and the Review certainly adheres to this objective. However, presenting all sides requires that individuals be found willing to take a stand and write an article at the appropriate level. Here is where the concept of the forum takes on its full significance: we depend on our readers to share a particular viewpoint and whoever wishes to do so is at liberty to respond in these pages, either in a letter or in a full-length article. This issue marks the beginning of these exchanges as readers begin to indicate considerable interest in their Regional publication.

The Review appreciates your feedback. We truly want this publication to be your forum.

Richard J. Marceau
Managing Editor

IEEE Canadian Review

I have just looked through your new publication and would like to congratulate you and your editorial staff on an excellent presentation. It is definitely a first-class publication, and I am sure that the members of IEEE Canada and the Board of Directors will applaud a job well done.

The aspect of this publication that appeals to me most, and I am sure to many members, is the diversity of topics within the publication. It deals with related fields of engineering affecting us today.

Again, please accept my congratulations.

Guy J. Houle, Montréal, Québec

Many thanks for including me in the mailing of the IEEE Canadian Review. I am impressed - you have produced a professional, well-organized, well-written publication. Be proud of your product - it is really good.

Melvin I. Olken, IEEE Society Services Director

IEEE Canada Snapshot

Robert Tanner, Former Director of IEEE Canada, has recently received the Degree of Doctor of Laws, *honoris causa*, from Concordia University.

Educated at Imperial College of Science and Technology in London, England, he began his career with the British Broadcasting Corporation as a pioneer in the world's first high definition television station developing audio techniques and researching the acoustics of studios and concert halls.

In 1947, he emigrated to Canada and commenced an outstanding engineering career with Northern Electric, Bell-Northern Research, and subsequently the Canadian Department of Communications. He contributed to Canadian engineering in many fields, managing the development of products and systems from audio equipment to microwave relay stations. His skill as an engineer and a manager was recognized by his appointment in 1973 as Director of Industrial Research of the Canadian Department of Communications.

As a consultant, he was responsible for the acoustical design of many important buildings, including the Royal Canadian Mint and the Stratford Festival Theatre in Ontario. He dedicated himself to this work after leaving the Department of Communications in 1975, and has since carried out the acoustical design of many buildings, including an Air Force Academy for Saudi Arabia, and the new Canadian Embassy in Washington.

In his remarkable career, Mr. Tanner has received many awards for his work. He has been honoured with IEEE Canada's McNaughton Gold Medal, IEEE's Haraden Pratt Award and the Robert H. Tanner Lecture Series in Toronto. Four professional societies have conferred their highest honour on him: he is Fellow of the Acoustical Society of America, Fellow of IEEE, Fellow of the Engineering Institute of Canada, and Fellow of the Institution of Electrical Engineers (of Great Britain). He is also a Member of the Institute of Noise Control Engineers.

Mr. Tanner has expressed his dedication to his profession not only in his outstanding work in engineering, but also in his contribution to the advancement of science and engineering. He has been for many years active in the IEEE. He held the offices of Director of the Canadian Region, Secretary, Executive Vice-President, and in 1972, President, becoming the first and only member of the Canadian engineering Profession so far to hold this high office. In fact, he is the only non-American ever to have been elected to this position. To this day, he continues to be active in many of the Institute's committees.

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TORONTO SECTION

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Authors are requested to submit a 300 word abstract for review.

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Paper contents are requested to be as specific and concrete as possible so as to promote automation technology. Product advertisement is not permitted in the technical program of the conference.

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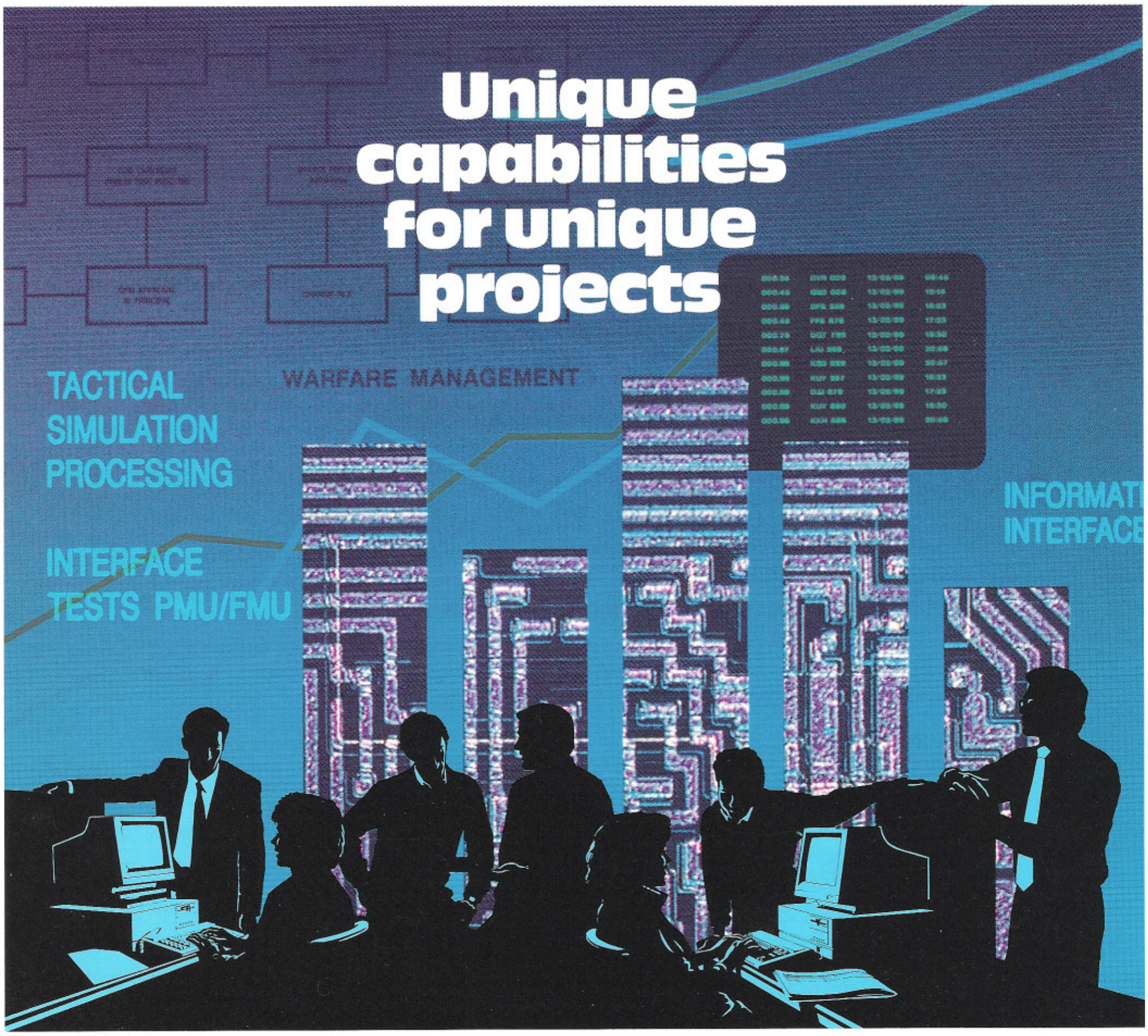

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