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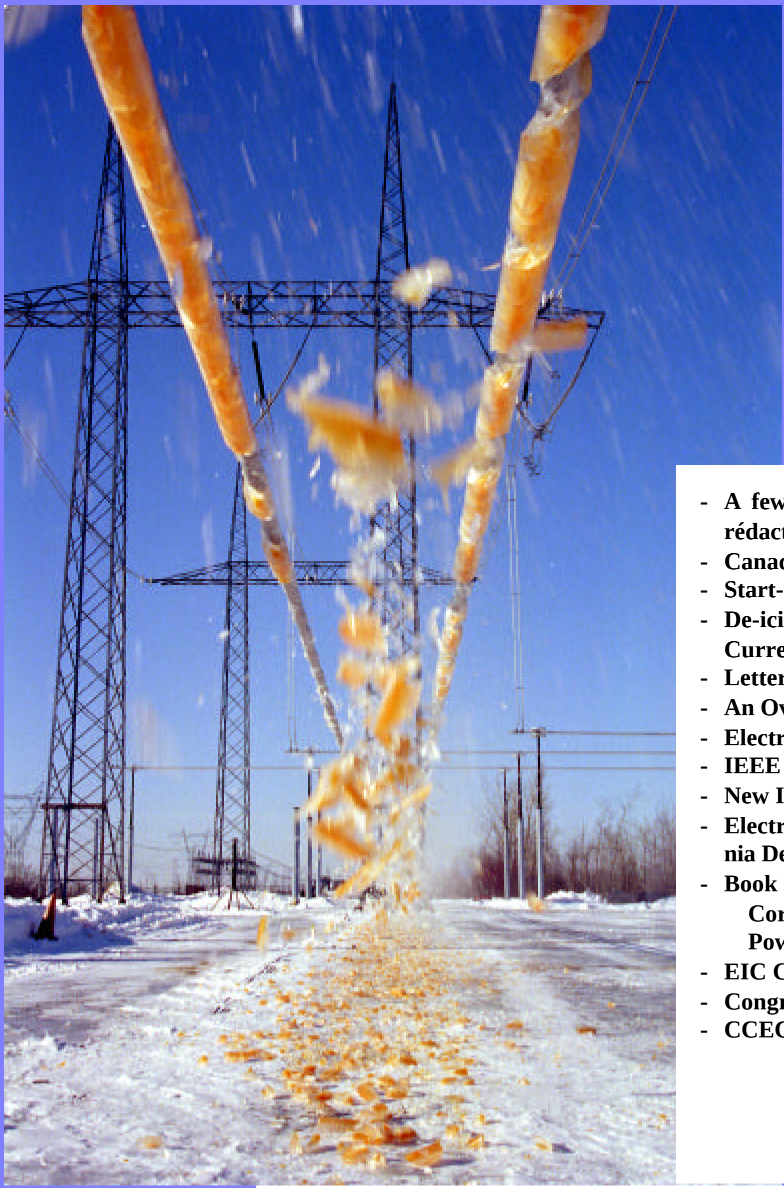
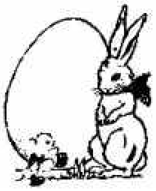
IEEE Canadian Review

La revue canadienne de l'IEEE





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IEEE Canadian Review General Information

The ***IEEE Canadian Review*** is published 3 times/year as follows: Spring (to appear in April); Summer (to appear in August); Fall (to appear in December). Its 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 Canadian academic (i.e. universities, colleges, secondary schools), government and business communities.

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

1- National Affairs	4- Education	7- Computers
2- International Affairs	5- Power	8 - Electronics
3- Industry	6- Communications	

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Quelques mots du rédacteur en chef

Vijay K. Sood, Hydro-Québec

Une nouvelle année, un nouveau défi: celui d'améliorer le site web de la revue canadienne de l'IEEE. Cette année, nous planifions de faire le nécessaire afin d'être branchés.

Je dois vous rapporter quelques récents changement au niveau éditorial du CR. Isabelle Chabot, qui nous a bien aidés lors de la dernière année en tant que rédactrice des coupures de presse a été promue par son employeur, et sera donc remplacée par Alexandre Abecassis (voir page 4). Je tiens à remercier Isabelle pour son assistance inconditionnelle pour nous fournir son support et ses services de traduction, souvent dans de courts délais. Je lui souhaite beaucoup de succès dans sa future carrière. En même temps, je souhaite une chaleureuse bienvenue à Alexandre pour le poste.

L'intérêt, le nombre de pages et les éléments de nouvelles envoyés au CR pour publication semblent continus. Mon travail d'incitation s'en trouve allégé. Je vous encourage tous à continuer de m'envoyer vos articles. En particulier, je souhaite voir des articles provenant des petites entreprises avec leur dynamisme et leur énergie. Si vous faites attention, vous remarquerez que nous sommes à 32 pages par numéro. La dernière année a été notre meilleure année jusqu'à présent.

Cependant, les revenus de la publicité sont toujours faibles. Je suis souvent solicité pour publier des annonces de placement. Malheureusement, à cause de nos dates de publication quadri-mensuelles, ces annonces de placement doivent être synchronisées avec les dates de publications pour être opportunes. Un chasseur de tête avec qui j'ai discuté était très furieux d'avoir à aller voir un magazine américain (et de payer "1.5" dollars) afin de publiciser des offres d'emplois au Canada! Tout ce que je peux faire, c'est de donner la priorité aux premiers annonceurs arrivés quant à l'espace disponible, même si ces derniers arrivent à la dernière minute.

Je suis encouragé par le marché de l'emploi pour les ingénieurs en génie électrique et en génie informatique. Cela signifie qu'enfin certains secteurs de l'économie commencent à obtenir la priorité qu'ils méritent. Les salaires devraient suivre. Si quelqu'un veut écrire sur la situation du marché de l'emploi, qu'il n'hésite pas à me rejoindre.

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Cover picture / *Photo de couverture*

The cover picture shows a de-icing test performed on a sample of overhead transmission line of 315-kV twin bundle mounted in the outdoor switchyard of IREQ's high-power laboratory. The de-icing principle is based on the circulation of a short-circuit current at the rated voltage of the transmission line and the subsequent action of electromagnetic forces that allow conductors to knock against each other and the ice to fall off. The test used 10 kA as the short-circuit current and an appropriate reclosing sequence. Note that the ice was colored orange to provide some distinctive features. A full description of the testing sequences and results is provided in the article on page 10.

A few words from the Managing Editor

Another year and another challenge: to improve the website of the IEEE Canadian Review (see www.ieee.ca). This year we plan to do something about going on-line.

I have to report some recent changes at CR editorial level. Isabelle Chabot who served us well for the past year as Newslog Editor has moved up in her company and has been replaced by Alexander Abecassis (see page 4). I thank Isabelle for her unwavering assistance in providing support and translation services, often at short notice. I wish her success with her future career. At the same time, I extend a warm welcome to Alexandre in this post.

The number of papers and news items sent in to the CR for publishing seems to be improving. This makes my job of arm twisting that much simpler. I encourage you all to continue to send in your articles. In particular, I want to see articles from those small companies with their dynamism and energy. If you notice, we are up to 32 pages per issue. Last year was our best year to date.

However, the advertising revenues are still slow in coming in. I am often called for placement adverts, but unfortunately due to our quarterly printing dates, I have to time the adverts just right to make a hit. One head hunter I talked with recently was very irate at having to go to a US-based magazine (and paying in “1.50” dollars) for advertising jobs in Canada! All I can do is to make it a priority to have that space available to any advertiser, even if they do come in at the last minute.

I am encouraged by the job market for electrical and computer engineers. This has meant that some key sectors of the economy are beginning to get the priority they deserve. Salaries should keep pace. If anybody wants to write to me about the job market, please do call me.

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Newslog Editor

Rédacteur des coupures de Presse

Alexandre Abecassis is a patent agent trainee at Swabey Ogilvy Renault, patent and trademark agents in Montreal.

Alexandre Abecassis travaille à Montréal chez Swabey Ogilvy Renault, agents de brevets et de marques de commerce, comme agent de brevets en formation.

Send any news clippings you would like to contribute via e-mail to alexandre.abecassis@ieee.org

Veuillez faire parvenir les coupures de presse proposées par e-mail à alexandre.abecassis@ieee.org

VANCOUVER, Nov. 6. The Transmeta Crusoe microprocessor, which was partly designed by Linus Torvald, will be used, for the first time in an embedded application, by Merilus Technologies Inc. This microprocessor is well known for its innovative, flexible, architecture.

BALTIMORE, Nov. 7. The Wildlife Habitat Council (WHC), a nonprofit organization, awarded employees of IBM's Software Development facility located in Markham at the Wildlife Habitat Council's (WHC) 12th Annual Symposium. IBM Canada's outstanding wildlife habitat management and environmental education efforts were recognized during this event.

TORONTO, le 9 nov. Un nouveau centre de formation des pilotes va être créé par CAE en Espagne. Ce centre, le troisième en son genre, permettra notamment la formation des pilotes sur Dash 8 et sur Bombardier CRJ.

MONTREAL, Nov. 14. J.D. Edwards Canada Ltd. with JDA(R) Software Group, Inc. will provide a technology solution for La Société des Alcools du Québec (SAQ) for effectively managing their operations. This solution will lead the SAQ to efficiently operate from warehousing stage up to the shipping stage. Such solution will enable the SAQ to adapt efficiently to market changes.

QUEBEC, le 23 nov. Le président de TERAXION, M. Alain Chandonnet a annoncé son intention d'investir près de 40M$ et de créer 500 emplois. Cet investissement renforcera le secteur optique à Québec. Le gouvernement de Québec, par la voix de son ministre des finances M. Landry, a appuyé les efforts de l'entreprise par un crédit d'impôt.

BURNABY, BC, Dec.6. TELUS Corporation is offering a Certificate in Internet Marketing with the partnership of University of British Colombia (UBC). This certificate will be offered through the national Telus Internet portals during a 6 months trial period. This will be the first university certificate program to be offered in Canada through Internet. Telus is seeking to lead the market of educational web content.

MONCTON, NB, Dec 11. ROGERS CABLE INC. announced an investment of 90 million dollar for enhancing its cable network. 100 jobs will be created over 24 months. Digital television as well as a broadband Internet access is expected.

MONTREAL, QC, Dec.15. In order to fight against cellular phone radiations, SAR shield developed a patented technology. SAR shield's technology reduces the radiation emitted by a cellular phone by up to 89% by absorbing electro-magnetic waves. SAR shield can be installed on any cellular phone.

MISSISSAUGA, ON, Dec.18. GLOBALSTAR launched its data service. GLOBALSTAR is a satellite based telecommunication system, which operates 48 Low Earth Orbit (LEO) satellites. By January 2001, Globalstar will be available in 90 countries. The data service operates at 9600 bits per second using Qualcomm GSP-1600 phone.

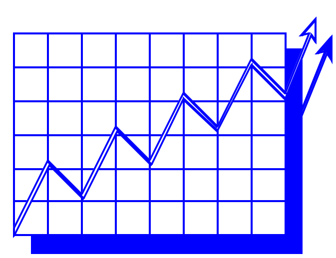
VANCOUVER, BC, Dec. 22. ABSOLUTE SOFTWARE announced the recovery of a laptop, which used its Computrace(r) product. The stolen laptop began to call the Computrace Monitoring Center every 15 minutes over the Internet. The police was able to trace the 18 received calls and raid the same day the thief's hideout.

MARKHAM, ON, Jan. 10. ATI Technologies Inc. and INTEL signed a cross-licensing agreement. The cross-licence agreement grants each company rights to certain patents owned by the other. ATI and INTEL will incorporate new features and technologies into their products. This agreement also settles pending litigation between the two companies according to the announcement.

TORONTO, ON, Jan. 12. TV U8TV.com, the first Canadian Internet will be launched by Alliance Atlantis Communications Inc and TVForReal.com January, 15 2001.

OTTAWA, ON, Feb. 8. CANARIE, a non-profit corporation dedicated to accelerating the development of Canada's Internet as well as the creation of innovative applications announced a plan to build the world's largest optic disc drive. The optic disc drive will be built using existing CANARIE's national optical research network CA net 3. The disc drive will work as a nationwide optical storage device. The expected size will be several gigabytes.

CALGARY, Feb. 15. ZERO GRAVITY offers wireless connection to Manitoban PDA users. PALM OS enabled PDAs such as HANDSPRING VISOR and PALM will be entitled to this service. The service comprises email access as well as wireless browsing; furthermore, a 128 bits encryption will be available with the browser enabling users to trade stocks for instance with confidence. ZERO GRAVITY service runs on MTS's wireless data cellular digital packet data network.



Start-up Advice for "Business Savvy" Technology People

by Paul Freedman
Simlog, Montréal, QC

Abstract

The article describes the experiences of a software developer who decided to take his newly developed product to market and start up a business. Our technological age and fast expanding small business environment demands more and more such start ups. The article is full of personal anecdotes which will prove highly interesting and useful to other people comtemplating similar (ad)ventures.

Sommaire

Cet article décrit les expériences d'un concepteur de logiciels qui décida de partir son entreprise en commercialisant son tout nouveau logiciel. Une telle initiative cadre très bien avec notre ère hautement technologique qui favorise l'éclosion de telles entreprises. Cet article regroupe donc plusieurs anecdotes personnelles qui seront sûrement très intéressantes et utiles pour d'autres personnes qui convoitent des rêves similaires.

1.0 Introduction

It's sometime said that we come to write what we would like to read. And three years ago, I would have liked to come across an article just like this one, filled with ordinary-sounding but important insights to help counsel the "technologically savvy" thinking about starting up a business.

I should, perhaps, mention that the title was inspired by the suggestion that the world of software products is led by "technologically savvy" business people and "business savvy" technology people. This article is therefore intended for technology people looking to become "business savvy".

Here, I can only claim to speak knowledgeably about software product businesses. And at the outset, I'd like to acknowledge the advice that I myself have obtained from all kinds of people involved with start-ups in all kinds of ways: founders of successful start-ups, consultants who've been employed by start-ups, business development people at research institutes and university tech transfer offices, and people I've met at technology incubators and venture capital firms. And the many books about entrepreneurship that kept me up late at night. And finally, my own business partner, our employees, my professional colleagues, and our business customers. They have all had a hand in shaping my thoughts which have turned into this article.

2.0 Getting Ready

So: you've developed some kind of new (software) technology. Even better, you have a prototype that's gone out to potential customers for field trials with real users. And best of all, the trials clearly demonstrated the merits of your technology (because if the results were inconclusive, you'd be wise to stop here). So commercialization is now on the horizon, and lately, you find yourself thinking (dreaming?) about starting up a business to do just that.

Well, most people begin by looking for similar existing products, academic research that if commercialized, might become a competing product, etc. Remember that the world seems to be growing smaller each day and the pace of business is increasing. And what might look like a wonderful business opportunity to you might just look like a wonderful business opportunity to other people too. They might be down the street or across the ocean. Luckily, the Internet can help you find out. Getting ready in this way is typically conducted while you're preparing a "business plan" to make the case for starting up a new company.

Starting up a business takes time and in order to stack the deck in your favor, look for a market niche and a product category that are "off the radar screen" of existing players. In this way, you just might have enough time to:

- create a first product from your technology with enough added value that you'll be able to sell it or to find customers to buy it
- improve that first product based on feedback from your first customers, by making existing features work better, adding new features, porting to additional computing platforms, etc.

Because there are competitors lurking everywhere, whether they are existing players with enough technical and business smarts to quickly bring to market something that might compete head on with your first product, or business savvy technology people like yourself thinking through these very same steps. On the other hand, you can't drive a car by only looking into the rear-view mirror. So face forward and push on!

3.0 About Partners

Starting up a software product business is rarely something for an individual to take on alone. Mostly, people have partners and there are really three kinds:

- Cofounders
- Strategic investors
- Financial investors

3.1 Founders

The first category comprises all the like-minded people, typically your professional colleagues (and friends), who are ready to make something out of nothing with you. Here, you must be absolutely certain that everyone looks at the world in the same way. There should be mutual recognition of, hopefully, complementary talents, strengths, and interests. And there must be absolute trust: if every single business decision always requires a half-day meeting to sort out, then you'll never get very far. (Technical people in particular can sometimes hold opinions with religious zeal). Founders must be able to count on each other: count on each other to be informed, to take the lead in their respective ways, and, of course, have a say in the most important business decisions.

Of course, your business plan should spell out in detail exactly who are the founders, what roles will they be playing as part of the start-up, etc. (If all of the founders want to be President, you've got a serious problem.) The business plan also spells out in some detail exactly what the start-up business is, what its product(s) will be, what kind(s) of customers will be targeted, etc. So all of the founders should help prepare the business plan, just to make sure that everyone "knows the score", by way of anticipating and resolving possible future conflict.

Because some people "need" to be everywhere and take part in every single decision. Having a partner like this will only cause you grief. That kind of person needs to be steering his own ship and never feels comfortable with shared management

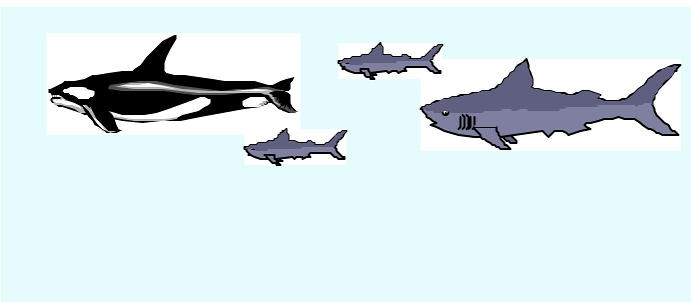
Founders must share, and that sharing must be based on mutual respect. And one of the most important things to share is the recognition that there is simply too much to do every single day, that you've just got to trust people to get on with things by themselves, while you concentrate on your own things. (Otherwise, the business won't move forward.)

I've been told that at a leading technology incubator, half the business plans never turn into businesses, just because the promoters can't sort out the human side of pulling together as future founders. Not enough mutual respect, not enough shared vision, not enough mutual recognition of complementary strengths and interests that people are bringing to the table. How sad. But then again, people are people are people. In my own case, when we were just dreaming, we were four. When things became more serious, we were three. By the time we were shipping first products, we were just two.

And this seems to be typical. The more founders there are, the more difficult business things are to manage just because it become's harder to reach consensus. One colleague, who's been a part of two start-ups, has even suggested to me that just one or two founders is the ideal number: even three is asking for trouble. (Of course, when there are many people, it might be possible to create categories of "junior" and "senior" founders with different amounts of responsibility and ownership).

So be absolutely sure (or as sure as you can be) before things begin and before shared ownership is established. Because when you're just starting up, all founders must be pulling their weight and pulling together. There'll be no time to be on the outs with someone, and probably no money to buy someone out. And without such money, you'll discover that it's just not healthy to have someone around who's just not contributing 100%. (At one start-up that I know, now very successful, three founders were obliged to buy out a fourth founder in the first year, long before there was a product to sell and a revenue stream in place. As a result, one was forced to sell his car, another some furniture, another his stereo, etc. just to raise the money. These things really do happen).

One last thing: preparing the business plan should also help the founders sort out their "exit" plans, i.e. their personal (professional) goals. Are you looking to be a big fish in a little pond, or a much bigger fish in an ocean of even bigger fish?



Are you looking to be a majority owner of a little company, or a minority owner of a much bigger company? And what kinds of circumstances would oblige you to "bow out" and leave the start-up? These are very hard questions and especially at the start, when everyone is (hopefully) dreaming the same dream, it's a subject that is often (unwisely) left for future discussion.

3.2 Strategic investors

The second kind of partner, "strategic investors", are established companies who decide to become a part of your adventure. These investors are counting on you to develop products that will somehow complement and promote their own, and bring new customers to the table that might be interested in buying their own products. Such strategic investors are really partners insofar as they provide tangible help to your start-up such as access to their personnel, space in their booths at trade shows for you, etc. And because they are partners, they will do their best to be supportive and patient.

3.3 Financial investors

Of course, it's sometimes the case that in order to get going, a lot of investment must be made up front. This is especially true in the telecommunications world (where product development means manufacturing) and in the biotech world (where product development means costly laboratories and clinical trials). But such needs are In the software business, this kind of situation is rarer but when too little technology exists already, or when it is judged to be too "primitive" to be exploited "soon", then large scale software development will require large scale funding. (to pay for the many people hours required).

So depending upon the nature of your business, how much work needs to be done to create a first product, what kind of sales and distribution channels needs to be set up, etc. and how quickly everything needs to happen (because there are other people looking at the very same business opportunity), then a third kind of investor can be not only advisable but essential.

These "financial investors" are choosing to invest their money in your adventure, instead of someone else's. Here there are no complementary products, no domain-related expertise. Just dollars. And these people are counting on you to hit a home run; nothing else will do. Because if you're not going to hit a home run, then they'll simply invest their time and money elsewhere.

To my mind, such investors are not real partners. They are not looking to become your business friend and they don't share your business dreams. Worse, if they come to decide that you're moving too slowly, or in the wrong direction, then you'll be kindly asked to step aside (or otherwise forced out) to make space for a new captain of the ship. And that's why many founders end up as "Chief Technology Officer" (CTO) or "Vice-President, R&D" instead of "President". This happened to two founders at two different start-ups that I know of. (Sometimes, founders are simply bought out and "shown the door").

But for many technology founders, moving into a role with technical (instead of business) emphasis suits them just fine. (Once the perceived blow to the ego fades with time.) These people are often uncomfortable setting aside their technology hats in order to wear business hats anyhow. Because running a start-up means doing just that: if you're not out talking to customers, then who is? If you're not on the phone or at the trade show chasing down leads, then who is? So if you're not prepared to play that role, then you'd be wise to recognize that sooner instead of later and look for someone else to take on that job instead. Don't forget: so long as you continue to be a part-owner, you'll still take part in the most important business decisions, whether you're the captain of the ship or not.

4.0 About Ownership

Don't confuse ownership with management direction. Regardless of how much or how little you own of your start-up, if you're in charge, then you'll probably stay in charge so long as things go well: first products roll out, customers buy them, new products roll out, customers buy them too, etc.

But if sales are growing slowly (or not at all), or if new products aren't selling well, or if your markets are judged to be small with not enough room for exponential growth, well that's when the other owners will want to make changes (unless you can persuade them otherwise). And here's where owning more than the others can count: when things get tough, you can stay in charge.

Of course, staying in charge also means that if you're not careful, you'll simply bankrupt your company, when someone else might have been able to turn things around. So there are times and places when business replanning is not only wise but essential. But if you own more of your own start-up, you can simply better choose when those moments arise.

5.0 About Employees

Sooner or later, your start-up will hire employees. When there are many founders, this might happen “later than sooner” but in most cases, there are employees right from the start, just because there's so much to do and not enough founders to go around.

These first employees are a key part of your team, often as essential as anyone else, since they've been hired to complement the skills that you already have. But don't expect them to work with the same kind of devotion and emotional attachment that you have. They are employees and if they're not well treated, then they'll simply move on to work somewhere else. So right from the start, you'll need to offer competitive salaries, competitive insurance benefits, etc. because those employees are taking a risk too: as a start-up, there's a lot more emotional and financial uncertainty about working for you instead of for somewhere else who's already well established. Of course, it might be more exciting to work for you and that's a “plus”, but a “plus” can quickly turn into a “minus” when things get tough.

So don't forget the daily/weekly words of encouragement, support, and appreciation. Of course, we all work better when we do something we like, when we do it well, and especially when others acknowledge that we do it well. But employees at a start-up need to hear this more often, given the start-up circumstances.

One last comment: whenever possible, it's wise to bring new people on board one at a time (or a few at a time). Firstly, this reduces the time spent by your existing technical staff on training new people, so that they can continue to concentrate on new technology development. Secondly, this helps preserve and promote your company's way of doing things (“culture”), i.e. it's easier for the new person to learn to do things your way if everyone else is already doing things your way (coding styles, source code configuration management, weekly reports, etc.). When many new people begin together, this fragile cohesiveness can break down fast.

6.0 About (Software) Consultants

Given that money is tight and product quality so essential, it's wise to look, to software consultants for outside help with your technology development when you're starting up. Due to their vast experience (seeing and doing good and bad things elsewhere), such people can advise your own technical team about all kinds of “infrastructure” including coding styles, testing procedures, source code configuration management and eventually, tracking customer problems.

It's when consultants, not employees, come to take on big parts of new product development, that the start-up can run into trouble, especially when the “how things get done” (and not just the “what to do”) cannot be sufficiently supervised by your own technical team. Because in the software world, you need to know your own technology inside out, in order to be able to control its development, support it in the field, and continue to make it grow.

7.0 About Your First Product

Quality is absolutely essential for a first product: one of the simplest ways of spinning out of control is shipping a first product that doesn't work well enough. That's because when you begin, the people who'll be dealing with customer problems are the same people who'll be responsible for new product development. So when customers start calling with problems, new product development simply stops. And once products are “in the field”, it becomes so much harder to make them work right, even with Internet access to download system logs, upload patches, etc. And dealing with these problems will demoralize your technical staff, throw off your business planning, and discourage your partners. Remember: you need compliments from first customers, not complaints.

You want those first customers to become your references for winning additional customers. So better to ship late with something solid, than ship on time with something that doesn't work well enough. (Of course, shipping on time with something solid is the ultimate goal.)

8.0 About Product Pricing

Everybody knows that when it comes to software products, the purchase price has little to do with “real” costs. For example, the price of a software-based product shipped on CDROM has little to do with the cost of the CDROM, its label, and its box. Here, product pricing has everything to do with the perceived value of the product in the customer's hands. Of course, if the purchase price is too low, then you won't be able to stay in business very long. On the other hand, if the purchase price is too high, then you won't make a sale (and once again, you won't be able to stay in business very long). So what can you do? Well, if you're marketing a new product that competes with existing products but somehow does its job differently (better), than you can look to those product prices for help when establishing your own.

But when you're marketing a new kind of new product, then you'll need to look elsewhere for guidance, and do your best to evaluate the perceived value of your product in the customer's hands. And then persuade the customer that your estimate is accurate! Here is where customer references can become so important: there's nothing like having documented evidence about value from an existing customer to help you make a sale to a new one.

9.0 About Marketing

Once I got past the vocabulary and the business school articles, I discovered (as I always suspected) that marketing is all about turning technology into products that customers buy. Not “want to buy” or “might buy” but “buy”, because unless money changes hands, there's no business. (There's just somebody spending money, presumably yours and somebody else's.) And remember too that customers have to associate enough perceived value with your product to buy it at the price that you've set. (More about establishing prices later).

So marketing means asking questions, listening carefully to the answers, and thinking even more carefully about collections of questions and answers, in order to develop a sense of how best to create products from your technology that customers will buy. This means thinking about how to characterize those customers in order to create a first product that they will buy. It also means recognizing that customers' buying decisions are not always logical or rational; after all, customers are just people too and sometimes we all buy things for “emotional” (irrational) reasons.This too must become part of your equation.

Marketing is part detective work, part psychology. And to do it well, I think that you must be truly interested in people, not just technology.

As a result, better marketing will always triumph over better technology. Stated otherwise, superior knowledge about what the customer wants and will buy is much more important than superior technology, when it comes to product success. And that's why it's important, especially at the start, to limit the number of product markets, since acquiring superior knowledge takes time and perseverance.

Of course, even “inferior” technology, as measured by fewer or more limited features, still requires first class product quality! (cf. “About your first product”).

So don't forget: when defined in this way, marketing is too critical, too essential, to leave to other people to do for you. It's all about making sense of things, of seeing farther ahead than the next guy, of looking at things more clearly than the next guy.

It's the basis of every business, and you need to learn how to do it, or step aside and find someone to do it instead (and make him a founder too).

Oh, one more thing. You might discover (as I did once) that an advanced engineering degree can be perceived as an insurmountable handicap when it comes to successful marketing. It's as if there's only room to excel in one domain, technology or business, but not both. Well, since I'm not going to return my advanced degree to the university, all I can do is shoulder on and teach myself what those kind of people think I can't learn. Because when all is said and done, business success (as measured by dollars) has a way of overcoming prejudice.

10.0 About Funding New Technology Development

The easiest way to pursue new technology development and more generally, grow your business is through “retained earnings”, i.e. profit that you re-invest. So that means, pricing your products as “expensively” as you can in keeping, of course, with the value of your product as perceived by your customers (cf. About product pricing). And that's why first sales are so important to start-ups, since they provide the necessary funds to keep you moving forward.

But it's sometimes the case that even more funds are required to finance new technology development, especially in the beginning when your revenues are limited. Here you'll discover that the “cost-sharing” governmental funding initiatives designed (in principle) to promote business growth are simply unsuited to start-ups. That's because even paying fifty cents on the dollar can be more than your cash flow (and bank balance) can stand. Worse, unless you can demonstrate tremendous growth potential (thanks to the anticipated new technology development), your start-up won't even qualify for such funding!

So in the end, it's wiser to look for potential customers with “special” needs who, for their own business reasons, are ready to bet on an uncertain horse. In our case, one such customer had ordered a bunch of new, costly, crane-like equipment and had experienced all kinds of problems with operator training. As a result, when placing another order for more of the same new, costly, equipment (as part of a major modernization effort in their plant), the customer was ready to turn to us to develop a new simulator to help train new operators better and more cheaply.

But there are two things to look out for when someone else pays for your new technology development. Firstly, there's the question of applying for R&D tax credits, since he who pays is the one who typically files the claim. But when you're just getting started, this hardly counts. Of much more importance is who owns the new intellectual property; wherever possible, this should be you. Typically, you can retain ownership but your first customer (who's funding the new technology development) might demand some kind of royalty payment each time you sell the same new product to someone else. That first customer might even demand that any future sales be put off until some time in the future, to ensure that the competitive advantage that this first customer now enjoys (thanks to your help) is neither immediately nor easily acquired by that customer's competitors. So negotiate as best you can; it's not always when you're not dealing from strength.

11.0 About Focus

While every start-up begins life with a well-defined mission (as described in your business plan), once you begin, you'll discover that it's oh so easy to become “side-tracked”.

At first, a potential customer might ask you to consider making important changes to your current or future products. And some start-ups spin out of control by promising too many changes to too many customers, even when those customers are ready and willing to pay for those changes. Because these changes are rarely complementary, and the ones required by some will be ignored by others. In the end, you might end up with a product combining all of these changes that no new customer would want to buy or worse, a whole series of slightly different products that can't be evolved together. Talk about a maintenance nightmare! (Don't forget that you'll be selling your product with something called a “one year guaranty”.)

Being part of a start-up means making every day count

The danger is called “opportunity cost”. When your technical team is busy thinking through the requested changes and preparing proposals, they aren't making progress on product development. And when you yourself are fielding calls of this kind, you're not chasing down leads to sell what you already have (or plan to have to sell very soon). Or push on with your own efforts to better understand your target market.

So be very careful. You can't be all things to all people. And this is especially so in a a start-up, when your revenue stream is uncertain and you feel that you just can't turn away “good business”. Well, building a “one-of-a-kind” systems might keep your technical staff busy, and might even make you some profit (if you've been very careful with your quotation), but you can't build a product-based company this way. And product-based companies are, in the end, more profitable than service-based companies (building “one-of-kind” systems) just because in the software world, the cost of “building” a product for sale is the cost of preparing another hard disk for another PC. Or even better, it's just the cost of duplicating a CDROM. It's only when you can sell the very same thing over and over again that you'll really get going with as a software business.

Of course, when things look grim, changes are wise, even essential. And I know of a couple of start-ups which found themselves changing business focus at least once. For example, a computer vision start-up was planning to commercialize innovative camera hardware only to discover that their real business value was in their innovative software library (for the image processing). They were eventually purchased by a well established company looking to improve their own robotic solutions for machine vision.

Another start-up began life with ambitious plans to commercialize innovative force-reflecting input devices (based on primitive but promising prototypes) only to discover that their real business value was in their patent portfolio. They were eventually purchased by a well established competitor looking to improve its own force-reflecting input devices.

The moral of these stories is this: just because you begin with one idea, that doesn't mean that a better idea won't come along. But make this kind of decision consciously. And think about product-based versus service-based companies.

12.0 About Business Stuff

Starting up a business means dealing with all kinds of things you used to have other people deal with instead. Like the name of the company, managing bank accounts, making payroll, keeping track of bills to pay, invoices going out to customers, calling them when they don't pay on time, etc. And then there's the 1001 legal elements like sales contracts, rental contracts, employment contracts, and insurance contracts. Well, there's nothing to do except learn the basics by reading the “how to” books about starting your own business, and find people to help you: at the very least, you'll need an accountant and a lawyer (but only on a part-time basis). Remember: don't sweat the small stuff, because you need to stay focused on developing your business.

13.0 About Planning

Being part of a start-up means making every day count. It means planning and replanning as events unfold. There's only so much time in the day and you have to put that time to the best possible use. So if you don't like to look after more than one thing at a time, or don't feel comfortable keeping many balls in the air as a juggler must do, then think twice (three times even) before you begin.

And this is often hard for technology people. That's because software development is terribly difficult and requires enormous concentration for extended periods of time. If that's what you like, then stick to software development and look for someone else to captain the ship.

Of course, even software development people are "ambushed" from time to time by demo's for unexpected visitors, interviewing prospective employees, preparing project proposals, dealing with customer support, etc. So they too must plan and replan, if not daily than at least weekly, in order to soldier on with what must be done.

14.0 About Learning

As an undergraduate student, I remember hearing a professor suggest that engineering was all about problem solving. And that education (at least in his class) was all about learning to learn what you needed to know to solve problems.

Seen in this light, going into business is just another kind of problem solving, for which lots of new learning is required. So the day that someone compliments you on your ability to learn and learn quickly, that will be the day that (business) success is just around the corner.

15.0 About Advice

When my first daughter was born, I remember how eager everyone around me was to offer advice: What to do and what not to do with a newborn. Of course, by the time my second daughter was born, those same people had somehow decided that now I was not only older but much smarter too, and they kept their advice to themselves.

So it seems wise to close this article with the following thoughts: by all means, seek out advice. (That's what I continue to do.) Ask people what they think, and especially why they think what they think. But keep your own counsel. After all, at the end of the day, it's your start-up adventure, not their's.

And remember: it's what you do *after* starting up that separates the winners from the losers.

16.0 Suggested Reading

[1]. Bhidé, A., "The Origin and Evolution of New Businesses", Oxford University Press, 2000.

[2]. Cooper, A., "The Inmates are Running the Asylum", SAMS (a division of Macmillan Computer Publishing), 1999.

[3]. Davidow, W., "Marketing High Technology", Free Press, 1986.

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[7]. Moore, G., "Inside the Tornado", Harper Business, 1995.

About the author

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He was for many years Lead Researcher at the Centre de recherche informatique de Montreal (CRIM), one of Canada's leading research institutes in information technologies. In 1999, he left CRIM to co-found Simlog (www.simlog.com) to commercialize innovative 3D simulation technology for heavy equipment operator training.

Previously Paul has served as Associate Editor and Managing Editor of the **IEEE Canadian Review**.

Characterizing Successful Start-ups

In his recent book "The Origin and Evolution of New Businesses" (Oxford University Press, 2000), Amar Bhidé of the Harvard Business School conducted an in-depth study of 100 of the businesses on "Inc." magazine's 1989 top 500 list, a compilation of the fastest-growing privately held companies in the United States. (Such companies had revenues of at least 100,000 $ (US) but not more than 25 million $ (US) in 1984, with the greatest percentage increase in sales over the five years leading to 1989.) To be included in his subset, Bhidé chose companies founded in the previous eight years, of small to intermediate size, in order to obtain a more homogeneous pool for subsequent study. About 36% were computer-related businesses. In what follows, dollars are $US.

In 1984, the average company in Bhidé's subset had 12 employees and average revenues of just over five hundred thousand dollars. Thirty-eight companies were losing money, ten were treading water, another thirty-seven were turning a very small profit (1-10%), and just fifteen were showing real profit (> 10%).

Five years later, the average company now had 100 employees and average revenues of almost 9 million dollars. Now just 13 companies were losing money, another 68 were turning a very small profit (1-10%), and 19 were showing real profit (> 10%).

Based on his in-depth interviews with company executives, Bhidé was able to characterize successful start-ups as follows:

- Most founders had little or no business experience when they began.
- About two thirds of the companies surveyed had just two founders, and none had more than four.
- Over 80% of the companies were "boot-strapped" using funds provided by the founders, family and friends (median start-up investment was ten thousand dollars). Just 5% secured financing from venture capitalists.
- Companies were operating in small, niche, markets where there is too much uncertainty about market size and about successful product characteristics to interest established players. More generally, start-ups were created in an "improvised" way where founders were able to profit from "turbulent" market conditions due to technological innovation or perhaps changing business practices such as governmental deregulation).
- A founder was chief salesman.
- Products were sold directly to other businesses (direct sales, business-to-business focus).
- Product pricing was relatively high (5000$US on average), making it possible to offer/perform (sometime extensive) product customizing according to customer needs without taking a loss.
- Most companies had little or no technological differentiation (just 15% of the companies surveyed were founded with a "unique selling proposition" in the form of new technology). As a result, the founders "personal value" makes proportionately more difference (than in well-established companies).

Finally, Bhidé discovered that when he studied those companies on Inc.'s 500 list in 1985 which went on to attain revenues in excess of 500M$US ten years later (including Microsoft and Oracle, to name two examples), all but one still had the same CEO and senior management team. Stated differently, where successful startups became successful large corporations, the same people were in charge.

Bhidé's message then becomes the following: "The value of a firm in its early stages is closely tied to the entrepreneur's personal knowledge, skills, reputation, and legitimacy. When entrepreneurs have or can develop the requisite skills, their on-going leadership can also help their firms attain noteworthy size and longevity".

De-icing EHV Overhead Transmission Lines by Short-circuit Currents

by Michel Landry, Roger Beauchemin and André Venne
Hydro-Québec, Varennes, QC

Abstract

This paper presents a new method for de-icing EHV bundled conductor transmission lines following severe ice storms. The method involves circulating short-circuit current (I_{SC}) at the rated voltage of the transmission lines and the subsequent action of electromagnetic forces that allow conductors to knock against each other to de-ice. Tests were performed on a sample overhead transmission lines with twin (315 kV) and quad (735 kV) bundles installed in the switchyard at IREQ's high-power laboratory. Impacts on power system stability and power quality are also discussed and relevant conclusions are drawn for application of the new method on Hydro-Québec's power transmission system.

Sommaire

Cet article présente les résultats d'essais d'une nouvelle méthode de déglaçage de lignes de transport à très haute tension suite à de sévères tempêtes de verglas. Cette méthode repose sur la circulation d'un courant de court-circuit, de faible amplitude et de courte durée, à la tension nominale de la ligne de transport, et de l'action de forces électromagnétiques provoquant l'entrechoquement des conducteurs et la chute de la glace. Des essais ont été effectués sur une portée réduite de faisceaux à 2 conducteurs (315 kV) et à 4 conducteurs (735 kV) installés dans l'aire d'essai extérieure du laboratoire Grande puissance de l'IREQ. Les impacts sur la stabilité du réseau et la qualité de l'onde sont aussi étudiés afin de conclure sur les possibilités d'application de cette nouvelle méthode sur le réseau de transport d'Hydro-Québec.

1.0 Introduction

The 1998 ice storm caused severe damage to Hydro-Québec's power transmission system. Most of the damage on overhead transmission lines was due to ice accumulation on conductors, causing towers to collapse (Figure 1).

Figure 1: Damage to overhead line by ice accumulation in 1998

De-icing methods using techniques such as conductor heating or mechanical de-icing using a roller are possible for overhead lines ranging from 25 to 245 kV. However, such methods cannot be easily applied to lines with twin or quad conductors at rated voltages of 315 & 735 kV respectively. To protect these lines against damage following future ice storms, a new de-icing method based on the circulation of short-circuit current (I_{SC}) at the rated voltage of lines was tested at IREQ [1].

2.0 Theoretical Background

2.1 Electrodynamic forces involved with twin bundles

Forces on bundle conductor spacers under fault conditions are discussed in [1,2]. The parameters to be considered in the calculation (Figure 2) of the electromagnetic forces are:

- d: distance between the two conductors;
- I: current circulating in the conductors, which is equal and in the same direction.

Under such conditions, the magnetic field intensity [3] at either wire caused by the other is equal to I/2πd. The attraction force per meter length is directly proportional to the current squared and inversely proportional to the distance between the conductors.

For a twin bundle at 315 kV, Table 1 gives the attraction forces on each conductor generated by the first crest of asymmetrical short-circuit currents. An asymmetrical factor of 2.7 for the first crest of I_{SC} is assumed to produce a maximum attraction force that is proportional to the current squared. To produce such full asymmetry, a making angle of zero degree is thus necessary.

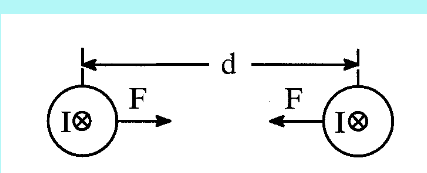

Figure 2: Twin bundle with conductors separated by a distance d

2.2 Electromagnetic forces involved with quad bundles

For a quad bundle at 735 kV, similar electromagnetic forces are generated except that the short-circuit current is divided into the 4 conductors. Figure 3 depicts a simplified representation of the different components (F_1, F_2 and F_3) of the attraction force on the conductors of a quad bundle with each conductor separated by a distance d. The resulting attraction force (F_R) on each conductor is the vectorial sum of these three forces. Table 2 gives the attraction forces on each conductor generated by the first crest of asymmetrical short-circuit currents for a quad bundle with a distance of 46 cm between each conductor.

For the same I_{SC}, the attraction force on each conductor is two times smaller than that on a twin bundle. For instance, for I_{SC} = 10 kA rms, the attraction forces on each conductor are 88.9 and 42.6 N/m, respectively, for twin bundles (Table 1) and quad bundles (Table 2). These

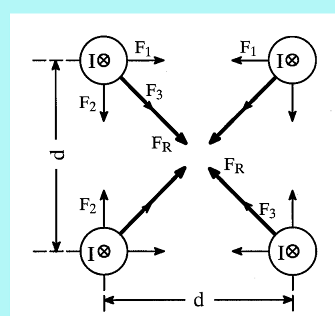

Figure 3: Attraction force on conductors of a quad bundle with conductors separated by a distance d

Table 1: Attraction force per meter length on each conductor of the twin bundle (d = 41 cm)

I_{SC} in the bundle (kA rms)	I_{SC} in each conductor (kA rms)	I_{SC} 1st-crest in each conductor (kA peak)	Attraction force (N/m)
6	3	8.1	32.0
8	4	10.8	56.9
10	5	13.5	88.9
12	6	16.2	128.0
15	7.5	20.3	201.0

Table 2: Attraction force per meter length on each conductor of the quad bundle (d = 46 cm)

I_{SC} in the bundle (kA rms)	I_{SC} in each conductor (kA rms)	I_{SC} 1st-crest in each conductor (kA peak)	Attraction force (N/m)
8	2.0	5.4	26.9
10	2.5	6.8	42.6
12	3.0	8.1	60.5
15	3.8	10.1	94.0
20	5.0	13.5	168.0

values already indicate that it will be possible to de-ice a twin bundle with a smaller short-circuit current.

2.3 Key parameter for de-icing using short-circuit currents

For de-icing conductors with a relatively small current, synchronized reclosing must be used in order to excite the natural oscillation of the conductors.

For BERSFORT conductors (diameter = 35.1 mm, w = 21.4 N/m), Figure 4 depicts the variation of the oscillation period as a function of the conductor spacer span and ice thickness r_I and conductor tension F_T. For a spacer span of 55 m, typical for 735-kV lines, the oscillation period is approximately 1 s.

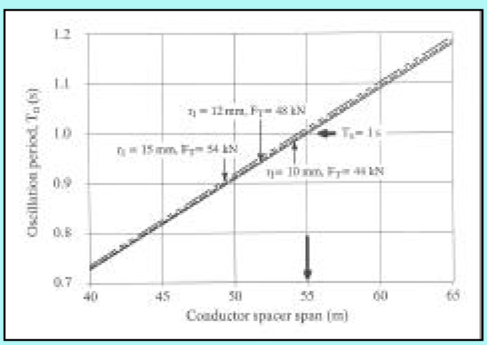

Figure 4: Variation in T_n as a function of the conductor spacer span and ice thickness

3.0 Power Tests On Twin And Quad Bundles

3.1 Test setup

Twin and quad bundle spans, 91 m in length, were mounted in the outdoor switchyard of IREQ's high-power laboratory. A load cell was connected in series with the bundle in order to adjust the conductor tension equivalent to that applied on a typical 400-m span between towers on EHV transmission lines.

A novel ice formation method was used. First, a thin and transparent plastic tubing of appropriate diameter was slid over each conductor. The diameter of this tubing is such that the required equivalent radial ice thickness (13-19 mm) is obtained on each conductor. Second, after re-tensioning the conductors, the tube was filled with water. Once it was completely frozen (i.e. a huge “Mr. Freeze”), the plastic tubing could be easily cut and removed. This process allows highly adherent ice to be formed on the conductors. Using this method, asymmetrical ice is produced around the conductors (see the insert, Figure 5), thus simulating actual conditions.

3.2 Test program

The test program was conducted on twin and quad bundles with the objective to find the smallest I_{SC} amplitude and duration required to de-ice the conductors. In order to reduce I_{SC}, it appeared very early in the test program that synchronized reclosing should be used in order to excite the natural oscillation of the conductors (Section 2.3), and then increase the knocking forces.

3.3 Test results

3.3.1 Twin bundle for 315-kV lines

For the twin bundle used, eight tests were completed with the outdoor temperature range from -3^{o}C to -21^{o}C. Due to space restrictions, only 3 test series are given in Table 3; a full set of results is available in [1].

The present de-icing principle is based on appropriate conductor dynamic motion that will cause the conductors to knock against each other and break the ice (Figure 5). During the test program on a twin bundle, I_{SC} values between 8 and 12 kA were applied with short-circuit durations up to 20 cycles. In addition, since the natural oscillation of conductors depends on the distance between conductor spacers (d_S), various distances (57, 62 and 42 m) between conductor spacers were also tested with the objective of validating a reclosing sequence that will provide maximum de-icing of the total 400-m span between the towers of EHV lines with the following typical distances between conductor spacers: 46, 59, 67, 62, 53, 59 and 47 m.

For d_S = 57 m, test series no. 1 indicates that 30% of the conductors

Figure 5: De-icing a twin bundle using 10 kA and an appropriate reclosing sequence

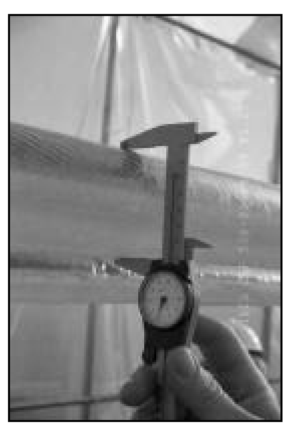

Table 3: Test results on a twin bundle used for 315-kV overhead lines

Test Series	I_{SC}		Test Sequence	T(°C)	Ice	
	I_{SC} (kA rms)	I_{SC} (1st crest) (kA peak)			Equivalent radial ice thickness (mm)	De-icing* (%)
Conductor spacer span (d_S) = 57 m						
1**	10.3	28.3	C-12 cycles-O	-21	16	5
	10.2	28.0	C-20 cycles-O			30
	10.1	27.7	C-20 cycles-O			42
	12.2	33.3	C-20 cycles-O			54
Conductor spacer span (d_S) = 42 m						
6**	10.2	27.9	C-18 cycles-O-0.9s - C-12 cycles-O	-16	16	< 1
	10.2	27.8	C-18 cycles-O-0.7s - C-12 cycles-O			39
	10.2	27.8	C-12 cycles-O			55
Conductor spacer span (d_S) = 62 m						
7**	10.2	28.0	2 x [(C-10 cycles-O) - 0.9s]	-15	16	18
	10.2	28.0	3 x [(C-10 cycles-O) - 0.9s]			70

Notes

* Within a given test series, the percentage of conductor de-icing is cumulative.

** Due to space restrictions, only 3 test series are given here; a full set of results is available in [1].

Table 4: Test results on a quad bundle used for 735-kV overhead lines (Conductor spacer span = 55 m)

Test Series	I_{SC}		Test sequence	T (°C)	Ice	
	I_{SC} (kA rms)	I_{SC} (1st crest) (kA peak)			Equivalent radial ice thickness (mm)	De-icing* (%)
1	20.1	54.7	C-12 cycles-O	-4	19	10
	20.1	54.8	C-12 cycles-O			26
2	15.5	42	C-6 cycles-O	-4	14 / 9	No de-icing
	15.5	42	2 x [(C-6 cycles-O) - 1s]	-4	-	6
	15.5	42	3 x [(C-6 cycles-O) - 1s]	-4	-	21
	15.1	41	3 x [(C-6 cycles-O) - 1s]	-3	-	42
3	10.1	28	3 x [(C-6 cycles-O) - 1s]	-2	13.4	No de-icing
	10.1	28	4 x [(C-6 cycles-O) - 1s]	-2	13.4	No de-icing
	10.1	28	4 x [(C-6 cycles-O) - 1.1s]	-2	-	No de-icing
4	12	32	4 x [(C-6 cycles-O) - 1.1s]	-2	-	Not measured
	12	32	4 x [(C-6 cycles-O) - 1.1s]	-2	-	70

were de-iced with a single application of 10 kA during 20 cycles (C-20 cycles-O).

For d_S = 42 m, test series no. 6 revealed that the time delay of 0.9 s, effective for the previous spacer distance of 57 m, had to be changed to 0.7 s. In fact, 55% de-icing was obtained at 10 kA with the following reclosing sequence: C-18 cycles-O-0.7s-C-12 cycles-O. This result confirms the graph of Figure 4, which gives an oscillation period of approximately 0.7 s for d_S = 42 m.

For d_S = 62 m, test series no. 7 demonstrated that the time delay of 0.9 s was totally suitable. In fact, approximately 70% conductor de-icing was obtained with this reclosing sequence: 2 x (C-10 cycles-O-0.9 s) plus 3 x (C-10 cycles-O-0.9s).

3.3.2 Quad bundle for 735-kV lines

Four test series were completed (Table 4) with the outdoor temperature range from -2°C to -4°C. I_{SC} values between 10 and 20 kA rms were applied with short-circuit durations up to 12 cycles. The distance between conductor spacer was fixed at 55 m.

As can be observed from test series no. 1, after two single attempts (C-12 cycles-O) at 20 kA, only 26% of the conductors were de-iced. Therefore, the reclosing sequences were tested for the subsequent test series. Test series no. 3 revealed that an I_{SC} of 10 kA does not produce sufficient electromagnetic forces for conductor de-icing. With I_{SC} = 15 kA (test series no. 2), about 20% of the conductors were de-iced after each reclosing sequence of 3 x (C-6 cycles-O-1s). Finally, for test series no.

Table 5: Identification of simulated lines

Line #	Substations Source/ End of line	Length (km)	3-ph faults I_{SC} (kA rms)	1-ph faults I_{SC} (kA rms)
315-kV lines				
3066	Hertel/Viger	15.4	15.0	11.8
3071	Duvernay/Notre-Dame	16.6	16.6	16.7
735-kV lines				
7036	Hertel/Boucherville	23.9	10.7	10.4
7010	Lévis/Laurentides	26.9	11.7	10.7

4, a de-icing effectiveness of 70% was obtained by applying 4 x (C-6 cycles-O-1.1 s) repeated 2 times.

4.0 Impact On The Power System

Numerical simulations were performed on a model of Hydro-Québec's power system in order to assess the impact of a short-circuit on typical system with 315 and 735 kV lines. The lines chosen were those with at least a 10-kA symmetrical short-circuit current for an end-of-line fault. Table 5 lists the short-circuits subjected to the analysis and gives their length along with the short-circuit current for three-phase and single-phase end-of-line faults.

The system was simulated and the short-circuit levels calculated while taking into account all lines in service and the generating facilities with a load level equivalent to 70% of the 2001 peak load. The load level corresponds to the load forecast for an ambient temperature of -5°C, the temperature expected during an ice storm. Adjustments were made to the system's shunt-compensation conditions so that the voltage at the substation at the beginning of the line of the circuit to be de-iced is equal to 1 p.u. The aim of the study was to evaluate the effects of short-circuits on system stability, on the voltage levels at the customer's installations, and on frequency. IREQ's stability program was used to simulate the short-circuits and evaluate the different phenomena. Models for dynamic and static system components were extracted from stability limit studies of Hydro-Quebec's power system for winter conditions. All simulations were performed for a 10-s time frame.

4.1 Stability

Two operating sequences were applied during the short-circuit simulation: a single closing operation C-tsc-O where the duration tsc of the short-circuit was 6 to 24 cycles, and a sequence of four closing operations, C-tsc-O-1.1s - C-tsc-O-1.1s - C-tsc-O-1.1s - C-tsc-O, where the duration tsc of the short-circuit was 6 or 12 cycles. The simulations on the four studied lines showed that system stability is compromised during a sequence of four closing operations on a 3-ph short-circuit at the end of a 735-kV line. In fact, the sequence of four closing operations applied to circuit 7036 caused a voltage instability after the fourth closing operation. The same sequence applied to circuit 7010 did not result in any system instability, but the analysis of the voltage graphs showed that the stability limits had almost been attained and that some instability could be expected if the system was evenly slightly in degraded or high-load mode.

Table 6: Number of customers affected by short-circuits

Voltage Drop (V_D)	735-kV lines		315-kV lines	
	3-ph short-circuits	1-ph short-circuits	3-ph short-circuits	1-ph short-circuits
$V_D < 10\%$	5%	8%	15%	37%
$10\% < V_D < 20\%$	13%	35%	29%	61%
$V_D > 20\%$	82%	57%	56%	2%

4.2 Voltage drops

System faults cause a voltage drop which can affect industrial customers. In fact, the protection systems of industrial customers which are sensitive to disturbances may react on a voltage drop and disconnect some or all of a customer's electrical installations. In addition to affecting the customer's production, an overly large loss of load results in an increase in voltage on the network which can lose control and cause successive tripping. Based on past experiences, a voltage drop lower than 10% at the HV side of customer's busbar could result in an acceptable level of disturbance in relation to a situation where action must be taken to prevent towers of the line from collapsing.

The voltage drop was evaluated when short-circuits are applied at the end of the four lines being studied. The assessment was done at the connection points of 60 industrial customers in different parts of the system. Table 6 gives an overview of disturbances at the customers' installations in terms of voltage drop and number of customers affected.

Voltage drops for three-phase faults are unacceptable, at the end of both 735-kV and 315-kV lines, due to the large number of industrial customers who would be affected. Voltage drops for 1-ph faults at the end of 735-kV lines are also unacceptable. Even if 1-ph short-circuits at the end of 315-kV lines produce less substantial voltage drops, the number of customers affected by voltage drops >10% is considerable.

4.3 Frequency variations

A 3-ph short-circuit current lasting 12 or 24 cycles at the end of a 735-kV line causes a frequency variation of +0.40/-0.20 or +0.60/-0.30 Hz, respectively. The frequency variation attains +0.90/-0.45 Hz during a sequence involving four closing operations on a 3-ph fault. Single-phase short-circuits at the end of 735-kV lines as well as 315-kV 1-ph and 3-ph short-circuits produce frequency variations typically under +0.30/-0.15 Hz. Such frequency variations are acceptable and their effect can be easily countered through the application of preventive measures.

5.0 Conclusion

This paper presents a new method for de-icing EHV overhead lines. based on exciting the natural oscillation of conductors by the action of electromagnetic forces to knock conductors against each other and the ice to fall off. In order to reduce the amplitude and duration of the short-circuit currents as much as possible, asymmetrical I_{SC} and reclosing sequences are necessary. To produce maximum asymmetry in I_{SC}, a special relay must be used to synchronize the breaker's closing time with the system voltage, thus ensuring a making angle as close as possible to zero degrees.

Impact studies on Hydro-Quebec power's system reveal that:

- On 735-kV overhead lines and for three-phase short-circuits, network stability would be jeopardized after the fourth reclosing.
- For 3-phase faults, voltage drops are unacceptable for both 315 & 735-kV lines as too many industrial customers would be affected.
- For 1-phase faults, voltage drops are lower but the number of customers affected by a voltage drop greater than 10% remains high.
- Frequency variations are, however, acceptable.

In summary, the method proposed here could likely be used for 315 kV lines, but only during emergency conditions such as those found during severe ice storms. For 735-kV lines, the required short-circuit currents and reclosing sequences are none-the-less too detrimental to network stability and, therefore, the method would probably not be applied.

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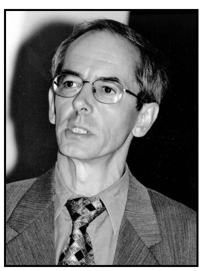

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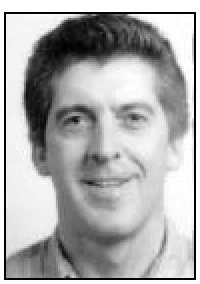

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Letters to the Editor/*Lettres envoyées au rédacteur en chef*

Become A Lake

An aging Hindu master grew tired of his apprentice complaining, and so, one morning, he sent him for some salt. When the apprentice returned, the master instructed the unhappy young man to put a handful of salt in a glass of water and then to drink it.

"How does it taste?" the master asked.

"Bitter," spit the apprentice.

The master chuckled and then asked the young man to take the same handful of salt and put it in the lake. The two walked in silence to the nearby lake, and once the apprentice swirled his handful of salt in the water, the old man said, "Now drink from the lake."

As the water dripped down the young man's chin, the master asked, "How does it taste?"

"Much fresher," remarked the apprentice.

"Do you taste the salt?" asked the master.

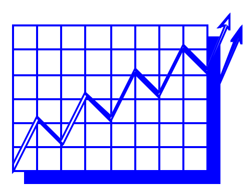
"No," said the young man.

At this, the master sat beside the young man who so reminded him of himself and took his hands, offering, "The pain of life is pure salt, no more, no less. The amount of pain in life remains the same, exactly the same. But the amount of bitterness we taste depends on the container we put the pain in. So when you are in pain, the only thing you can do is to enlarge your sense of things... Stop being a glass. Become a lake."

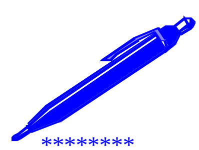
Bob McLoud
Markham, ON

Today in the Stock Market

Helium was up, feathers were down.
Paper was stationary.
Fluorescent tubing was dimmed in light trading.
Knives were up sharply.
Cow steered into a bull market.
Pencils lost a few points.
Hiking equipment was trailing.
Elevators rose, while escalators continued their slow decline.
Weights were up in heavy trading.
Light switches were off.
Mining equipment hit rock bottom.
Diapers remain unchanged.
Shipping lines stayed at an even keel.
The market for raisins dried up.
Cola fizzled.
Caterpillar stock inched up a bit.
Sun peaked at midday.
Balloon prices were inflated.
And batteries exploded in an attempt to recharge the market.



Lewis Vaughan
Montreal, QC



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The Editor invites readers to send in their comments and letters on matters of mutual interest to the membership. The Editor reserves all publishing rights.

An Overview of DWDM Networks

by Shaowen Song

Wilfrid Laurier University, Waterloo, ON

Abstract

This article provides an overview of the applications of Dense Wavelength Division Multiplexing (DWDM) technology. It examines the network architecture and the recent development of two major DWDM-based networks, namely the backbone network and the residential access network. The DWDM applications in Local Area Networks (LANs) are not included in the article. The article also looks into the future of broadband integrated service networks based on the DWDM technology.

Sommaire

Cet article présente un survol des applications de la technologie du “Dense Wavelength Division Multiplexing” (DWDM). On y examine l'architecture et les développements récents de deux réseaux basés sur le DWDM: le réseau central DWDM et le réseau d'accès résidentiel DWDM. Les applications DWDM dans les réseaux locaux (LANs) ne font pas l'objet de cet article. Cet article présente aussi un aperçu de l'avenir des réseaux de services intégrés à large bande basés sur la technologie DWDM.

1.0 Introduction

In traditional optical fiber networks, information is transmitted through optical fiber by a single lightbeam. In a wavelength division multiplexing (WDM) network, the vast optical bandwidth of a fiber (approximately 30 THz corresponding to the low-loss region in a single-mode optical fiber) is carved up into wavelength channels, each of which carries a data stream individually. The multiple channels of information (each having a different carrier wavelength) are transmitted simultaneously over a single fiber. The reason why this can be done is that optical beams with different wavelengths propagate without interfering with one another. When the number of wavelength channels is above 20 in a WDM system, it is generally referred to as Dense WDM or DWDM. We use DWDM as a general term in this article.

DWDM technology can be applied to different areas in the telecommunication networks, which includes the backbone networks, the residential access networks, and also the Local Area Networks (LANs). Among these three areas, developments in the DWDM-based backbone network are leading the way, followed by the DWDM-based LANs. The development on DWDM-based residential access networks seems to be lagging behind at the current time. This article provides an overview of the network architectures that have been developed for the backbone networks and the residential access networks. This article also examines the current status and the potential future of these two types of networks. DWDM application in LANs is considered as a separate area, which is not included in this article.

2.0 DWDM Backbone Networks

2.1 Overview

We can divide the network structures of DWDM-based backbone networks into three classes:

- Simple point-point DWDM link,
- DWDM wavelength routing with electronic TDM (time domain multiplexing) and switching/routing backbone network, and
- All-optical DWDM network.

This section discusses the network architecture and the mechanisms of these three types of DWDM backbone networks.

2.2 Point-To-Point DWDM links

The simplest application of the DWDM technology in backbone networks is the point-to-point link. Figure 1 shows the architecture of the networks using 4 network switching/routing nodes as an example. In this architecture, the electronic nodes can be SONET/SDH switches, Internet routers, ATM switches, or any other type network nodes. The DWDM node consists of typically a pair of wavelength multiplexer / demultiplexer (lightwave grating devices) and a pair of optical-electrical/electrical-optical convertors. Each wavelength channel is used to transmit one stream of data individually. The DWDM wavelength multiplexer combines all of the lightwave channels into one light beam and pumps it into one single fiber. The combined light of multiple wavelengths is separated by the demultiplexer at the receiving end. The signals carried by each wavelength channel are then converted back to the electrical domain through the O/E convertors (photodetectors). In this way, one wavelength channel can be equivalent to a traditional fiber in which one lightbeam is used to carry information. The dotted-lines in Figure 1 represent the wavelength channels. It is worth noting that the wavelength channels in one fiber can be used for both directions or two fibers are used with each for one direction.

The advantage of the point-to-point DWDM links is that it increases the bandwidth by creating multiple channels with low costs. The limitation of this approach, however, is that the bandwidth of each wavelength channel may not be fully utilized due to the speed of the electrical devices, which is referred to as the well-known electro-optic bottleneck. Also, the use of the wavelength channels may not be optimal due to the fact that the meshes formed by the wavelength channel are all identical, which can be seen in Figure 1.

2.3 Wavelength routing with electronic TDM

Figure 2 depicts the second type of DWDM application in backbone networks, in which wavelength routers are used to configure or reconfigure the network topology within the optical domain and the TDM (Time Domain Multiplexing) network nodes are used to perform multiplexing and switching in the electrical domain. This combined optical and electrical network architecture can be applied in SONET/SDH in which the electrical TDM network nodes would be SONET switches, or

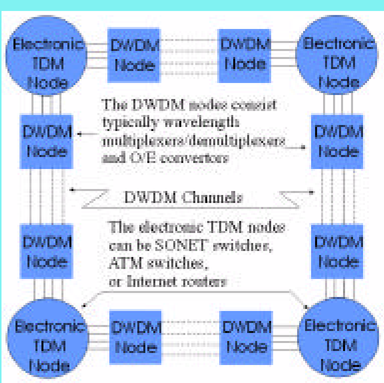


Figure 1: DWDM point-to-point link backbone network

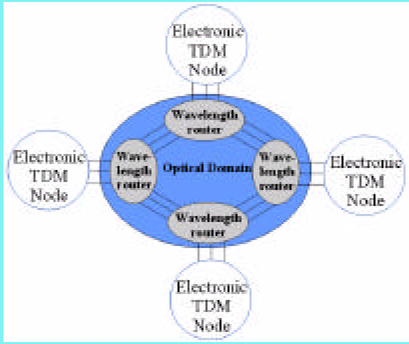


Figure 2: Wavelength routing with electronic TDM DWDM networks

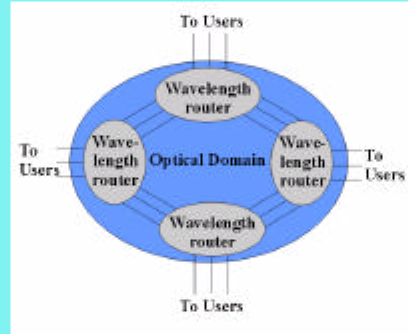


Figure 3: Wavelength switching without TDM

in the Internet in which the electrical TDM network nodes would be the Internet routers. The architecture can also be used in an ATM network where the electrical TDM network nodes would be ATM switches.

The advantage of this combined architecture in comparison with the simple DWDM point-to-point links is that it can optimize the use of DWDM wavelength channels by reconfiguring the mesh formed by the wavelength channels. The topology of reconfiguration can be dynamic in which network topology is reset periodically according to the traffic with the time period in the order of seconds or milliseconds. The reconfiguration can also be static in which the mesh is set for a longer period of time. The enabling technology for this architecture is the wavelength router in the optical domain. Different types of wavelength routers are available commercially which range from mechanically controlled to thermally controlled and to semiconductor wavelength switches.

The advantage of this architecture is its ability to utilize the bandwidth capacity to the level that the electronics can handle, because of the reconfiguration of the mesh by the wavelength routers. The problem, however, is still the electro-optic bottleneck. Nevertheless, it has improved in comparison with the point-to-point DWDM links.

Several technical issues are required to be dealt with for this architecture, which include the control system for the mesh reconfiguration, the traffic evaluation among the DWDM channels and among the fibers, as well as the technology for constructing the wavelength routers. These technical issues have been the topics of research for some time and all are still undergoing development at the current time.

2.4 All-Optical DWDM Networks

The goal of all-optical DWDM networks is to eliminate the conversions between electricity and light. The all-optical network is also referred to as the transparent network. Two types of all-optical DWDM backbone networks have been proposed, which are:

- Wavelength switching DWDM networks without TDM [1], and
- DWDM with optical domain TDM [2].

These two types of DWDM backbone networks are discussed in the following two subsections.

2.4.1 Wavelength switching without TDM

Circuit switching can be achieved by using wavelength switches (also called wavelength routers). Figure 3 shows the architecture of the network, in which wavelength switches are used to establish connections between the two communicators. This is quite the same as the old PSTN (Public Switched Telephone Network) system where the crossbar type of electrical switches are used to establish the circuit for the two users.

The wavelength switches for this type of networks can switch among the wavelength channels of multiple fiber input and output ports. A wavelength router may have the additional capacity of changing the wavelength of the signal between routers resulting in high utilization of wavelength channels. In the case of a wavelength router without wavelength conversion, the two users involved in the communication are connected by one signal wavelength across all of switches in the light path. However, with the wavelength conversions, the two sides of the communication can be connected by different wavelengths in different fiber links between switches. Figure 4 shows an example of a wavelength router structure with multiple fiber inputs and outputs.

The advantage of this type of DWDM network is its simplicity in the switching mechanism. The major problem for this network is the under utilization of the bandwidth capacity of the wavelength channels. This is because once the light path is established between the two sides of the communication parties, it is up to the user to use the available bandwidth of the wavelength channel which can be tens of GHz or even hundreds of GHz. It is obviously inefficient for voice communications. Therefore, this type of all-optical DWDM backbone networks will unlikely be used to replace the SONET/SDH. However, it can be useful for Enterprise intranets where different types of communications can share the same network with low costs of building it. Also, because of the transparency of the network, it provides many advantages, such low error rate and low maintenance costs.

2.4.2 Wavelength switching with optical TDM

As it has been mentioned above, the wavelength routing all-optical network has the problem of low efficiency in utilizing the bandwidth of wavelength channels with each having the capacity of hundreds of Gigabits per second. Although the combined wavelength routing and electronic time domain multiplexing can increase the bandwidth utilization to some degree, it introduces the O/E conversions that may restrict the speed and cause packet delays. Therefore, it is natural to implement optical TDM in future optical networks, which eliminates the O/E conversions resulting in a transparent high-speed all-optical network.

Replacing the electrical TDM nodes in the DWDM with electrical TDM architecture (Figure 2) by optical TDM nodes, we obtain a DWDM wavelength routing with optical TDM architecture, as shown in Figure 5. As we have mentioned in Section 2.2 that the electrical TDM/switching nodes in Figure 5 can be of any kind, such as SONET/SDH switches, Internet routers, and ATM switches. This indicates that the all-optical TDM nodes in the all-optical architecture can be optical SONET/SDH switches, or all-optical ATM switches, or all-optical Internet routers. Different types of all-optical TDM/switch nodes can also be in one network, provided the protocol conversions are implemented.

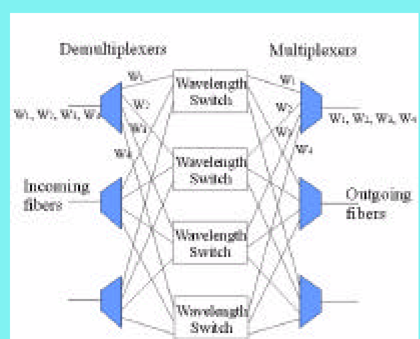
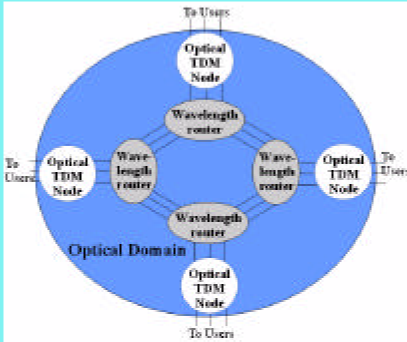


Figure 4: A wavelength router

Figure 5: All-optical TDM/switch with wavelength router



In fact, the optical TDM/switch node and the wavelength router in one routing site (Figure 5) can be combined into one all-optical switching node that not only forwards packets through time domain multiplexing but also selects the light path intelligently according to the availability and traffic loads of the links. This architecture is shown in Figure 6.

The only question left so far is how can we build such all-optical TDM/switch nodes. This is the problem that has not been solved. Although some research and proposals have been published, such as using a hybrid mechanism where electrical signals are used to perform the control and light signals are used to carry the data [3], the system is far from mature. Also it still involves electricity which still has many problems to be dealt with.

Looking into the possibilities of building the three major types of the current electrical switches, namely the SONET/SDH switch, the ATM switch, and the Internet router, the SONET/SDH switch is the simplest one among the three since it is for circuit switching. The Internet router is the most complex one among the three, since it requires a digital optical processor and all-optical memories. In any case, digital optical logic devices are required to build these switches. Therefore, it seems clear that we need to have optical digital processing power before we can implement any of these TDM switches, unless other mechanism emerges to revolutionize the existing concept of packet switching networks.

3.0 DWDM Access Optical Networks

3.1 Overview

An overriding belief existed even in the early 1970's that optical fiber would one day make its way into the subscriber loop and be used to connect individual homes. Research on the fiber based residential access network architecture and protocols have since then become one of the major areas in the telecommunication arena. The ATM (Asynchronous Transfer Mode) based B-ISDN (Broadband Integrated Services Digital Network) architecture had been once believed to be the leading candidate for realizing the fiber-to-the-home access network. However, with the technological development of the DWDM, broadband residential access fiber network has taken another turn, which leads to a DWDM-based fiber optical network to deliver both narrowband and broadband services. This section provides an overview of the network architectures that have been developed for the residential access networks based on the DWDM technology.

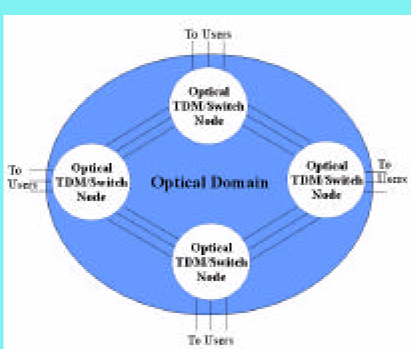
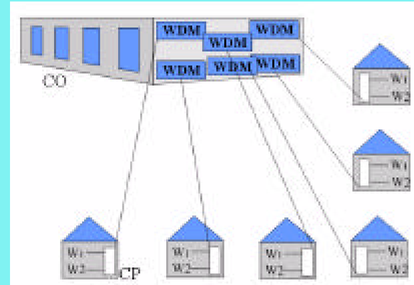


Figure 6: All-optical TDM/switch with self wavelength selection

Figure 7: Single-star PON architecture



DWDM-based access optical networks can be classified into two categories, passive DWDM access networks and active DWDM networks. The term of active DWDM network here refers as to the DWDM network in which the TDM (time domain multiplexing) is applied in the wavelength channels. These two types of access network architecture are discussed in the following subsections.

3.2 DWDM Passive Optical Networks (PON)

DWDM passive optical networks (PON) use the wavelength channels to connect the users with the central office. Each service uses one wavelength channel. The early PON was developed for narrowband services, such as the PON architecture developed by British Telecom. However, recent PONs are for both broadband and narrowband services.

A passive subscriber loop is attractive because it uses no active devices outside the central office (CO), except at the customer premises. Several architectures of passive optical networks have been proposed for WDM or DWDM, which include the single-star, the tree, the double-star, and the star-bus.

Figure 7 shows the single-star architecture in which each household has a dedicated fiber to the central office (CO). The WDM channels in the fiber are used to carry all required services, such as voice and video. This architecture is designed for easy installation and upgrading; however, the cost of dedicated optical fiber between the customer and the CO in this network is still a major concern. Thus, this architecture may not be suitable for widespread deployment in the near term.

Figure 8 shows the tree PON architecture, in which the DWDM channels are split in the way of tree branches with each user having one or more wavelength channels. This architecture reduces the fiber use in comparison with the single-star. It is a better architecture, especially for DWDM-based system in which a large number of wavelength channels are available. This architecture can satisfy the customer needs for both narrowband and broadband services. One drawback of this network architecture is its rigidity, in terms of network upgrading.

The star-bus architecture can be considered as a variation of the tree architecture, which improves the flexibility of the tree architecture.

Figure 9 depicts the double-star PON architecture. This architecture provides more flexibility in comparison with the star-bus architecture. It

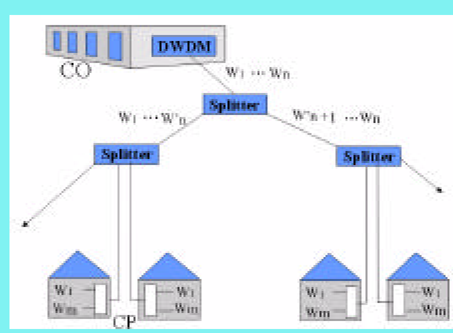
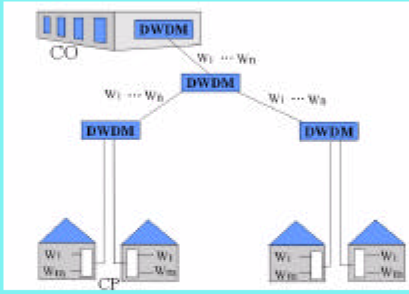


Figure 8: Tree PON architecture

Figure 9: The double-star PON architecture



can be considered as the front-runner among the possible architectures of PON for residential access applications.

3.3 DWDM Active Access Optical Networks

In the passive DWDM access networks, each wavelength channel is used to provide one service at a given time regardless of the channel capacity and bandwidth requirement of the service. With the increasing bandwidth capacity of DWDM technology, the bandwidth of one signal channel becomes high enough to carry several or many services even in the access environment. This leads to the thinking of applying TDM in each individual DWDM wavelength channel, resulting in the active DWDM access optical network in which TDM is used within each channel to provide integrated services. The Asynchronous Transfer Mode (ATM) has been proposed as the TDM protocol in the active DWDM access networks. With the ATM coming into the picture, the original B-ISDN (Broadband Integrated Services Digital Network) protocols are again surfacing in the access network arena. But this time, only one wavelength channel replaces the whole optical fiber in the system.

The network topologies for the passive DWDM access network discussed in the previous subsection can also be used for the active DWDM access network.

Although an active DWDM access network provides high utilization of the wavelength channels and in return reduces the fiber costs, it adds additional costs because of the ATM devices in the system from CO to user premises. It also increases the complexity of system management and maintenance, which leads to high operating costs.

Another twist in this hard-to-decide matter is the birth of the very high channel-count DWDM, in which thousands of wavelength channels are created and transmitted with one fiber. Essex Corp. has reported a 4,000-channel DWDM system. This may make the active DWDM access network architecture lose its potential advantages, and make the passive high channel-count DWDM PON become the leader in the race of access network architectures.

4.0 Concluding Remarks

This article provides an overview of the DWDM applications in two networks, the backbone network and the access network. The DWDM point-to-point technology has already played an important role in the backbone networks and it will continue to be installed for existing and new fiber links. However, for the all-optical DWDM network to become viable, we may have to wait till the optical processing power becomes available. This may create a time gap between the DWDM point-to-point applications and the all-optical DWDM transparent networks. In the access network case, it is still not clear whether the passive or the active is the leader. Although the cost barrier has been weakened through replacing the fiber by DWDM channels in the active access network architecture, the TDM devices in the system may still be too high at the present time. On the other hand, the fiber cost (along with the costs of the passive devices) in the passive architecture is probably still not cheap enough to make it ahead of the active architecture. However, the very high channel-count DWDM may change the landscape of the access network world, and it may become even cheaper than the combined costs of twisted pair copper and coaxial cables.

5.0 Acronyms

ATM	- Asynchronous Transfer Mode
B-ISDN	- Broadband Integrated Services Digital Networks
DWDM	- Dense Wavelength Division Multiplexing
SDH	- Synchronous Digital Hierarchy
SONET	- Synchronous Optical Network
TDM	- Time Domain Multiplexing
WDM	- Wavelength Division Multiplexing
CO	- Central Office
CP	- Customer Premises

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His current research interests include broadband access networks, residential gateways, optical logic & computing, and DWDM networks. He is a member of the IEEE Communications Society.

IEEE announces awards to Acadia first-year Electrical Engineering and Computer Science students

November 8, 2000 - Acadia University, Wolfville, NS. The Canadian Atlantic Section of the Institute of Electrical and Electronics Engineers (IEEE) today announced an award of $100 each to the students with the highest final grade in two first-year Engineering and Computer Science courses at Acadia.

Students of COMP 1213 (Digital Systems) and APSC 2213 (Electric Circuits) will compete for the two awards.

A presentation will be made to the winners during Engineering Week activities in March 2001 at which time the winning students will each also receive a free one-year student membership in the IEEE. Presented in collaboration with the Acadia University student branch of the IEEE, this award is designed to increase awareness among Engineering and Computer Science students of the IEEE and its activities.

On hand for the announcement were Dr. André Trudel, Director, Jodrey School of Computer Science and Dr. Andrew Mitchell, Director, Ivan Curry School of Engineering, Mr. Brian Maranda, Chair of the Canadian Atlantic Section, IEEE, as well as several representatives of the Canadian Atlantic Section of the IEEE.

Electronic Visual Cortex Stimulator - The Electronic Eye

by Mohamad Sawan

École Polytechnique, Montréal, QC

1.0 Introduction

Several implantable smart medical devices have been introduced recently, among them the cardiac pacemaker, the cochlear implant, the bladder controller and the visual stimulator. Such devices are dedicated to recuperate or enhance neuromuscular functions in patients by means of peripherals or central nervous systems. The electronic visual cortex stimulator -- popularly called the "electronic eye" -- is dedicated to create an adequate vision for totally blind patients and is the object of this article [1].

Three approaches have been considered world wide to develop an electronic eye. The first approach uses a cuff electrode around the optic nerve [2], and the second is based on an artificial retina [3]. In these two approaches, the optic nerve must be intact. However, the third approach consists of connecting directly the electronic visual stimulator to the visual cortex disregarding the optic nerve pathway.

2.0 Electronic Eye from Ecole Polytechnique

Direct neural electrical stimulation of the brain, by passing the retina and the optic nerve, is the basic principle of the electronic visual cortex stimulator (EVCS) proposed by PolySTIM research team headed by Prof. Sawan at the Ecole Polytechnique de Montreal. The interest in this latter technique is that it can serve most blind patients.

The proposed EVCS includes a miniaturized camera, which is integrated in an external controller and replaces the function of the eye. This external controller acquires images and transmits them to the implant that maps them into the visual cortex using a matrix of microelectrodes. Current injection through a pair of electrodes generates the sensation of a luminous dot (a phosphene) in the visual field of the patient. The image acquired by the camera can then be transmitted to the user by generating a group of properly controlled phosphenes whose intensity depends on characteristics of the stimulating current.

Professor Sawan's team started this project in 1994 and completed a non implantable prototype in the middle of 2000. Figure 1 shows the electronic part of the prototype of the implantable EVCS, and Figure 2 is the picture of the display part of this same prototype emulating the matrix of microelectrodes model. In addition, the picture of Figure 3, shown on a PC screen, represents the real image and the corresponding pixelized one that a blind patient could "see" using the implantable device.

Early last year, a team of American researchers from New-York presented a first model of a visual cortex stimulator, a system including a camera connected to a laptop computer driving a bundle of 68 wires connected directly to the brain [4]. This American prototype allowed a patient to recuperate a partial vision.

PolySTIM proposes a prototype that gives the following benefits:

- First, the image resolution is higher: The implant fixed in the visual cortex will contain 625 electrodes in one square centimeter. Such a resolution should provide the user with a visual acuity of approximately 20/30, sufficient for appreciable mobility and reading capabilities.
- Second, the device will not use a direct connection between the external camera and the implantable device in contact with the cortex. Instead, images, commands and energy, as well as data retrieved from the monitoring of internal activities, are exchanged using a bi-directional radio-frequency link.

The team from Ecole Polytechnique started recently collaboration with the Montreal Neurological Institute at McGill University in order to validate the generation of phosphenes associated to the visual cortex stimulation, and to perform long term *in vivo* testing of the electronic implant. Miniaturizing the device in the upcoming years and future testing of the whole system in human brains gives hope to provide blind people with an adequate vision by the end of this decade.

3.0 References

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[2]. Verrart, C., Delbecke, J. et al. "Selective Stimulation of the Human Optic Nerve", IFESS'99, Sandai (Japan) August 1999.

[3]. Stieglitz, T., Beutel, H. et al. "A Flexible Retina Implant for People Suffering from Retinitis Pigmentosa", IFESS'99, Sandai (Japan) August 1999.

[4]. Dobelle, W.H., "Artificial vision for the blind by connecting a television camera to the visual cortex", American Society of Artificial Internal Organs (ASAIO), No. 46, pp. 3-9, January 2000.

Figure 1: The electronic part of the non-implantable prototype of the EVCS.

Figure 2: The display part of the non-implantable prototype of the EVCS emulating a 16x16 matrix of microelectrodes model.

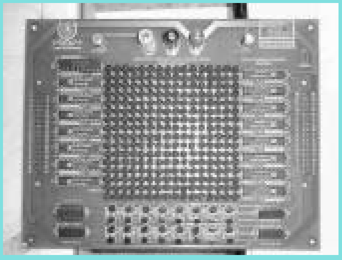

Figure 3: The user interface of the external controller prototype presenting the real image and its corresponding 25x25 pixelized one that a blind patient could see using the implantable device.

IEEE Canada Fall Meeting in London, ON -- October, 20-22, 2000

President Celia Desmond proposes a toast and addresses the delegates at the Fall meeting in London, Ontario.

Taking Care of IEEE Business

Site of the Fall Meeting of IEEE Canada - The historic Delta Inn of London, Ontario.

Members at the banquet enjoying net-working with other members of IEEE Canada

The Graduates of the Last Decade (Gold) Team.

(From left to right) Slawo Weslowski, Ivana Vujosevic and Dominic Rivard are the bearers of the GOLD banner.

Celia Desmond (left) and Marc Provencher (right) present Dominic Rivard (centre) from Trois Rivieres an award for his work on the preparation of the IEEE By-Laws.

President Celia Desmond prepares to address the delegates of IEEE Canada.

IEEE Circuits and Systems (CAS) Society Award

Dr. M.N.S. Swamy, Research Professor and Director of Signal Processing and Communications at Concordia University, was a recipient of two major awards from the IEEE Circuits and Systems (CAS) Society:

- **Golden Jubilee Medal** - "In recognition of his outstanding contributions to Circuits and Systems", and
- **Year 2000 Education Award** - "In recognition of his outstanding contributions in the fields of distributed parameter networks, filters, graph theory, and multi-dimensional signal processing, and of his contributions to engineering education through administrative leadership, textbooks, teaching, and outstanding mentoring of his many graduate and postdoctoral students".

Dr. Swamy received a B.Sc. (Hons.) degree in Mathematics from Mysore University, India, in 1954, a Diploma in Electrical Communication Engineering from the Indian Institute of Science, Bangalore in 1957, and M.Sc. and Ph. D. degrees in Electrical Engineering from the University of Saskatchewan, in 1960 and 1963 respectively.

He served as the Chair of the Department of Electrical Engineering from 1970 to 1977, and Dean of Engineering and Computer Science from 1977 to 1993 at Concordia University.

He has published extensively in the areas of number theory, circuits, systems and signal processing, and holds four patents. He is the co-author of two book chapters and three books: Graphs, Networks and Algorithms (Wiley, 1981), Graphs: Theory and Algorithms (Wiley, 1992), and Switched Capacitor Filters: Theory, Analysis and Design (Prentice Hall International UK Ltd., 1995). He is presently the Editor-in-Chief of the IEEE Transactions on Circuits and Systems-I, and the journal Circuits, Systems and Signal Processing, for which he was an associate editor since its inception. He is also an Associate Editor of the Fibonacci Quarterly. He is the Concordia University coordinator for Micronet, a National Network of Centers of Excellence in Canada. He has supervised over 20 doctoral graduates and mentored over 40 post-doctoral fellows.

Dr. Swamy is a Fellow of a number of professional societies including the IEEE, IEE (UK), and the EIC. He is also a member of the Eta Kappa Nu, an Honor Society of Electrical Engineers. He is also a life fellow and life patron of the International Biographical Association and the American Biographical Institute.

Fellows of the IEEE - 2001

Congratulations to the following newly elected IEEE Fellows from Region 7:

Ramesh Mulchand Gulrajani Universite de Montreal Montreal, Quebec.	For contributions to the forward and inverse problems of electro-cardiography.
Ke Wu Ecole Polytechnique de Montreal Montreal, Quebec.	For contributions to hybrid integration of planar and non-planar microwave and millimeter-wave circuits and guided-wave structures.
M. Omair Ahmad Concordia University Montreal, Quebec.	For contributions to the design and implementation of digital signal processing algorithms.
Robert Edward Kearney McGill University Montreal, Quebec.	For contributions in understanding peripheral neuromuscular system dynamics and development of methods for the identification of biomedical systems.
John Kuffel Ontario Power Technoligies Toronto, Ontario.	For contributions to the introduction of digital recording and signal processing techniques in high voltage measurements and advancements in transmission and distribution systems.
Raafat R. Mansour University of Waterloo Waterloo, Ontario.	For contributions to the development of high temperature superconductive filters and multiplexers
Rangaraj Mandayam R. University of Calgary Calgary, Alberta.	For contributions to biomedical signal and image analysis.
Emil M. Petriu University of Ottawa Ottawa, Ontario.	For contributions to the development of pseudo-random encoding techniques for absolute position measurement.
Victor Hugo Quintana University of Waterloo Waterloo, Ontario.	For contributions to power system optimization techniques and power engineering education
Demetri Terzopoulos University of Toronto Toronto, Ontario.	For contributions to the theory of deformable models and leadership in their application to computer graphics, computer vision, medical imaging and computer-aided design.
Wai-Cheung Tang COM DEV International Cambridge, Ontario.	For contributions to the miniaturization of microwave filters and multiplexers for satellite applications.
Ke Wu Ecole Polytechnique de Montreal Montreal, Quebec.	For contributions to hybrid of planar and non-planar microwave and millimeter-wave circuits and guided-wave structures.
Yiyan Wu Communications Research Centre Ottawa, Ontario.	For contributions to digital television research and standards development.

Electricity Deregulation: Doubts Brought On by the California Debacle

by *Maurice Huneault*
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Abstract

Electricity industry deregulation has been actively sold around the world as a liberating economic force. Proponents of free market economics have all but promised cheaper electricity and better quality of service as a result of deregulation. Several countries have already accepted that reasoning and have proceeded with vast transformations of their electricity industries. By and large, results of these moves made during the 1990s had been deemed positive. It then came as a shock when the California electricity market, which had operated well since its debut in 1998, suffered severe volatility and extreme prices in the second half of 2000. In this paper, we review deregulation in general and the California case in particular, provide reasons for the debacle and suggest conditions for a successful electricity market.

Sommaire

Les promoteurs de la déréglementation dans l'industrie de l'électricité y ont vu un véhicule de progrès économique qui assurerait à la fois la diminution des prix et l'amélioration de la qualité de service. Plusieurs pays ont adopté ce raisonnement et ont procédé à de vastes transformations de leurs industries de l'électricité. Dans l'ensemble, les résultats des changements initiés pendant les années 1990 sont perçus comme étant positifs. La débandade récente du marché californien, suite à deux ans d'exploitation réussie, a donc soulevé la consternation. Dans cet article nous examinons la déréglementation en général et l'implantation californienne en particulier. Nous avançons des raisons pour la débandade, et nous suggérons des conditions minimales nécessaires pour assurer le succès d'une implantation.

1.0 Introduction

The resurgence of the free enterprise spirit in public thinking over the last two decades has spearheaded the restructuring of several large industrial sectors in western economies. Most notable among these are aviation, natural gas, communications and, more recently, the electricity industry. Deregulation of the latter has been of prime concern in many countries since the end of the 1980s. Proponents sell the merits of this open industry structure from both business and technical perspectives, all of which, they claim, should assure lower prices and better service to consumers. Up to now, over 30 countries have implemented or initiated electricity industry deregulation. In its completed form, the result has been a separation of hitherto vertically integrated electric utilities into several independent entities according to function (generation, transmission, distribution, retail and services), the fragmenting and possibly the sale of production assets to promote competition in supply, the opening of the industry to new participants, the removal of incumbent rights/obligations, and the creation of a new market environment for wholesale and retail electricity trading. The wholesale markets, also called spot markets, establish their electricity prices in real time as a function of short-term supply and demand functions provided by market participants through computer links. Deregulated electricity industries worldwide have reached various stages of this process.

In the United States, the electricity industry debated the issue of deregulation at length during the 1990s. Academics had long before championed the move, but the industry itself had been slow to act. Federal legislation in 1992 paved the way and indeed pushed individual states in the direction of deregulation. Little progress was achieved however until the end of 1995, when the Federal Energy Regulatory Commission (FERC) resolved questions regarding transmission access. California was one of the first states to promote deregulation. Starting from an initial proposal in 1994, interested parties expended much time and effort forging the design of their new, custom-made electricity industry model. Their implementation, inaugurated in April 1998, allows competing generators to sell into a central electricity market or to individual clients. During a transition period, the investor-owned incumbent utilities were to buy exclusively from that market, but would eventually be allowed other trading arrangements. They also serve as sole retailers to most consumers in their areas, but eventually that would also be opened up to competition. The incumbents remain the sole transmission service providers. Three new institutions coordinate commercial and technical activities in the new structure: a wholesale energy market (PX), regional market coordinators, and a power system operator called the Independent System Operator (ISO). These entities can process requests for energy and for transmission access on short notice, thereby enhancing electricity trading. For its first two years the California electricity market seemed, at least from the outside, to be quite successful. Elsewhere in the United States, groupings of utilities in the Northeast successfully implemented deregulation, with the mid-Atlantic PJM group actually being the first in January 1998. The success of these two markets provided impetus to the deregulation movement. Presently, half the states have either deregulated or have plans in the works to do so.

The California electricity market unexpectedly broke down in the second half of 2000. During that period, electricity prices there surged way beyond those in other American electricity markets saddled with many of the same rising fuel costs. Average daily prices for bulk power during the summer peak months were in the unusually high range of \$150 to \$200/MWh, but even after the peak period prices continued to rise. On one December day, the average daily price in California reached \$500/MWh, a tenfold increase over habitual average prices. The increases were sparked by a scarcity of energy resources, but were compounded by other factors. The two larger incumbent utilities, Pacific Gas & Electric and Southern California Edison, are now saddled with huge debts, having been forced to buy at the going prices on the wholesale market, but being obliged to sell to its customers at lower fixed rates. A third incumbent utility, San Diego Gas & Electric, fulfilled certain conditions allowing it to pass on its own energy bills to consumers before the onslaught of the summer crunch. There, disgruntled consumers saw their electricity rates double over the time span of one bill. The severity of the crisis was generally recognized only after the larger incumbents sent out an alarm late in the year, when their financial situations had become precarious. Consequently, some neighboring utilities refused to sell into the California market, fearing default of payment, thereby reducing the pool of energy resources. All this resulted, starting in late fall, in regular rolling blackouts throughout the state. Authorities from FERC and the ISO tried to settle market prices with price caps, to no avail. Finally California legislators stepped in at the beginning of 2001 to suspend electricity market activities and to force producers into selling to the state at prices deemed reasonable. They also relaxed the screening process to facilitate the construction of new facilities, which could come on line as early as 2003. A fascinating account of the whole adventure can be found in documents at the web site http:/www.stoft.com/.

Despite the suddenness of this situation, it can be argued that several long-term factors are largely to blame for the debacle. For one, no new generation or transmission has been built in the state for some time, despite the steady increases in load spurred by impressive economic growth. California supplements its own generation with large imports from its neighbors, but little new energy has been made available from those sources as well. As a result, capacity reserves in California are now very low. Furthermore, many transmission corridors in the state are constantly congested. That is significant because market pricing rules force up prices for all energy consumed in times of congestion. To compound the problem, present water levels for hydro generation in the American West are low, and both fuel costs and emission credit costs have jumped dramatically over the last year. Naturally, the high input costs and the scarcity of energy have been reflected in the increasing electricity prices on the wholesale market. Adverse consumer demand could not be counted on to temper the high prices, unsuspecting consumers being shielded by fixed rates in most of the state.

Certainly the California adventure has sent shock waves throughout the industry, particularly within fledgling electricity markets and among undecided regulators. Some pundits now argue, after the fact, that this was a calamity just waiting to happen. However, the California market is similar in many ways to other, successful electricity markets. What, then, caused the collapse of the California market in particular? Now many observers are asking the ominous question: Whose next? Closer to home, could this market meltdown happen in Alberta or Ontario, the two Canadian provinces that have already adopted deregulation? Following a whirlwind tour of the deregulated electricity industry, the author will provide his analysis of the problem.

2.0 Electricity Deregulation Around the World

The 1980s served as a period of reflection for deregulators who saw advantages in breaking up the monopoly structure of the industry. They developed a general “philosophy” that would appeal to all energy market participants. Its main advantages were expected to be a reduction in energy prices through the opening of competitive energy markets, long-term gains in efficiency, the influx of private capital and the offering of new or improved services and products. New, more efficient producers would see their efforts rewarded with profits dictated by the marketplace. Leaders of the movement often shouted from the rooftops their abiding belief in free market principles, but in many cases the particulars of their national electricity industries dictated change. In addition to its stated advantages, deregulation was often a way out of a bind, and the untold advantages of industry reforms were actually important motivators. In several countries, the national debt stifled growth. There, the public sector could no longer meet the investment needs of the public electricity industry. Hence with deregulation and ensuing privatization, governments freed up public funds and collected much needed cash from the sale of industry assets. In most countries, deregulation provided an opportunity to rectify industry ills one way or another:

- by pushing through much needed corporate reorganization and downsizing, by enforcing efficient business practices,
- by repairing the wrongs of previous legislation, or
- by freeing utilities from unwanted externalities such as political meddling or the influence of militant unions.

Since 1982, several countries have enacted legislation to open their electricity industries to competition. Three countries are generally recognized as pioneers: Chile (1982), England and Wales (1990) and Norway (1990). The following paragraphs describe briefly the major implementations of deregulation in those and a few other countries.

Unbeknown to most industry observers in the English-speaking world, Chile undertook a bold plan of industry restructuring, passing legislation in 1982 and gradually implementing the plan through the decade. Many structural choices made in the Chilean reform were eventually copied elsewhere – in particular, the segmentation of the industry and the compulsory spot market using marginal pricing principles. The work produced in Chile inspired several similar initiatives in Latin America. Argentina, which experienced economic hardships similar to those in Chile, restructured in 1992. Gains in these two countries came mostly from the introduction of efficient business practices in an industry previously fraught with incompetence and rampant nepotism. Results were spectacular, as investment capital flowed into the countries, prices plummeted and the quality of service improved immeasurably. Several South American countries followed suit from 1993 to 1995, as did Central American countries in 1997. Brazil in 1998 and Mexico in 1999 also introduced plans to deregulate, but they cannot be said to favor the Chilean/Argentinean model.

Although not openly admitted, deregulation in England and Wales was a means to rid the electricity industry of its burden to subsidize the British coal industry and to reduce its work force. Supporters of deregulation in political circles quickly won the national debate, culminating in legislation in 1990 to start up a deregulated industry in 1991. The national utility was then split into three producers (eventually more private producers joined in), one transmission company and twelve regional distribution companies. The adopted market structure called for the compulsory participation of all energy traders in a national spot market. A single national energy price was set by the spot market auction based on marginal pricing practices, to which various general and regional uplifts were applied using a complex set of rules. Those rules have been criticized as being unnecessarily complex. The major criticism of English deregulation, however, has been that it allowed the incumbent energy producers to exercise market power, i.e., that their size allowed them to dictate prices above competitive levels. It is known that sellers under certain circumstances can keep prices unduly high by systematically manipulating marginal pricing. Analysis shows that average electricity prices did fall in England and Wales through the 1990s, but less than could be expected considering the dramatic drop in fuel prices. Unsuccessful attempts by the regulator to introduce greater competition among producers finally lead to a complete shift in trading rules. Initiated in 1998, the reforms will soon go into effect. Payments in the formal national market will now follow a pay-as-you-bid rule, and trading outside the formal market is strongly encouraged.

In the years preceding Norwegian deregulation, regulators there tried unsuccessfully to merge electricity companies in the hope that consolidation would bring greater efficiency and uniform prices throughout the country. Exploiting the country’s abundant hydraulic resources, the over 80 producers and 200 regional distributors served their constituencies well, but on the whole the country had over-invested to build large capacity reserves. Deregulation became the mechanism for achieving the goal of national uniformity. Following legislation in 1990, reforms were initiated over a period of five years starting in 1991. Major changes were implemented immediately in 1991; they made the electricity market easily accessible to both producers and consumers, and made dealings transparent. Under deregulation, privatization and consolidation were not imposed, since the presence of numerous public producers reduced the eventuality of market power. The reform was seen to be successful as consumer prices quickly decreased. The Norwegian reform has spread to the other Scandinavian countries since 1995 in a market called NORDPOOL. The great novelty in this market is that formal trading mechanisms other than a spot market were put in place. These involve medium and long term forward and futures contract markets. Also, bilateral trading outside the formal markets is encouraged. Electricity prices offered by retailers are published in newspapers for all to see, and consumers can change retailers with minimal effort. These measures have certainly been a factor in maintaining competitive prices.

The English model spread to Scotland and Northern Ireland from 1990 to 1992, and certainly influenced other Commonwealth states such as Australia (since 1991), New Zealand (electricity reforms since 1987, deregulation since 1994) and the Canadian provinces of Alberta and Ontario. Reforms in Australia and New Zealand are considered successful. Before deregulation the electricity business in Australia and New Zealand was healthy, relying on cheap, abundant energy sources. In Australia, the states of Victoria and New South Wales proceeded with separate plans for deregulation. The most striking difference in approaches is that Victoria privatized its production assets, while New South Wales maintained its public ownership. After putting their reforms in place, the two states joined forces to form a national market. The amalgamation stabilized electricity prices by giving consumers access to a larger and more diverse production pool. New Zealand’s industry makeup is partly similar to that of Norway. Before deregulation, one state producer, exploiting mostly small hydro power plants, supplied numerous municipal utilities. Deregulation there started at the retail level, with amalgamated incumbent distributors encouraged to provide competitive retail services outside their borders, and with new retailers being formed. To promote competition in generation, the national producer has since been split up. Otherwise the government has kept regulations in the industry to a minimum. Factors contributing to the sustained competition in both countries have been the application of comprehensive and comprehensible market rules, segmentation of the industry (production down to the plant level in Australia, retail in New Zealand), and some public participation in the industry.

Although not a pioneer, the United States is certainly an important player on the world stage. The American electricity industry also had its unique problems leading up to deregulation. The oil crisis of the 1970s pushed the electricity industry towards alternative sources of energy. Many utilities opted for nuclear energy, not realizing how the required investments would eventually spiral out of control. Legislation called PURPA, passed in 1978, liberalized the energy industry by assuring green producers an outlet for their production. Utilities bought this energy in long term contracts at prices that, as it turns out, were way above market prices. Hence these measures forced large expenditures upon certain utilities. Being state-regulated, those utilities could not seek economic relief by investing in cheaper energy resources in other states. By the end of the 1980s, excess costs passed on by the most strapped utilities substantially raised consumer rates in many areas of the country, particularly in California and the Northeast. New legislation in 1992 finally addressed the problem by allowing for the creation of energy markets, the open access to transmission facilities and the participation of new energy providers. The law calls for state-by-state restructuring, but allows for unfettered commerce across their boundaries. Naturally, those areas with the highest electricity tariffs were the first to deregulate. As indicated already, California and the PJM system were the first to deregulate in 1998, and now New England and New York are nearing completion of their implementations. It is noteworthy that philosophies for market rules between east and west are quite different from one another. That has lead to polite animosity between the two groups. The eastern approach, based on locational marginal pricing, had already been applied in New Zealand and now seems more widely accepted. Since 1998, other states, though not all, have pronounced themselves in favor of deregulation. The first step in regionalizing electricity trade is the creation of a regional ISO, now called an RTO. Presently six American regions fall under the supervision of ISOs, and a recent FERC ruling forces all regions to prepare plans to integrate into RTOs.

One last major player in the list is the European Union. After years of deliberation, they submitted a directive to its members at the end of 1996, requiring them to present plans by the start of 1999 for the opening of their electricity markets by the early 2000's. These plans are now being implemented. Note that Spain had already proceeded on its own with plans to deregulate. Other reforms that cannot be strictly classified as deregulation have been underway in Eastern Europe (privatization), Southeast Asia (liberalization similar to PURPA) and Southern Africa (international trade).

To the author's knowledge, four Canadian provinces have actively looked into deregulation. For British Columbia and Québec, minimal structural changes were made to ensure a continued participation in the lucrative American electricity markets. That involved the separation of the transmission provider from the rest of the provincial utilities, and modifications in legislation to allow open access to their transmission systems. Independent power producers and marketers aren't likely to proliferate in those provinces, since bulk rates offered by the incumbent utilities are among the lowest on the continent. British Columbia initially held bolder plans for complete deregulation, but has backed off over the last year. On the contrary, the complete deregulation package has been adopted in Alberta and Ontario. In fact, Alberta put in place its energy market in 1996. It floundered over its first two years, and it was reorganized along the lines of the British system in 1998. Contrary to common promises, electricity prices in Alberta have increased substantially since the inception of deregulation. Reasons cited are a quick expansion of load in the province, limited electricity reserves and market power exercised by the three large producers. The Alberta government recently announced rebates to relieve the burden on its consumers. In the east, Ontario passed the needed legislation in 1998, has fragmented the old Ontario-Hydro into several companies including Ontario Power Generation and Hydro One (transmission/distribution), and is now poised to start up its electricity market.

3.0 Competitiveness in Electricity Spot Markets

With respect to the positive effect on consumer prices, we rate in Table 1 the success of the implementations described in the previous section.

Table 1: Ratings of implementations of deregulation

Rating	Implementations of deregulation
Success	Norway, Australia, New Zealand, PJM, Chile, Argentina
Partial failure	England and Wales
Failure	California from the summer of 2000 onward, Alberta
Too early to tell	The rest of Latin America, countries of the European Union

In spite of its success in lowering prices, the best measure of success of a market is probably its competitiveness. In the virtual electricity markets where haggling is impossible, competitiveness implies that the market rules must be well thought out. They must treat participants on a common footing and provide them with choice, but at the same time must be decisive and quickly implemented. The formal analysis of competitiveness in a market is a difficult task. It tries to separate true measures of market efficiency from extraneous factors, such as variations in costs of fuel or capital, climatic conditions, etc.

Whether competitive or not, the behavior of prices in electricity spot markets is prone to volatility. In addition to daily and seasonal peaks and valleys, occasional short-lived price spikes soar beyond the top of the graph. Analysis shows that in itself this behavior is not surprising and, in fact, periods of high prices are necessary for the financial health of the industry. To understand why, a short description of marginal pricing in electricity markets is provided.

Electricity spot markets are modeled on commodity markets. Buyers and sellers participate in an auction where they provide information on the prices and quantities they are willing to buy or sell. The auction caller tallies up the total demand and matches it with the least expensive offers. The most expensive offer to be retained determines the sale price for the entire lot being traded in that auction. This is called the marginal or spot price. Such an auction is performed every hour or half hour in electricity markets. Traditional tools for the dispatch of electricity were modified only slightly to perform this calculation. In auctions however, contrary to practices in traditional dispatching, production costs are replaced by production offers that need not reflect true costs. The price of the last retained watt becomes the sale price of all the energy sold at that time. Dispatch tools can also route energy to avoid overloading portions of the transmission system. The situation where some transmission lines are operating at a limit is called congestion. A region situated "behind" congested lines cannot receive additional power through the transmission system, and its additional energy sources are limited to its local area. Its marginal cost is then different from than that on the other side of the congested line. Actually, the presence of any congested line in a network imposes different marginal prices at every node of the network. This is called locational marginal pricing.

When a large base load plant supplies the last watt during low-load periods, the price of electricity is as low as it can get. During these periods offer surpasses demand, and sellers need to be competitive if they are to be retained in the auction solution. Under these conditions sellers extract little profit from their operation. Marginal prices for base load are roughly in the $20 to $30/MWh range, but in some markets (California for example) sellers have been willing to give away power rather than shut down their thermal or nuclear plants. At the other end of the load curve, when high-priced peaking generators supply the last watt, the price of electricity jumps. In that situation the marginal pricing mechanism rewards the efficient sellers, since marginal prices for peaking units can run over the $100/MWh range. Sellers recover their substantial fixed costs (capital costs, maintenance and general staffing) during these periods. Hence it is argued that these recovery periods are necessary if sellers are to make money. The problem in some markets, as indicated below, is that the level of recovery is not dictated by competitive forces, but rather is controlled by the sellers.

In a scenario where there are always several competing sellers available to provide the last watt, this market mechanism would yield the lowest average prices to consumers. In this case, the market price is not necessarily a low price, but it is a competitive price. Buyers on the wholesale market pay the spot price. They in turn become sellers on the retail markets; there they often average out their customers bills to avoid the confusion caused by the constantly varying spot prices.

There are potential problems with the marginal pricing mechanism as applied to electricity markets. Electricity markets are quite different from other commodity markets. First and foremost, electricity is an essential product, and most buyers are not in a position to "take it or leave it". Commodity markets do not share with electricity markets the urgency to supply the product, since in the former buyers can balk at high prices (and sellers at low prices). That is because the presence of stockpiles regulates the spot price. Stockpiles would have to be depleted (replenished) before trading would resume at extreme prices. Buyers of electricity by and large are not equipped to displace consumption from periods of high prices to those of low prices. As a result, their energy demands are often taken for granted by sellers no matter what the price. This places the seller in an advantageous position, and sets up opportunities for sellers to exercise market power in high system loading conditions. Periods during which system load surpasses say 85% of installed capacity typically occur twice a day for periods that can vary from a few weeks (winter peak in Québec) to a few months (summer peak in California). Periods of maintenance which limit system capacity can be just as vulnerable to energy shortages. During those periods, in many markets, the presence of all the major producers is required to satisfy the load. Producers who foresee the tight energy supply can submit a particular portfolio of offers to the market from their different power plants. Most are low-priced offers for large chunks of energy, all sure to make the cut in the auction, but a few very high-priced offers are thrown in. Prices of these offers often surpass the actual generation costs of the most economically inefficient generators. The latter risk setting the marginal price. No matter who sets a high marginal price, all sellers benefit. This auction is performed within the rules, and prices are pushed as far as the market can bear. It must be kept in mind however that in this case sellers control the market, as buyers are not adequately represented. It is clear that prices in California in the latter half of 2000 were caused by this kind of price manipulation. A situation that falls outside the rules involves the deliberate withholding of generation capacity or the creation of network congestion to create the same conditions of scarcity at lower load levels. Allegations of this sort of behavior have been put forth in some electricity markets, but they are difficult to prove. Market prices in either of these situations reflect scarcity and opportunity rather than actual costs. Extreme situations have arisen in the American Midwest and Northeast since 1998 where unexpected shortages and high loads pushed wholesale prices above $6000/MWh for short periods.

Analysts have studied most electricity markets for signs of exercise of market power. The British market prior to its reorganization and the California market prior to its meltdown were extensively analyzed, as was to a lesser extent the Alberta market. In all three, analysts identified many situations during which the exercise of market power most likely resulted in high prices. Various authors also dug up indirect signs of abusive pricing: annual profits, executive salaries and bonuses remarkably higher than in the rest of the industry.

4.0 The Problems with the Deficient Markets

In essence, electricity markets work well only when competing forces are balanced at all times. As indicated above, this is a difficult condition to ensure in electricity markets. It requires abundance of the product being sold, comprehensive market rules, transparency in dealings, choice for all participants, and vigilance on the part of participants and of impartial observers. Successful markets have met all of these conditions; one or more of these conditions was lacking in the deficient markets.

The most serious problem in the deficient markets is that sellers maximize their profits by exploiting scarcity. That occurs because consumers are inadequately represented in the auction mechanism. Previously in the regulated industry environment, consumers were represented by the regulator. Its departure leaves a void that has not been filled. Consumers in the deregulated environment do not have the opportunity to influence spot market prices, much less to refuse them, except by turning off the switch. Note that consumer mobilization to spot prices is a broad and difficult problem which has not yet been resolved. The alternative, shunned in the deficient markets, is to allow other forms of trading with direct contact between buyers and sellers. The English and California markets foresaw active consumer participation only after lengthy transition periods. California's problem is that it could not get through the transition period. In partial defence of California power producers, once the market got out of control it was impossible for any one of them to reverse the process. Any of the larger producers could set the high market price, and most probably took the position that "if we don't do it someone else will". Unwittingly they killed the goose that laid the golden egg.

Long term bilateral contracts between buyers and sellers are useful tools, but of themselves are not the answer to all woes. If sellers believe that high spot market prices can be sustained, they will refuse to enter lower-priced contracts. In markets exhibiting problems of market power, sellers have the leverage to maintain in their contracts the high prices otherwise anticipated on the spot market. That is the present situation in Alberta, where most of the power production has been auctioned off to retailers in large chunks over long term contracts. With only three major power producers and little import capacity, Alberta has no competition at the source, and so competition at the retail level offers little benefit. The recent offer by the Alberta government to reimburse consumers in response to high electricity prices is, in the author's opinion, an admission of defeat of their electricity market.

Price caps have been imposed in many markets, not so much to enforce competitive prices but more as a safety valve to guard against excessive prices. In December 2000, with prices running rampant, price caps were adjusted to various levels in California in an effort to stabilize prices. Rather than give in, sellers refused to sell at prices below the cap, and regulators quickly capitulated. That, in the author's opinion, was a high stakes game of chicken. Sellers, backed by a powerful FERC commissioner, argued that the high prices were needed to attract new investment. More on that aspect further, but it was quickly pointed out that at those recent price levels, the California power industry could have paid itself an expansion twice its present size in just ten years.

Up to now we have only described the mechanics of electricity markets. Here, finally, the notions of human presence, of vigilance and expectations should be introduced. Vigilance is exercised in a state's power industry as a whole by its governance. Representatives of the industry's stakeholders watch over the proceedings, signal conditions unfavorable to them, and generally influence the direction in which the industry evolves. Members of healthy governance must be given sufficient clout to defend their points of view. At the microscopic level, various advocate associations offer the same kind of visibility to their segments of the industry and to their members. These two groups form the much-needed independent observers alluded to earlier. The second term, expectations, relates to the reasonable objectives participants set for themselves. Buyers must realize that, as part of their electricity bills, they must pay a premium to attract investment for required growth. Sellers must realize that there is a limit to what consumers are willing to pay. A much-neglected aspect of deregulation, at least in the technical literature, is how human interaction is needed to forge and maintain a harmonious market.

Articles in a recent issue of IEEE Spectrum Magazine raised the spectre of market meltdown in the American Northeast next summer. That region has seen high peak-load prices and intense price spikes during the last three years, but at most times prices are held in line. There is reason for concern for the next round, since producers certainly know by now when they hold market power. Hard reasons for optimism that markets will hold are that the East is fed by a much larger pool of competing producers that the West, and that utilities are at the same time both buyers and sellers. A soft reason for optimism, conveyed in an opinion heard by the author, is that the eastern utilities have maintained their traditional public role and their traditional expectations. We will get an indication next summer if that still holds true.

5.0 Longer Term Factors in Deregulation

The market pricing mechanisms described previously explain short term market behavior. The long term needs for industry investment and expansion are equally important when assessing market pricing. A few factors are briefly considered here.

Of prime importance, market prices should entice enough investment capital in the competitive portions of the industry to meet future needs. It is generally agreed that investors should be rewarded with reasonable rates of return, but traditional utility financing has been rather conservative compared to that in competing financial markets. Expectations of recent investors in the new electricity markets might have been too ambitious. Looking again at California, incumbent utilities sold their generating facilities at prices way above book value. In turn, the new owners justified high prices in an attempt to recover their investments as quickly as they would have with dot COM stocks. The outcome is history. Initial investor interest in generation expansion has been stalled by the uncertainty concerning expected prices in the expanded system, in part due to the volatility of present prices. Unreasonably high prices recently seen in California were not really attractive to investors because they were recognized as being untenable. Another factor impeding investment is the presence of direct and indirect barriers to entry such as licensing requirements, environmental studies, parliamentary commissions, etc. As a result, some electricity industries face the daunting situation of having no clear expansion plan and no real perspectives for expansion.

Investment in the transmission sector is also problematic. Transmission providers who collect so-called congestion rents have little incentive to expand, since expansion could alleviate congestion. They too exploit scarcity. The revenues of many transmission providers are regulated however, and they would have nothing to loose by expanding. The problem is that new transmission can miss the mark if, over the life of the new facilities, generation patterns shift around in the network. In this case, part of the projected transmission revenues would not be collected and the investor might incur a deficit. The absence of planning in generation expansion therefore induces uncertainty in transmission planning. In some countries, such as Chile and Japan, the proposed solution to transmission planning is to let public planners identify the needs for transmission expansion. They would then auction off rights to interested companies who would build and operate the new transmission facilities for profit.

The author believes that involvement, whether to plan, coordinate or simply facilitate expansion, remains an important responsibility of public institutions in the electricity industry. The decision to invest in generation or transmission facilities in a deregulated environment, however, ultimately lies with private enterprise, and is based on its anticipation of financial success in the marketplace.

6.0 Conclusions

Electricity deregulation has served both as a means to shake up poorly managed power industries and to promote efficiency in the healthy ones. Concentrating only on the latter, deregulation was oversold to consumers based mostly on promises of short-term benefits. Consumers in markets with an abundance of electricity resources reaped the expected benefits, but many others did not because of uncompetitive seller-biased markets. There, spot markets using marginal pricing could not be expected to sell the same limited resources at lower prices than the regulated utility. Besides prices, much-promised innovative services such as custom power and financial services have rarely appeared anywhere.

If a region's regulated electric utilities are willing and capable to support future expansion, if their financial positions are sound and their rates are advantageous, and if their energy sources are still plentiful, then regulators should take note that full deregulation offers no real benefit. That seems to be the present position taken by Québec, the author's home province. For others, deregulation is an option worth pursuing. The author feels that the real benefits of deregulation should be expected in the long run. The potential of deregulation comes from the opening of the industry to new players and their vast resources of capital, technologies and expertise. Eventually, the efficient expansion brought about by their participation should assure a greater degree of competitiveness to the market.

The contents of this paper are summarized in the form of recommendations, which could help in establishing the merits of deregulation for a given implementation:

- A competitive industry is a prerequisite for deregulation. This involves the active participation of many buyers and sellers, and to lesser degrees of regulators and planners.
- Electricity trading must be open, transparent, and as unconstrained as possible. Several trading mechanisms should be encouraged and results of trade on public markets should be easily accessed.
- Each transitional phase of a deregulation plan must maintain a competitive environment.
- The market doesn't regulate itself into higher states of grace all by itself. Market rules must be carefully thought out to avoid market power, but even so, watchdogs from the outside should scrutinize the markets and react to anomalies.
- The ultimate caution: You can't fix a broken electricity industry just by deregulating it.
- Private industry should not be expected to invest billions of dollars over night if healthy incumbent utilities show no inclination.
- Don't wait until energy reserves are non-existent to deregulate. This is a corollary of the previous statement.
- Segmentation of the industry makes certain issues fall through the cracks. Planners should handle such issues.
- Public interest must be considered.
- The governance of the new institutions should assure some form of continuity from a regulated to a deregulated environment.

Let us end with a few comments on the Ontario plan for deregulation. Ontario embarked on this path motivated in part by the idea that new players could harness the latest generation technologies. It is realized however that for the time being Ontario Power Generation (OPG) is by far the province's largest electrical energy provider. In the absence of competition in the new market, strong regulation will be maintained to mitigate market power. OPG agreed to revenue caps during a transition period of 10 years, after which divestitures will have reduced its provincial market share to 35%. On the retail side, it is hoped that the close to 300 municipal utilities will act as strong advocates for consumers. The protracted transition market is then something of a novel hybrid. This author feels that it will take some time before competitive forces can develop in such a scheme.

About the author

Maurice Huneault holds B.Sc.A. and M.Sc.A degrees from Laval University and a Ph.D. from McGill University, all in electrical engineering. He is presently a researcher at the Hydro-Québec Research Institute, IREQ. His research interests are in the fields of power systems analysis and optimal operation, and in particular in power industry deregulation.

Université du Québec
École de technologie supérieure

Campagne de financement de l'ÉTS : mission accomplie!

Montréal, le 16 février 2001 - La campagne de financement « ÉTS 1995-2000 - un avenir de génie » s'est terminée avec succès puisqu'elle a permis de recueillir un montant de 10 103 000 $, soit une somme supérieure aux objectifs de départ. C'est ce qu'a annoncé hier soir M. Louis A. Tanguay, chef de la direction de Bell Canada International et président de la campagne de financement de l'ÉTS, à l'occasion d'une cérémonie de clôture de la campagne de financement - soirée qui s'est déroulée hier soir à l'École de Technologie Supérieure.

De gauche à droite: M. Robert L. Papineau, directeur général de l'ÉTS, M. Michel Laurence, professeur au département de génie électrique de l'ÉTS et M. Yvon Dubois, directeur du fond de développement et directeur des relations avec l'industrie de l'ÉTS.

Rappelons que cette campagne de financement, lancée en 1995, avait pour mission d'établir des partenariats stratégiques École-Industrie et de créer des alliances avec les donateurs afin de financer les projets prioritaires de l'ÉTS. Les montants recueillis ont déjà répondu à plusieurs besoins identifiés à l'origine, à savoir : l'excellence de l'environnement éducatif; le développement et l'expansion du campus et le développement technologique. Sur les 10 millions de dollars amassés, 5 millions de dollars ont été attribués sous forme de contribution à des projets spécifiques, ou encore, de dons d'équipements et de logiciels, tandis que les 5 autres millions de dollars ont été remis en argent. Sur cette seconde portion, un don exceptionnel de 1 million de dollars a été fait par M. Michel Laurence, professeur à l'ÉTS. « J'ai fait ce don au Fonds de développement en reconnaissance de l'appui que j'ai moi-même reçu de l'École dans le passé. Par ce don, je souhaite dire merci à la communauté universitaire d'avoir permis mon implication dans le milieu industriel » a déclaré M. Laurence.

Mis à part M. Laurence, 72 % des professeurs et des employés ont contribué à la campagne, pour une somme totalisant 275 000 $. Il s'agit là du plus haut taux de participation jamais observé au Canada dans une enceinte universitaire. De leur côté, les étudiants ont versé 350 000 $ dans le cadre de la campagne, ce qui est une somme appréciable compte tenu des moyens limités de cette catégorie de donateurs. « L'Association des étudiants et fière de l'apport de ses membres et elle constate qu'il y a eu un « retour d'ascenseur » a affirmé M. Patrick Charpentier, président de l'Association des étudiants de l'ÉTS.

Outre les dons faits par des membres de la communauté universitaire, les dons de plus de 250 000 dollars provenaient des entreprises suivantes : Molson Canada, Région Québec Atlantique; Bell Canada; Fondation J. Armand Bombardier; Sun Microsystems of Canada Inc.; Primavera Systems Inc.; et TransÉnergie Technologies.

En plus d'avoir permis la réalisation de nombreux projets importants pour l'ÉTS, la campagne de financement a aussi permis la création d'un fonds de dotation de 2,5 millions de dollars. Ainsi, à l'image de bien d'autres institutions universitaires, les revenus de ce placement - que l'ÉTS entend bien bonifier à l'occasion d'une prochaine campagne de financement majeure - , serviront à la réalisation des projets des communautés universitaires futures.

Ainsi, cette soirée de clôture a marqué une étape importante dans l'histoire de l'ÉTS qui, par son dynamisme, son savoir-faire et surtout son approche pratique, joue un rôle fondamental au Québec au chapitre de l'avancement des connaissances et du développement industriel et technique. Comme l'a bien résumé dans son allocution M. Robert L. Papineau, directeur général de l'ÉTS : « La retombée majeure de cette campagne réside dans une extraordinaire synergie où chaque partenaire a le privilège d'appuyer le développement d'une part de ses activités sur le savoir-faire ou sur les ressources de l'autre ». Et il a conclu en ajoutant : « Nous ferons tout en notre pouvoir pour perpétuer un tel état de faits ».

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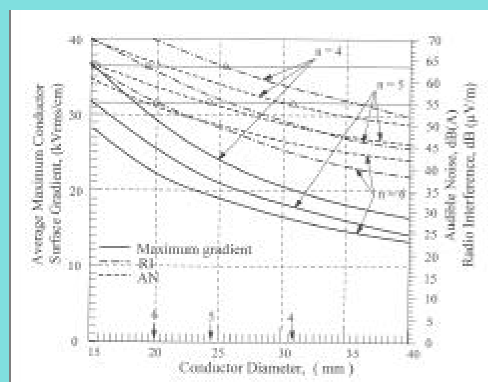
Book Review

Corona Performance of High Voltage Transmission Lines

by P. Sarma Maruvada,
Published by: Research Studies Press Ltd, Baldock, Hertfordshire, England,
310 pages, ISDN 0-86380-254-0, 2000

Book reviewed by Farouk A. M. Rizk
Expodev Inc., Montréal, QC

The book comprises four parts dealing respectively with Basic Concepts, AC Transmission Lines, DC Transmission Lines and Testing and Design Considerations.



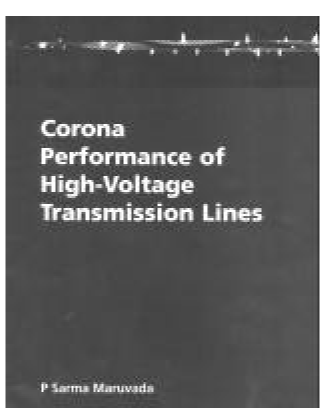
Part I of the book starts with a brief review of AC and DC transmission lines configurations as well as basic field theory and circuit theory models. Corona performance is introduced mainly in terms of corona losses (CL), radio interference (RI) and audible noise (AN). Weather conditions relevant to corona phenomena are reproduced from an IEEE Standard and statistical description of corona effects is introduced.

A chapter is devoted to a review of the different techniques for calculation of conductor surface gradients. These include analytical methods, which result in rigorous solutions for simple configurations and acceptable approximations for bundle conductors. Accurate methods of general application described include the methods of successive images and the method of moments. The limitations of the methods of charge simulation, finite difference and finite element methods for field calculation of multi-conductor systems are mentioned.

Chapter 3 deals with basic ionization processes as well as modes of DC corona discharges of both polarities in non uniform fields. Here the author draws from earlier work by N.G. Trinh. AC corona modes are also introduced. The Shockley-Ramo theorem is introduced and applied to account for induced current on conductors in a coaxial cylinder configuration. The notion of corona onset gradient is defined and reference is made to the pioneering work by Peek and Whitehead. Microgap discharges are briefly introduced as the main source of electromagnetic interference generated by distribution lines.

Part 2 of the book deals with AC transmission lines. Chapter 4 starts with the physics of corona losses (CL) and ozone formation. General three-dimensional formulation of the AC corona loss problem is introduced with the recognition that analytical solution cannot be obtained even for simple configurations. Corona loss generation function is formulated. Finally, empirical methods for corona loss prediction are described from earlier investigations by Gary and his associates at EdF, Nigol at Ontario Hydro, Chartier at BPA and the author's own work, with N.G Trinh, at IREQ.

Chapter 5 includes an extensive account of radio interference (RI) due to transmission line corona. It starts with fundamental notions of frequency domain analysis of corona current pulses and corona pulse power spectral density. The notion of RI excitation function is introduced. Pulse propagation on a single conductor line is formulated, then extended to a multi conductor system through modal analysis. Empirical RI formulae by CIGRE, based on CISPR radio noise meter, and BPA based on the old ANSI specifications are quoted. Semi-empirical methods which combine experimentally determined RI excitation function with analytical methods of propagation describe work undertaken by EdF, IREQ, EPRI, CIGRE and BPA.



Chapter 6 starts with Audible Noise (AN) propagation analysis and proceeds to account for AN frequency spectrum of transmission lines and introduces formulae for AN prediction based principally on Chartier's work at BPA.

Part 3 of the book deals with DC transmission lines. Chapter 7 is devoted to space charge fields and corona losses. The concentric cylinder configuration has already been successfully solved analytically by Townsend. Analysis of the unipolar corona case draws from the works of Deutch and Popkov but more extensively from the author's doctoral thesis work at the University of Toronto, with due attention to the underlying assumptions. This work was also earlier extended to deal with the bipolar line configuration. Recent attempts to improve the mathematical formulation principally by discarding Deutch's first assumption, namely that space charge affects only the magnitude but not the direction of the electric field, were briefly introduced. Finally different empirical formulae for bipolar corona losses were reviewed.

Chapter 8 deals with radio interference and audible noise from DC lines, where the positive conductor is considered as the principal source of RI and AN, while both poles have to be accounted for in evaluation of corona losses. While the space charge configuration is more complex than with AC lines, propagation analysis is simpler due to the existence of only two conductors. Empirical formulae for RI and AN evaluation draw mainly from the work of BPA and IREQ.

Part 4 of the book deals with Testing and Design Considerations. Chapter 9 starts with a description of test cages and experimental lines used for corona investigation and the author's own work at IREQ figures prominently. Of special interest is the interpretation of RI and AN measurements on short lines. Instrumentation for CL, RI, AN are described, followed by a section devoted to electric field and space charge density measurement.

The final chapter 10, deals with general design criteria for RI and AN for AC and DC lines and gives two examples for conductor bundle selection of 500 kV and 750 kV lines.

Almost 25 years have passed since issue of the book by Gary and Moreau devoted to AC corona. The present book covers up-to-date material on both AC and DC corona performance of transmission lines. The presentation is thorough and systematic and strikes a balance between theory and practice.

I enjoyed reading the book and recommend it to design engineers, graduate students and research workers in this field.

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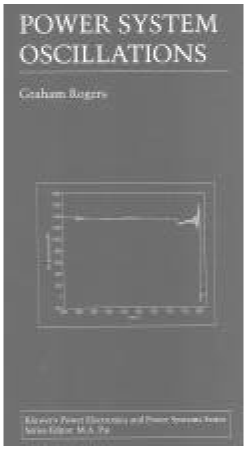
The CR Editor acknowledges the support of Mr. Guy Robinson, Publishing Editor, Research Studies Press Ltd., UK. for this Book Review.

Power System Oscillations



by Graham Rogers

Cherry Tree Scientific Software
Kluwer Academic Publishers, Boston
in 2000
328 pages.
ISDN 0-7923-7712-5

Book reviewed by Vijay K. Sood
Hydro-Québec, Varennes, QC

This book deals with the analysis and control of low frequency oscillations in interconnected power systems. Oscillations in the frequency range 0f 0.2 - 3 Hz can be excited in a power system by normal small load variations and must be damped out to maintain stable system operation. Since no warning is given for these small growing oscillations, it is usually difficult for system operators to intervene manually to restore system stability. Hence it is important to analyse a system's behavior to augment limits to stable system operation.

This type of phenomena was first observed in the 1960's in North American power systems. The well-documented recent collapse in the western USA/Canada power system in August 1996 highlighted the danger from such oscillations (as illustrated on the book cover).

Twenty years ago the mathematical tools were not sufficiently developed to design successful damping controllers. Today, the analysis tools are powerful enough and one such tool (Matlab) is used by the author to provide models and examples which assist in understanding the phenomena. The author provides a set of routines on a CD-ROM, called a Power System Toolbox, to assist readers comprehend the system oscillations and develop controls for damping. (It is, however, important to point out that The MathWorks Inc.-- the company that produces and sells the Matlab program -- also has a Power System **Blockset** Toolbox which is quite **unrelated** with this present topic and Power System **Toolbox**).

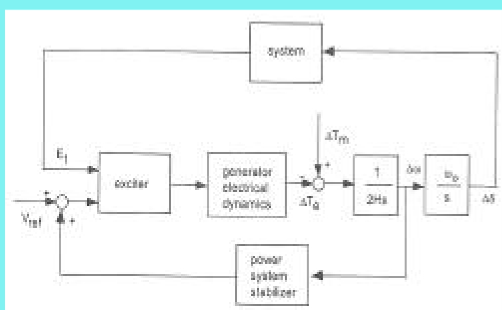


Figure 1: Block diagram showing stabilizer action.

The book is divided into ten chapters, has two appendices and is 328 pages long.

Right at the outset in the introduction, the author states that the reason for the book is to discuss:

- the nature of power system oscillations,
- the mathematical analysis techniques necessary to predict system behavior, and
- control methods to ensure that oscillations decay with time.

In chapter 2, the nature of power system oscillations is discussed and explanations of local and inter-area modes of oscillations are provided. The impact of the use of either a classical or detailed generator model on these oscillations is demonstrated with the help of simulations.

Chapter 3 deals with the modal analysis of power systems whilst chapter 4 deals with the modal analysis for controls. These two chapters provide fundamental and theoretical background to the rest of the book.

In chapter 5, the power system structure and oscillations for a 16 generator, 68 bus system are examined and insightfully explained. The figures 5, 6 and 7 showing the angle eigenvectors could have been better labeled. Also, Figure 8 appears faded since this figure must have been originally in color.

Chapter 6 on Generator Controls deals with the speed governor and automatic voltage control. There are sub-sections dealing with hydraulic and steam turbines, In terms of excitation systems, there are sub-sections dealing with dc exciters and static exciters.

Chapter 7 deals with Power System Stabilizers which have been used for many years and are more cost effective in damping oscillations than FACTs devices. The chapter covers the basics, and then provides an example of the stabilization of a complete system using the 16 generator example. A separate chapter 8 is utilized for a description on the problems and solutions possible with Power System Stabilizers.

In Chapter 9, a discussion on Robust Control is presented. With the importance given to modern control techniques, this chapter is a useful and necessary addition to the book.

The damping of oscillations by means of electronic power system (FACTS) devices is a subject of much current research and discussion. In Chapter 10, the author presents damping by the more common FACTS controllers such as SVC, HVDC and TCSC. Generic block diagrams of these controllers are presented and their performance is analysed with the aid of residue based controls.

The book contains two appendices:

A1: This provides the Model Data Formats and Block Diagrams of the various controllers.

A2: This provides some details about handling Equal Eigenvalues with Matlab routines.

A third appendix on Root Locus analysis techniques may very well have been usefully added since the book relies heavily on analysis with this method.

As is quite inevitable in a book of this nature, it contains numerous typographical errors, but these may be overlooked. The text formatting is simple and could have been better with the use of modern desktop publishing systems. Never-the-less, the book is abundantly illustrated with Matlab generated figures which are generally informative. The root locus plots are frequently employed and whilst useful, they would have benefited from some additional explanatory remarks in some places. These features may be corrected in a second edition of the book.

I found the author's use of the comments and discussion at the end of each chapter particularly beneficial. The book is easy to read. I enjoyed reading the book and found it to be practical and informative. It will be recommended reading for post-graduate students, and a useful reference for researchers and practising power systems engineers. The book does reflect the 40 years of experience called in by the author.

****

The CR Editor acknowledges the support of Mr. Alex Greene (email: Alex.Greene@wkap.com), Kluwer Academic Publishers for his support of this Book Review.

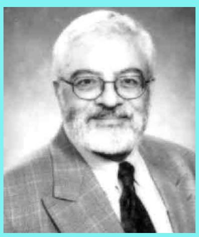
The **Engineering Institute of Canada** (EIC) announces its year 2001 Honours, Awards and Fellowships. Seven senior awards and twenty Fellowships were recognized during National Engineering Week, at the Institute’s Annual Awards Banquet held at the National Arts Centre in Ottawa, on 2 March 2001. Here we present the IEEE Canada members who were honoured this year:

L'institut canadien des ingénieurs (ICI) annonce la nomination de ses récipiendaires Fellow et médaillés honorés pour l'année 2001. Dans le cadre de la semaine nationale de l'Ingénierie et au cours d'un banquet annuel de reconnaissances de l'Institut qui a eu lieu au Centre National des Arts à Ottawa, le 2 mars 2001, sept médaillés senior and vingt Fellow ont été reçus. Nous présentons ci-dessous les membres canadiens de l'IEEE qui ont été honorés cette année:

LA MÉDAILLE JULIAN C. SMITH MEDAL

Founded in 1939 by a group of senior members to perpetuate the name of a Past President of the Institute, the Julian C. Smith Medal is awarded for “Achievement in the Development of Canada”.

Établie en 1939 par un groupe de membres seniors pour commémorer le nom d'un ancien président de l'Institut, la médaille Julian C. Smith est décernée pour des réalisations importantes dans le développement du Canada.



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EIC FELLOWS

The Engineering Institute of Canada elects annually a select number of engineers to the grade of Fellow for their exceptional contributions to engineering in Canada.

L'Institut canadien des ingénieurs procède chaque année à l'élection d'un certain nombre de «Fellows». Il s'agit d'ingénieurs qui se sont signalés par leur contribution exceptionnelle à la profession au Canada.

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Electrical & Computer Eng.
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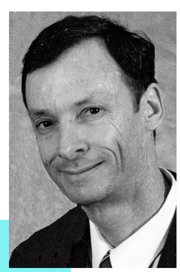

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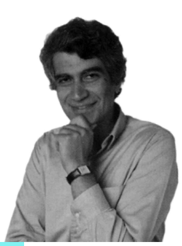

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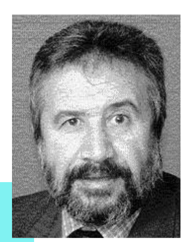

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CCGEI / CCECE 2001

Technologie pour le millénaire
Congrès canadien en génie électrique et informatique
Du 13 au 16 mai 2001 L'Hôtel Delta Chelsea
Toronto, Ontario, Canada

Un programme technique de très haute qualité comprenant des ateliers de développement professionnel pour améliorer votre carrière, des séminaires scientifiques et des sessions de découvertes techniques sont quelqu'uns des avantages de la conférence canadienne sur le génie électrique et informatique. Cet événement aura lieu dans une des villes les plus culturellement diversifiées dans le monde, c'est-à-dire Toronto, au Canada du 13 mai au 16 mai 2001. Le comité organisateur de la conférence et le président, docteur Haran Karmaker de la compagnie General Electric Canada, accueilleront les participants venant de partout à travers le monde à l'hôtel Delta Chelsea, dans le centre-ville de Toronto lors du CCECE 2001. Cette conférence est organisée par le conseil du centre canadien (CCC) de l'IEEE et est commanditée par IEEE Canada et par les sections du CCC.

1.0 Programme Technique

Le thème de la conférence est “Des Technologies pour le nouveau Millénaire”. Le comité du programme technique, co-présidé par le professeur Bob Dony de l'Université de Guelph et le professeur Kostas Plataniotis de l'Université de Toronto, a révisé un nombre record d'articles provenant de toutes les régions du Canada et du monde entier. A partir de ces articles, ils ont assemblé un programme technique exceptionnel représentant les derniers développements dans les technologies du génie électrique et informatique. Il y aura des présentations orales et des posters. Les sessions invités du matin présenteront un résumé de l'état courant de la technologie et une vision pour chacun de ces champs d'activité se développant très rapidement.

Les détails du programme technique et des sessions de formation seront affichés sur le site web de la conférence à: http://www.ieee.ca/~ccece01/

2.0 Ateliers et Séminaires

Plusieurs sessions de séminaires et d'ateliers de développement professionnel sont prevues pour le dimanche après-midi. Les ateliers sur les aptitudes de développement du leadership et de la gestion de projet ont été organisés en concert avec la réunion de la région 7 de IEEE (Canada). Puisque le nombre de places dans les ateliers et les séminaires est limité, les participants intéressés sont priés d'aviser le secrétariat de la conférence le plus tôt possible.

3.0 Prix de l'Article d'un Étudiant

Un lunch de remise de prix pour les étudiants honorera les meilleurs articles d'étudiants de la conférence et sera une excellente opportunité pour rencontrer d'autres participants. Ce dîner est en partie commandité par un de nos commanditaires industriels et inclut un discours d'une grande qualité.

4.0 Exposants

Les participants à la conférence auront l'opportunité de visiter le hall d'exposition où des kiosques des différents commanditaires de la conférence seront disposés. Une grande variété de kiosques est planifiée pour couvrir les intérêts techniques et professionnels des participants. Un certain nombre d'emplacements pour de nouveaux exposants est encore disponible. Veuillez contacter le secrétariat de la conférence par email à: c.lowell@ieee.org ou par téléphone au (905) 628-9554

5.0 Réceptions et Banquets

CCECE 2001 accueillera tous les participants à une réception le dimanche soir, 13 mai. Tous les participants y sont invités. Cette réception sera une occasion de rencontrer les autres participants du monde entier ainsi que leurs époux.

6.0 Transport et Hébergement

Pour de l'information sur le transport et sur l'hébergement, veuillez consulter les liens sur le site web de la conférence. Toronto est une des villes les plus vibrantes dans le monde. Il y a plusieurs attractions touristiques d'intérêt pour les participants et leurs accompagnateurs incluant les Chutes Niagara de renommée mondiale, qui sont à une courte distance de Toronto.

7.0 Enregistrement et Information

Pour de l'information additionnelle sur la conférence et pour obtenir un rabais d'enregistrement hâtif, veuillez consulter le site web de la conférence à: http://www.ieee.ca/~ccece01/.

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CCECE 2001

Technology for the Millennium
Canadian Conference on Electrical and Computer Engineering
May 13-16, 2001 Delta Chelsea Hotel
Downtown Toronto, Ontario, Canada

A high-quality technical program, career-enhancing professional development workshops, tutorial sessions and technical plenary sessions are only a few of the highlights of the Canadian Conference on Electrical and Computer Engineering. This event will be held in one of the most culturally diverse cities of the world - Toronto, Canada - on May 13 - 16, 2001. The Conference organizing committee and the Chair Dr. Haran Karmaker of General Electric, Canada will welcome participants from around the world to the Delta Chelsea Hotel, downtown Toronto, the venue of CCECE 2001. This conference is being organized by the IEEE Central Canada Council (CCC) and is sponsored by both IEEE Canada and the CCC constituent sections.

1.0 Technical Program

The conference theme is “Technology for the Millennium”. The technical program committee, co-chaired by Prof. Bob Dony of the University of Guelph and Prof. Kostas Plataniotis of the University of Toronto, has reviewed a record number of papers from across Canada and around the world. From these, they have assembled an exceptional technical program representing the latest developments in electrical and computer engineering technologies. Both oral and poster paper sessions are planned. The morning plenary sessions will provide an overview of the current state of the technology and visions for future developments in these fast-paced fields.

Details of the technical program and the plenary sessions will be posted on the conference web site:

http://www.ieee.ca/~ccece01/

2.0 Tutorials and Workshops

Several tutorial sessions and professional development workshops are planned for Sunday afternoon. Workshops on leadership training skills and project management are being organized in concert with the IEEE Canada Region 7 meeting. Since the number of seats in the tutorials and workshops is limited, interested participants are advised to notify the conference secretariat as soon as possible.

3.0 Student Paper Awards

A special student awards luncheon will honor the best student papers of the conference and provide an excellent networking opportunity. The luncheon is partially sponsored by one of our industrial sponsors and includes a keynote speech.

4.0 Exhibitors

The conference attendees will have the opportunity to visit the Exhibition Hall where exhibits from the conference sponsors will be displayed. A wide range of exhibits is planned to cover the technical and professional interests of the attendees. Space for new exhibitors may still be available. Please contact the conference secretariat at e-mail address c.lowell@ieee.org, tel. (905) 628-9554.

5.0 Receptions and Banquets

CCECE 2001 will welcome all attendees at a reception on Sunday evening, May 13th. All participants are invited to attend. This reception will provide an opportunity for everyone to network with peers and their spouses from all over the world.

6.0 Travel and Accommodations

For information on travel and accommodations, please follow the links on the conference web site. Toronto is one of the most vibrant cities of the world. There are numerous attractions for the entertainment of the attendees and their companions including the world famous Niagara Falls, a short relaxing day trip from Toronto.

7.0 Registration and Information

For additional information on the conference and advance discount registration, please consult the conference web site: http://www.ieee.ca/~ccece01/.