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The ***IEEE Canadian Review*** is published 3 times/year as follows: Winter (to appear in April); Spring/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
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Quelques mots du rédacteur en chef

Vijay K. Sood, Hydro-Québec

Je désire vous faire part de trois points.

Le premier a trait au Congrès canadien en génie électrique et informatique, CCGEI2002, qui a eu lieu a Winnipeg, Manitoba, en mai 2002. Le congrès a été un succès retentissant, d'ailleurs ce numéro contient amplement de commentaires et de photos sur le congrès aux pages 27-30. Il y a eu des prix IEEE Canada qui ont été remis à des membres et à des bénévoles. La revue **IEEE Canadian Review** (CR) a recu le prix du **bureau régional IEEE** (page 28). Ce prix est personnellement gratifiant. Toutefois, c'est un honneur qui est partagé par tout le personnel de la rédaction (voir en page 2) du CR. **Terry Malkinson** (voir photo) était présent à la cérémonie et j'étais heureux de constater qu'il a su en profiter. Je félicite le reste de l'équipe **Brunilde Sanso**, **Chela Vaidyanathan**, **Slawo Wesolkowski**, **Mme. Vinay Sood** et **Alexandre Abecassis**. Je voudrais remercier les gens qui ont considéré notre candidature pour le prix (Brian Lee, Roger Nelson et Om Malik) et IEEE pour cet honneur.

Le second point concerne les changements survenus au sein de l'équipe de rédaction du CR. Brunilde Sanso nous quittera et je tiens à lui offrir mes meilleurs vœux; elle va nous manquer. Je vous annonce deux nouveaux membres du comité de rédaction: **Shaowen Song** comme adjoint à la rédaction et **Camille Alain Rabbath** comme assistant à la rédaction; leurs notes biographiques se trouvent en page 11. N'hésitez pas à les contacter pour toute aide ou information.

Le troisième point a trait aux plans d'avenir pour le CR. Nous travaillons présentement sur la version en ligne de la revue canadienne de l'IEEE. Toutefois, la progression est lente. **Bob Alden** s'est joint à nous comme consultant et j'espère que cela accélérera le développement.

Enfin, j'aimerais avoir vos commentaires sur nos progrès. Quels sont vos intérêts, vos soucis et comment pouvons-nous vous aider? Donc, aidez-nous à vous aider et n'hésitez surtout pas à m'envoyer un courriel. Écrivez-moi une bonne blague si ça vous dit.

Ah oui, n'oubliez pas de passer un bel été!

Cover picture / *Photo de couverture*

The cover picture shows the historique Fort Garry Hotel in Winnipeg, MB site of this year's Canadian Conference on Electrical and Computer Engineering 2002 and the Region 7 Spring Meeting. Some of the events that took place at these meetings are presented on pages 27-30 of this issue. The inset photo depicts the lavish interior of the refurbished hotel.

Next year, the 15th Canadian Conference on Electrical and Computer Engineering 2003 and the Region 7 Spring Meeting will be taking place in Montreal, QC. The Call for Papers for this meeting are presented on pages 31 and 32 of this issue. We look forward to meeting you there next year.

A few words from the Managing Editor

There are three items that I wish to inform you about.

The first item concerns the Canadian Conference on Electrical & Computer Engineering, CCECE'2002, which took place in May 2002 at Winnipeg, MB. This was a resounding success (Congratulations all!), and this issue has commentary and pictures galore on pages 27-30. There were IEEE Canada awards handed out to members. The **IEEE Canadian Review** (CR) was fortunate to pick up an **IEEE Regional Board Award** (see page 28). This is personally very gratifying. However, it is an award shared amongst the editorial staff (see page 2) of the CR. **Terry Malkinson** (photo inset) was present at the ceremony and I was happy to see that he could enjoy the occasion. I congratulate the rest of the team **Brunilde Sanso**, **Chela Vaidyanathan**, **Slawo Wesolkowski, Mrs.Vinay Sood** and **Alexandre Abecassis.** I take this opportunity to thank the nominators (Brian Lee, Roger Nelson and Om Malik) and IEEE for this honor.

The second item concerns editorial staff changes at the CR. Brunilde Sanso will be taking leave and I offer my best wishes to her; she will be missed. I am announcing two new additions to the staff: **Shaowen Song** as Associate Editor and **Camille-Alain Rabbath** as Assistant Editor; their short biographical notes are presented on page 11. Please contact them for any assistance.

The third item concerns future plans for the CR. We are working on the online version. However, the progress is slow. **Bob Alden** has joined us as Consultant and I hope that this will finally get the ball rolling on this.

Finally, I need to hear from you about our progress. What are your interests, concerns and how can we assist you? So do help us help you and email me sometime. Send me a joke, if nothing else.

Also, do not forget to have a great summer!

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Newslog Editor

Rédactrice des Coupures de presse

Alexandre Abecassis is a patent agent trainee in Montreal at Ogilvy Renault, Lawyers and Patent and Trade-mark Agents.

Alexandre Abecassis travaille à Montréal chez Ogilvy Renault, Avocats et 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

MONTRÉAL, QC, Apr. 4, 2002. DSI Datotech Inc. has developed a human/computer interface which is based on a gesture recognition technology. The technology may be used either in CAD/CAM industry or in multimedia. The technology comprises the recognizing of hand and finger movements. It allows 3-axis navigation in 3 dimension.

TORONTO, ON, Apr. 3, 2002. U.S. Army has signed a contract with CAE, which is valued at approximately CA50M$. Under this contract, CAE will provide an AH/MH-6 Light Assault/ Attack reconfigurable combat mission simulator to the Army Special Operations Forces Aviation Training and Rehearsal Systems. The simulator will be used by the U.S. Army 160th Special Operation Regiment.

ST-LAURENT, QC, Apr. 10, 2002. ART Advanced Research Technology and Siemens Dematic Electronics Assembly Systems Inc have signed an agreement to at least evaluate an integration of ART's ISIS(R) systems into Siemens solutions. ART's ISIS(R) systems provides an infrared verification system for inspecting electronics printed circuit board assembly.

MONTREAL, QC, le 16 Avr. 2002. Nomino Technologies s'associe à Telus solutions d'affaires pour un partenariat relatif à la revente et à l'intégration de ses produits. Nomino Technologies opère dans le traitement automatique du langage naturel et notamment en linguistique computationnelle évoluée.

BURLINGTON, ON, May 7, 2002. According to the new Ontario Electric Code, installation of Arc Fault Circuit Interrupter (AFCI) is now mandatory in all bedroom receptacle circuits. The AFCI will help prevent arc faults, which are the most common source of residential fires caused by electricity. Ontario is the first province of Canada to make ACFIs mandatory in all new home constructions.

LAVAL, QC, le 15 mai 2002. Le système Celsius de Datacom a permis de retrouver un chargement de camion qui avait été dérobé par des malfaiteurs. Le système permet de localiser géographiquement par satellite une remorque ainsi que la température de la cargaison de ladite remorque.

OTTAWA, ON, May 27, 2002. Cognos has announced a settlement in a pending patent litigation by Business Objects. The settlement agreement dismisses a lawsuit filed by Business Objects alleging an infringement of US Patent No 5,555,403. To obtain this settlement, Cognos agreed to pay 24M$. The two parties have also agreed on a five-year moratorium on patent litigation between said two parties.

LONGUEUIL, QC, Jun. 3, 2002. D-Box Technologies Inc has presented his revolutionary Odyssee (R) Motion Simulator at the 55th International Film Festival of Cannes (France). More than 2000 professionals from the film industry attended the presentation. D-Box's latest technologies transform home theater systems into virtual reality experiences.

LAVAL, QC, Jun. 10, 2002. Electromed Inc. announced that Hospital Clinic of Barcelona, Spain, has selected Electromed France to install a network connecting all its cardiac cathlabs. The contract will cover various aspects of the hospital's cardiac imaging needs. Electromed Inc. develops digital cardiac imaging solutions.

OTTAWA, ON, Apr. 29, 2002. A partnership has been signed between CANARIE Inc (Canadian Network for the Advancement of Research, Industry and Education), GT Group Telecom and Shaw Telecommunications Inc for the providing of a high speed, private Internet network. The private Internet network will link all research institutions coast-to-coast and should be operational by July 2002. The network will enable CANARIE to take advantage of higher bandwidth applications.

MISSISSAUGA, ON, Le 13 mai 2002. Microsoft Canada va ouvrir un nouveau siège social de 73M$ à Mississauga. De plus, un centre de support technique va être crée entraînant 50 ouvertures de poste. Ce centre permettra notamment de fournir un support technique pour les usagers de l'éditeur de logiciel.

MISSISSAUGA, ON, March 28, 2002. Cybersecure Inc is the first Canadian company to be rated "Gold Certified Partner". Only 10 security solutions providing companies in the world have reached such a recognition level. This recognition was created by Microsoft for companies providing security solutions under the Microsoft platform.

MARKHAM, ON, June 17, 2002. Toshiba has introduced a new Pocket PC comprising an integrated IEEE802.11b Wireless Local Area Network (WLAN) interface as well as Intel PXA250 processor which runs at 400MHz. The handled weights 185g and is therefore one of the lightest Pocket PC available on the market.

A critical survey of protocols proposed by the IETF as enablers for customer interaction in an electronic customer relationship management system - Part II - Protocol Suite

by *S.C. Sivakumar*
Computing and Information Systems Group,
Saint Mary's University, Halifax, NS

Abstract

A modern enterprise needs to interact with customers anytime, anyhow and anywhere to be successful in the global marketplace. This level of customer interaction has become possible due to the advancements in network infrastructure and the simultaneous development of voice and multimedia protocols for seamless transport of information. Instant and unified messaging extends this capability to enable customer touch point integration. Part I of this paper provided a critical analysis of the metrics for customer interaction in an electronic customer relationship management (eCRM) system from customer, business and technology viewpoints. Based on this analysis, this paper will review the features and the services offered by some of the protocols as proposed by the Internet Engineering Task Force (IETF) with respect to their effectiveness in enabling effective customer interaction, and derive an IETF based protocol suite that may be used in an eCRM system.

Sommaire

Une entreprise moderne a besoin d'échanger avec ses clients peu importe le moment, la façon et l'endroit si elle veut obtenir du succès dans le marché économique mondial. Ce niveau d'interaction avec le client est devenu possible grâce au progrès réalisé dans l'architecture des réseaux et grâce au développement simultané de protocoles vocal et multimédia. Ces protocoles permettent un transport d'information sans faille. La messagerie instantanée et unifiée accroît l'interaction avec le client et permet l'intégration par points de contact. La première partie de cet article a proposé une analyse des métriques de l'interaction des consommateurs dans un système de gestion électronique des relations avec les consommateurs, dénoté eCRM, des points de vue des consommateurs, de l'entreprise et de la technologie. En se basant sur cette analyse, le présent article révisera les caractéristiques et les services offerts par certains des protocoles proposés par l'IETF relativement à leur efficacité à interagir avec les consommateurs. De plus, l'article présentera une suite de protocoles qui est basée sur l'IETF et qui peut être utilisée dans un système de gestion eCRM.

1.0 Introduction

Today most e-businesses implement eCRM by using human-computer interaction and thereby reduce the need for human intermediaries. CRM entails four phases, 1) customer interaction, 2) data analysis and mining, 3) knowledge discovery, and 4) market planning [1]. Electronic customer interaction involves encouraging the customer to spend time electronically in order to obtain sufficient information regarding the customers needs, preferences and requirements. This information is analyzed using a process such as data mining to extract knowledge about customer values. Customer values are, in turn, used as the guiding principle in the market-planning phase to customize and personalize the services/goods/sales offered by the enterprise. An integrated approach to eCRM is important because it can be effectively used to analyze information for continuous, online and real-time learning of customer values. The three stakeholders typically identified in an eCRM framework are the customer, the business enterprise and the provider of technology [1]. Part I – eCRM metrics of this paper, analysed the requirements of an effective eCRM customer interaction system and proposed a set of metrics from the perspective of the three stakeholders [2]. It is shown that the eCRM customer interaction metrics can be categorized as mutually exhaustive, mutually exclusive and non-overlapping. Good eCRM system design should aim at maximizing the mutually exhaustive requirements, minimizing the effects of mutually exclusive requirements and optimizing the overlapping requirement within cost objectives to enable effective electronic customer interaction.

Section 2 of this paper outlines the core objectives of an effective eCRM customer interaction system. Also, this section critically evaluates the various protocols as proposed by the IETF that may support one or more of these core objectives. Section 3 outlines an IETF based protocol suite that may be used for enabling real-time multi-media communication and non-real-time unified messaging in an eCRM system. It is shown that this protocol suite meets most of the core objectives of an effective customer interaction eCRM system.

2.0 Suitability of protocols proposed by IETF in meeting eCRM objectives

We will now evaluate the various protocols as proposed by the IETF that may support one or more of the following core objectives of an effective eCRM customer interaction system viz.,

1. Accessibility- a protocol that initiates and maintains multi-media sessions over IP and public switched television network (PSTN)
2. Responsiveness – protocol support for specifying quality of service (QoS), delay and latency, and bandwidth parameters of the communication channel,
3. Scalability – i.e., support for multiple simultaneous users,
4. Security and privacy – protocol provision for authentication, authorization and encryption of message,
5. Integrate Internet based services with legacy PSTN services,
6. Support in the protocol for seamless adoption from wireline to wireless media,
7. Integrate video, voice, fax, e-mail and instant messaging systems into one unified eCRM messaging system,
8. Support automatic call routing,
9. Support number portability, and
10. Service extensibility through modular construction of protocol. Support for interoperability of the various protocols that enable customer interaction in an eCRM system.

It should be noted that objectives 5-9 inclusive, will help implement customer touch point integration i.e., the customer is able to communicate with the enterprise through any communication channel, any device and any service.

The sections below discuss IETF proposed protocols that can be used for real-time multi-media communication session initiation, real-time instant messaging, unified internet mail messaging and, service and service provider portability.

2.1 Session Initiation Protocol

Session initiation protocol (SIP) is a user-to-user protocol developed by IETF [3] that uses text-based signalling for initiating, modifying, maintaining and terminating interactive communication sessions such as internet telephone calls, and multimedia conferences between one or more users. It is used to establish and maintain session level information such as bandwidth and media type (whether the message is a voice, video, fax, instant message or a combination of two or more of the above. SIP can be used to specify media characteristics, QoS parameters, security considerations, and to protect the identity and privacy of the caller. Specifying media characteristics such as bandwidth and acceptable latency is important in ensuring (near) real-time interaction with the customer. QoS parameters such as low packet delay and low packet loss help an enterprise reserve network resources before establishing a session. QoS parameters also determine the quality of the multimedia communication. The authentication feature of SIP provides a mechanism for access control, so that a SIP client may reject unauthorized or undesirable call attempts. Such security features are essential to prevent threats such as stalking, spamming and spoofing. SIP provides support for end-to-end encryption of the message, thus protecting the contents of the call from snoopers and stalkers to protect customer privacy. Further, SIP enhances the caller's privacy by giving the caller the right to not disclose the caller's identity, name or IP address, if so desired. SIP enables user devices to exchange information that enables customized services e.g., user location which finds the callee; user availability which indicates when a callee may become free to accept a call; call handling including call transfer, call forwarding and call termination; call management which screens incoming and outgoing calls; and call hold. Advanced services supported by SIP include support for 3-way conferences where the callee may invite a third-party into the call; single-line extension in which a call will ring several extensions in sequence; and customer specific call routing in which call forward and user location are used repeatedly to enable personal mobility systems. SIP services are integrated with legacy PSTN services by enabling the placement of calls between SIP devices, and PSTN devices by signalling call information and then routing the call through a SIP network gateway to the appropriate PSTN gateway and vice versa. Thus, it is seen that SIP meets the core eCRM objectives of enabling accessibility, responsiveness, secure communication, customer privacy, integrating Internet services with PSTN services, and automatic call routing for real time multi-media communications.

The authentication feature of SIP provides a mechanism for access control, so that a SIP client may reject unauthorized or undesirable call attempts.

2.2 Protocols for real time instant messaging

Typically, Instant Messaging (IM) consists of short text messages that are exchanged in real time over the Internet between the subscribers of an instant message service. IM gives customers, an easy way to communicate with the enterprise and is highly suitable for sending short text messages. Thus, IM is an important and scalable means of communication between retail customers and service personnel in e-business. If IM is extended to include real-time voice and video messages as well, then it can be used as a personal integrated communication touch point and can be used effectively by the enterprise to foster one-to-one customer-enterprise relationships. Currently, the developers of popular commercially available IM programs use proprietary protocols that may not be compatible with each other and therefore may not interoperate with one another. The business potential of instant messaging can be better realized, if IM applications use protocols that are compliant with [4, 5] as proposed by the IETF. In the instant message presence protocol (IMPP), as proposed by IETF, the user connects to a central presence service that verifies the user's identity and registers the user as being online. When another user registers and connects, the new user will know about the users already logged on because the presence service maintains information on who is online. When a user has a message to send, the sender delivers it to the instant message service, which then delivers the instant message to the recipient's inbox. An IM session compliant with RFC2778 and RFC2779 can be setup-using SIP. Since, IM allows a subscriber to track when another subscriber logs on and logs off (the presence information of other subscribers), security considerations are a very important issue. RFC2778 and RFC2779 specify that presence information be distributed only to authenticated subscribers who are authorized to view it. This prevents stalking. IM protocols developed under IETF guidelines use end-to-end encryption of the message to prevent unauthorized access, insertion, modification and deletion of messages. Spoofing, i.e., replaying a genuine message is prevented using date stamps. IETF based IM protocols are required to be accessible in low-bandwidth, high latency environments to enable both wired and wireless messaging.

2.3 Protocols for non-real-time unified messaging

An enterprise may wish to receive all messages (voice messages, fax, text) in one mailbox and access all this information from any device (PC, terminal, mobile, hand held) of its choice. Thus, the characteristics of a good unified messaging system are device mobility, service mobility and terminal mobility [6]. Device mobility refers to the ability to redirect messages across various devices such as fax, pagers, phone, computer, handheld devices. Service mobility refers to ability to access various types of services such as e-mail, voice mail, and PSTN services from any user end-point i.e., all user end-points see the same raft of services. Terminal mobility refers to the ability of a user/endpoint to physically move from one physical location to another while still having the ability to redirect messages across devices and being able to access the same set of services [7]. Typically, a unified messaging system works by, using any standards-based email client-application on which subscribers can receive text e-mail, fax and voice messages in non real time; then play, view, store, delete, forward or share the message with others using a standard desktop client. A unified messaging system automatically converts voice and fax messages to digital formats such as WAV for voice, and tag image file format (TIFF-F) files for faxes. These data files are then attached to emails and delivered over the Internet, or virtually any corporate LAN, to the user's email system.

The Voice Profile Internet Mail (VPIM) workgroup of the IETF [7] intends to make VPIM the voice component of a unified messaging protocol suite. The user records a voice message then enters the VPIM address where the message should be delivered. VPIM uses 32K adaptive differential pulse code modulation (ADPCM) to encode the voice. Similarly, an image or a fax may be encoded in the TIFF-F format. VPIM converts the message to a Multipurpose Internet Mail Extension (MIME) or a simple mail transfer protocol (SMTP) or extended simple mail transfer protocol (ESMTP) attachment depending on the implementation. Since, VPIM uses open Internet standards (MIME or SMTP), it offers interoperability with other voice mail systems. The VPIM system locates the voice mailbox address for the intended recipient, and delivers the message over the Internet. The message can be retrieved like traditional e-mail using a POP or IMAP server. VPIMv2, therefore, leverages existing infrastructure including the enterprise intranet and legacy voice mail systems. These features will greatly enhance the appeal of VPIMv2 protocol to enterprises that would like to keep in touch with their customer pool (many of whom have Internet e-mail capable computers). VPIM supports multi-part voice messages that may be composed of more than one audio part. Similarly, multi-part mixed messages may be composed of audio, image, multi-media or text. VPIM systems may be either transport-conformant or content-conformant. Transport-conformant VPIM systems merely store and forward voice messages to a repository, while content-conformant systems have additional functionality that enables such systems to generate and interpret VPIM messages. On receipt of a message, the receiving servers send delivery status notification messages that indicate delivery, non-delivery or delay in delivering the message to the recipient. These features make VPIM attractive to an enterprise, which may want to deliver the same customized audio and fax messages to groups of customers informing them of the latest development in goods and services offered by the enterprise. In particular, this feature may be exploited by the enterprise for promotional purposes in targeting a subset of the customer pool that share common characteristics and interests. Thus, VPIM enables customization in customer interaction, in addition to offering unified messaging. However, spoofing is a concern in VPIM systems as the protocol does not provide a means of authenticating the sender. Like an Internet mail system spamming is a problem with VPIM. VPIM provides rudimentary privacy protection mechanisms that prevent a sender's voice message from being forwarded to anyone other than the intended recipient, if so desired by the sender.

It is imperative to integrate fax with Internet mail for a comprehensive unified messaging system, as it is appealing to the enterprise in terms of cost savings and opportunities for enhanced customer touch point integration. While, PSTN fax communication is real-time and session based, the Internet Fax (IFAX) protocol (as proposed by the IETF) is Internet messaging based and is currently not in real time. Internet Fax can operate in any one of four modes: simple (SIFAX) [8], extended (EIFAX), full (full mode fax profile for internet messaging FFPIM) and terminal (TMIFAX). Each mode of IFAX offers different levels of capabilities with respect to interoperability with legacy PSTN based fax machines and other IFAX devices, capacity to exchange information regarding their capability, negotiate connection parameters, fax processing status and confirmation of delivery. Capability negotiation includes sending information such as paper size, colour, image coding, image file structure, so that fax messages generated by transmitting end do not exceed the recipient's capabilities. Unlike legacy PSTN based fax devices, IFAX devices do not provide means for authenticating the sender. Hence spoofing and spamming are real concerns that the enterprise may address by providing virtual private networks, encrypted tunnels or transport layer security mechanisms.

Thus, VPIM and IFAX support the core eCRM objective of integrating non real time video, voice, fax, and e-mail into one unified eCRM messaging system. Both VPIM and IFAX are scalable and can support multiple users simultaneously. Both protocols can also interoperate with legacy PSTN based voice mail and fax services

2.4 Protocols that support Number Portability

Number portability is a telecommunications network feature that refers to portability of dialled geographic numbers i.e., end users retain their dialled telephone numbers (E.164 number) irrespective of the subscribed services used, change in service provider and change in location. Accordingly, there are three different types of number portability viz., service portability, service provider portability and location portability [9]. Service provider portability is the ability of end users to retain, at the same location, existing dialled telephone numbers as they change from one service provider to another. Location portability is the ability of end users to retain the same dialled telephone number, even as they relocate from one geographic area to another. Service portability is the ability to retain the same dialled telephone number with the same service provider as the subscriber changes service, e.g., from PSTN to ISDN.

The IETF is addressing the issue of service and service provider portability with the formulation of RFC2916 [9]. The service portability functionality is desirable as an enterprise/user typically subscribes to several services (each with its own name space) and is identified by a user identity in each name space. It would be advantageous for the enterprise, if a unique ID i.e., a single E.164 number can identify it. The naming service then maps the users unique ID to one of several user identities depending on the service desired. This feature can be used to enable customer touch point integration. Here, there are two scenarios, (i) an enterprise may wish to access any of several services from any user terminal in the enterprise with a single identified E.164 number (ii) a single E.164 number for customers to access several services to which they may subscribe, with seamless linking of services. The customer knows which services to use (SIP, e-mail, PSTN, fax) in order to reach the enterprise and vice versa. However, there are two requirements for such a naming service, viz., it is globally distributed and scalable. This scheme maps an E.164 number into a domain name system (DNS) entry. The DNS is a globally distributed mapping service that has an Internet based hierarchical directory structure and is therefore scalable. Also, DNS supports fast connectionless queries. The domain "e164.arpa" has been created to facilitate storage of E.164 numbers. The E.164 number is converted into a dotted string notation, which is then appended with the string ".e164.arpa" to obtain the DNS entry. Typically, each DNS entry is associated with a resource record that points to the set of uniform resource indicators (URI) associated with that DNS entry. This feature is now used to contain the list of services including phone numbers that exist for the specific DNS entry. The order of the list specifies the preference order of the service/phone numbers that can be used to contact the enterprise. New service records can be added to and old records deleted. Changes in service or service provider are now transparent to the customer and to the enterprise. The contents of the service registrar may change over time as more services evolve and are subscribed to by the enterprise. However, malicious/wrong entries can cause an incorrect URI/service/phone number to be associated with a given E.164 number. Intended or unintended removal of the URI/service/phone number from the resource record will cause a denial of service, as the enterprise is now not reachable through its E.164 number. Apart from these security issues, one must also consider that the

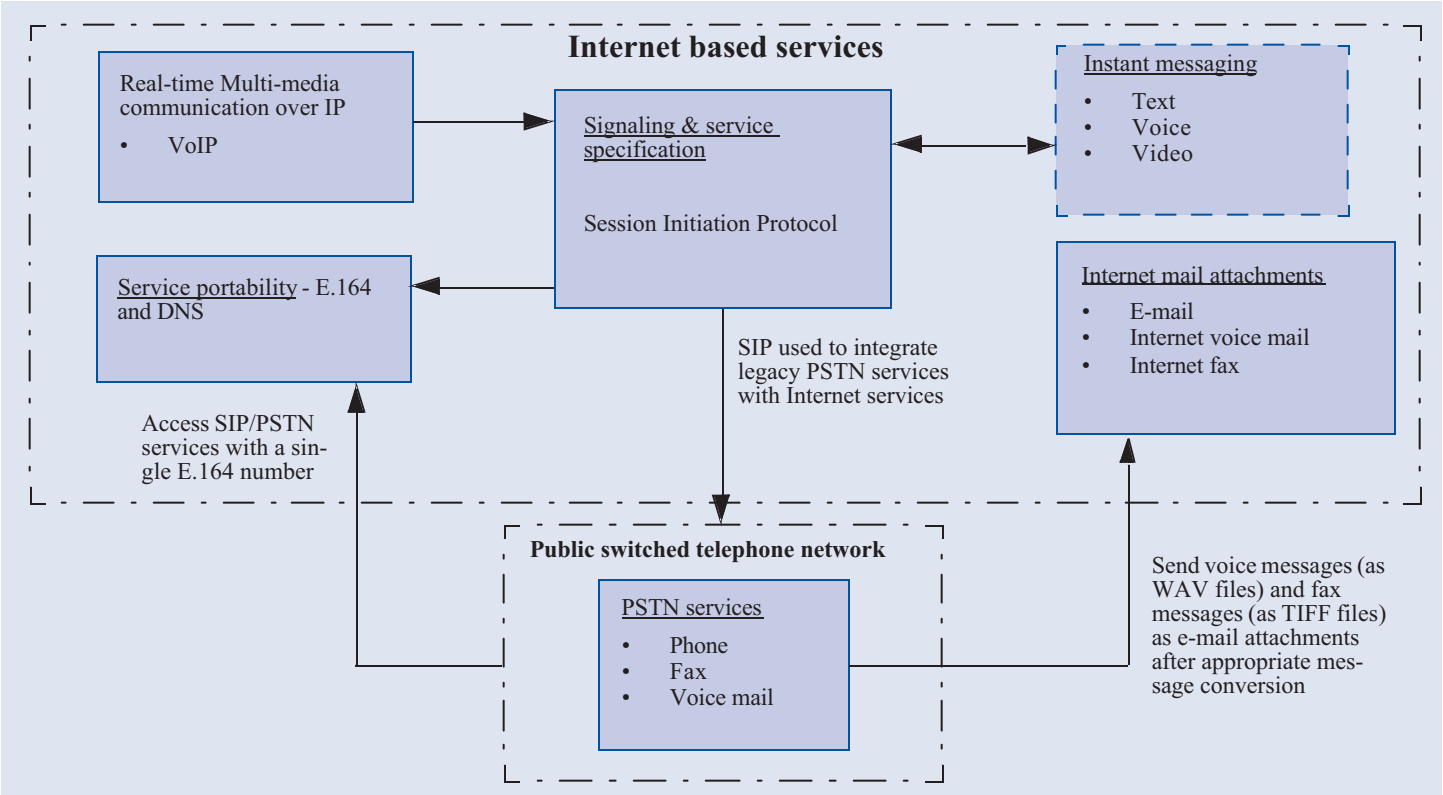

Figure 1: IETF based protocol suite for enabling real-time multi-media communication and non-real-time unified messaging in an eCRM system

DNS is a public infrastructure and the E.164 to DNS service might overload it.

3.0 Protocol suite to enable customer interaction in eCRM using IETF protocols

Figure 1, shows the various protocols discussed in this paper and how they can be used to enable customer touch point integration. It is seen that SIP can be used to set up real-time multi-media communication sessions and also set up real-time text based instant messaging. Legacy real-time PSTN services such as phone calls, and fax transmissions to legacy PSTN devices can also be accessed from corporate internets through a SIP network gateway which would then route the calls to the appropriate PSTN gateway and vice-versa. When several services are subscribed to by the enterprise, then the enterprise may set up a single E.164 number to handle any of these services from any user terminal in the enterprise. Also a customer wishing to communicate with the enterprise on any communication channel may do so using this unique E.164 number. While the enterprise may subscribe to, and/or delete any of these services or change service providers, such changes are transparent to the customer. The enterprise can have access to a comprehensive unified messaging system that combines voice mail and images from, Internet based and PSTN systems, by transforming voice and images into appropriate file formats before transmitting them through the Internet e-mail system for non-real-time processing by customer service representatives at the enterprise or for providing information to customers.

4.0 Conclusion

This paper analyzed the signalling and service specification capability of SIP in initiating real-time multi-media communication. Specifically, SIP can be used to specify media characteristics, QoS parameters, security considerations, and protect the identity and privacy of the caller if so desired. To enable mobile eCRM, the capabilities of SIP may have to be extended to take into account the signalling, security, and other technical requirements in wireless systems. Currently, IM is an important and scalable means of real-time instant text communication between retail customers and service personnel in e-business. If IM is extended to include real-time voice and video messages as well, then an IM system can be an effective personal integrated communication touch point. The IETF IM workgroup is currently looking at ways to extend IM to wireless instant messaging platforms. VPIM and IFAX support the core eCRM objective of integrating non-real-time voice mail, fax, and e-mail into one unified eCRM messaging system. While both VPIM and IFAX are scalable, can support multiple users simultaneously and interoperate with legacy PSTN based voice mail and fax services, security and privacy issues are not adequately addressed in these protocols. Number portability is an important component of customer touch point integration as an enterprise can now be identified by a through a unique ID consisting of an E.164 number, irrespective of the services (such as PSTN or ISP) subscribed to and any change in service provider. The IETF proposed protocols consisting of SIP, IM, VPIM, IFAX and number portability together constitute a protocol suite that meet most of the core objectives of an effective customer interaction eCRM system. The IETF protocol suite considered in this paper can interoperate, with SIP being used to establish real-time multi-media and IM sessions and for accessing legacy PSTN services. The IETF protocol suite considered are continuing to evolve and are working towards extending the features of these protocols to enable mobile communication. In the near future, it may be possible to adapt this protocol suite to enable an enterprise to make the transition from wireline commerce to mobile-commerce.

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6.0 List of abbreviations used in the paper

DNS	- Domain Name System
eCRM	- Electronic Customer Relationship Management
IETF	- Internet Engineering Task Force
IFAX	- Internet Fax
IM	- Instant Messaging
IMPP	- Instant Messaging Presence Protocol
ISP	- Internet Service Provider
MIME	- Multipurpose Internet Mail Extension
PSTN	- Public Switched Telephone Network
QoS	- Quality Of Service
RFC	- Request For Comment
SIP	- Session Initiation Protocol
SMTP	- Simple Mail Transfer Protocol
TIFF	- Tag Image File Format
URI	- Uniform Resource Indicator
VPIM	- Voice Profile Internet Mail

This is the second of a two-part paper submission by the author. The first half of the article appeared in issue no.40 of the **IEEE Canadian Review** in the spring of 2002.

About the author

Shyamala C. Sivakumar obtained her B.Eng. (Electrical) from Bangalore University, India in 1984. Thereafter she worked as a design engineer in the Avionics Bureau at Hindustan Aeronautics Limited, Bangalore, India until 1989. She obtained her M.A.Sc (Eng.) and Ph.D from the Department of Electrical Engineering at the Technical University of Nova Scotia, Canada in 1992 and 1997 respectively.

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Her research interests include digital signal processing, artificial neural networks, modeling and design of biometric authentication systems, multi-media technology for innovative applications in e-commerce and enterprise network security.

Email Address

An unemployed man is desperate to support his family. His wife watches TV all day and his three teenage kids have dropped out of high school to hang around with the local toughs. He applies for a janitor's job at a large firm and easily passes an aptitude test.

The human resources manager tells him, "You will be hired at minimum wage of $5.15 an hour. Let me have your e-mail address so that we can get you in the loop. Our system will automatically e-mail you all the forms and advise you when to start and where to report on your first day."

Taken back, the man protests that he is poor and has neither a computer nor an e-mail address. To this the manager replies, "You must understand that to a company like ours that means that you virtually do not exist. Without an e-mail address you can hardly expect to be employed by a high-tech firm. Good day."

Stunned, the man leaves. Not knowing where to turn and having $10 in his wallet, he walks past a farmers' market and sees a stand selling 25lb crates of beautiful red tomatoes. He buys a crate, carries it to a busy corner and displays the tomatoes. In less than 2 hours he sells all the tomatoes and makes 100% profit. Repeating the process several times more that day, he ends up with almost $100 and arrives home that night with several bags of groceries for his family.

During the night he decides to repeat the tomato business the next day. By the end of the week he is getting up early every day and working into the night. He multiplies his profits quickly. Early in the second week he acquires a cart to transport several boxes of tomatoes at a time, but before a month is up he sells the cart to buy a broken-down pickup truck.

At the end of a year he owns three old trucks. His two sons have left their neighborhood gangs to help him with the tomato business, his wife is buying the tomatoes, and his daughter is taking night courses at the community college so she can keep books for him. By the end of the second year he has a dozen very nice used trucks and employs fifteen previously unemployed people, all selling tomatoes. He continues to work hard. Time passes and at the end of the fifth year he owns a fleet of nice trucks and a warehouse which his wife supervises, plus two tomato farms that the boys manage.

The tomato company's payroll has put hundreds of homeless and jobless people to work. His daughter reports that the business grossed a million dollars.

Planning for the future, he decides to buy some life insurance. Consulting with an insurance adviser, he picks an insurance plan to fit his new circumstances. Then the adviser asks him for his e-mail address in order to send the final documents electronically.

When the man replies that he doesn't have time to mess with a computer and has no e-mail address, the insurance man is stunned, "What, you don't have e-mail? No computer? No Internet? Just think where you would be today if you'd had all of that five years ago!"

"Ha!" snorts the man. "If I'd had e-mail five years ago I would be sweeping floors at **Micro Byte Macro Systems**, making $5.15 an hour."

Which brings us to the moral:

Sadly, I received this via email too ....

Ann McLoud

North York, ON

Student focus for the IEEE Canadian Review

The student community, in general, is focused on job prospects after completion of their studies. Articles pertaining to job prospects should also be included in the magazine. These articles may address different specializations currently in demand by the industry and/or aspects pertaining to job searches, companies looking for such candidates etc. Since this is one of the most sought after topics for a student, the magazine may entice more interested readers.

Gagan D. Singh
Saskatoon, Saskatchewan

Editor's note: Noted. Some issues back, we had an excellent article on web based job sites. Anyway, thanks for the suggestion.

IEEE Canada

Guidelines for submitting an article to the IEEE Canadian Review

Contact any one of the Associate Editors (address information is available on page 2 of this journal). A short abstract should be sent in and will be reviewed before approvals are given for a full paper submission.

Follow these broad-based guidelines for paper preparation:

- Papers (in English or French) must be on topical subjects of interest to the vast majority of our members across Canada,
- Papers selected for the CR are not the type that would normally be submitted to a Conference or Transactions/Journal type of publication. Any mathematical material must be kept to a minimum,
- Papers are normally about 4 pages long (about 2000 words), but articles can be as short as 1 page or as long as 6 pages,
- Submit text in ascii (or WORD) format, as well as a typeset version in PDF format,
- Graphics and images must be in only two colors (Black and Reflex Blue) or Grayscale; Graphics should be scanned at 300 dpi, in 8 bit Grayscale, and submitted electronically in either jpeg, gif or tiff formats,
- A short Abstract (about 200 words) in English and French (we can provide assistance in translation) is required,
- A short biographical note (about 150 words) about the author(s) is also required, together with a passport size photo,
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- Items are normally submitted on-line directly to the Editor,
- We particularly encourage articles from small businesses on topics in electrical, electronic, computer or telecommunications related industries etc.
- We encourage academic institutions to present their new programs so that the community is aware of recent program changes,
- Newsworthy items such as senior appointments in academia and industry are also welcome.

For further information, contact Vijay Sood, Managing Editor, at:

v.sood@ieee.org

Phone: 450-652-8089

How To Brighten Your Style - Part 2: Writing clear, concise sentences

by *Cheryl and Peter Reimold*
Perc Com.

SUMMARY SENTENCE:

A good sentence gives one message quickly and correctly, with no useless words.

A sentence can be beautiful or boring, but its most important criterion in business writing is that it transmit the writer's thought quickly and correctly. You can ensure that your sentences meet this need by following these three simple rules.

1.0 Put only one message in a sentence.

Please read the following sentence once. Then close your eyes and restate the message.

> *It should further be noted and is described in detail in the application that the ABC woodyard, as all woodyards, can only be expected to discharge in times of great precipitation, when any impact on the woodyard's discharge would furthermore be minimal compared to the effect of runoff from the surrounding areas.*

Well? Was it enjoyable? To encourage people to read what we have written, we must make the transfer of thought easy and pleasant. This means one thought to a sentence. The sentence above contains at least five messages:

1. You should pay attention to the information that follows.
2. The application describes this information in detail.
3. The ABC woodyard will discharge only in times of great precipitation.
4. This is true of all woodyards.
5. In heavy rain, runoff from the surrounding areas has a greater effect than the discharge from the woodyard.

Decide what you want to stress and put only that in your sentence. Extra information that you think may be useful can follow.

2.0 Put the essence of your message into the main parts of the sentence: the subject, verb, and object (if there is one).

Consider this sentence:

> *The fact that we had a new manager had the effect of initiating many changes in the department.*

Now, let's strip it down to the basics. The subject of the sentence is fact, the verb is had, and the object is effect. Together, they give us the following message: Fact had effect.

Hm. This has no meaning, let alone immediacy or accuracy.

Now let's rewrite the sentence, putting the essence of the message into the subject, verb, and object:

> *The new manager initiated many changes in the department.*

Stripped down to the basics of subject, verb, and object, the message is this: Manager initiated changes. That is, indeed, the essence of the message we wished to convey.

3.0 Use no useless words.

Words that add no significant information have no place in your sentences. How many words could you remove from this sentence?

> *Considering all the dimensions involved, the Departmental Task Force set out to develop a productivity measurement system that would be a tool plant management could use to guide decision-making and to direct action toward successful productivity improvement.*

Well, first we have to decide what the message is. We decided it was the following — and we removed 17 words.

> *The Departmental Task Force set out to develop a system that plant management could use to measure and improve productivity.*

Next time we'll see how to connect effective sentences.

Cheryl and Peter Reimold (telephone 1+ 914-725-1024, e-mail perc-com@aol.com) have taught communication skills to engineers, scientists, and businesspeople for 18 years. Visit their new educational web site at www.allaboutcommunication.com.

This article is the second in a series of "tips and techniques" for the purpose of assisting you in developing an effective communication style. We hope that this series will be of value to you professionally and personally. We value your feedback.

Life Members On The Move In Canada

IEEE Canada

At the May meeting of IEEE Canada in Winnipeg, Manitoba, Ron Potts, Chair of the Life Members (LM) Committee of Region 7, convened a meeting to strategize on how LMs might best organize and function across the 8,500 km breadth of this country. The questions addressed were; what should be our role? what structure would best serve us? and what projects could be initiated immediately?

It was reaffirmed that in addition to socializing, important as that is, the right path for us to follow is to offer ourselves as a resource for Sections to support them in their programming. In short it is "give back time". All LMs have enjoyed the benefits of IEEE membership over the years and some of us are in a position to repay those blessings with further service. So how would we do that?

1.0 Recognition Of Our Role

We concluded that LM Chapters operating independent of the local Section activity would be a retrogressive step. The best use of LMs time and effort will be when they are used in close collaboration with the plans of the Section and their various committees. To do that we need to know that the local Section in an area is receptive to this offer.

LMs decide it is payback time!

Action: Starting with the Winnipeg meetings of **IEEE Canada**, convince the Section attendees of the merits of this proposal by indicating potential projects where we can be of assistance. Indicate to the Section Chairs that a positive recognition of their support would be to have an LM sit as a non-voting member of their Executive Committee.

2.0 Life Member Chapter Formation

We addressed a second and more onerous task which is to design the most effective local structure in which the LMs can function effectively. A few statistics will demonstrate this difficulty. Out of the 30,000 LMs in the world, 849 are located in Canada. Approximately 60% of these (512) are affiliated with just four major Sections, Toronto (211), Ottawa (151), Montreal (144) and Vancouver (106). The remaining LMs are scattered across the country in the other sixteen Sections which make up Region 7.

Action: Extend the successful efforts of Chair Potts in contacting LMs in Central Canada with respect to establishing self-sustaining LM Chapters. Concentrate on doing this in the heavily populated Sections starting with Toronto, Ottawa, Montreal and Vancouver. For all other Sections, unable to sustain a full blown LM Chapter, initiate an LM liaison contact to pursue those programs beneficial to the local Section.

3.0 Potential Activity

We discussed the areas in which we might be able to be of assistance to Sections in furthering their programs. Obviously, depending on our recruitment of LMs willing to serve, the list of potential projects is endless. We decided to suggest three areas of activity as a start:

3.1 Senior Member Campaign

The percentage of Senior Members to our total membership has dropped in recent years from 20% to 10%. We suggest that LMs in conjunction with Section Membership Development Chairs can mount a proactive campaign to restore previous levels.

3.2 Critique And Promote Virtual Museum

The History Committee has mounted on the WEB a virtual museum at <www.ieee.org.museum>. It went live in January of this year. Its purpose is to create a greater awareness of engineering as a career. The target audiences are students aged 10 to 18 years, educators and the general public. LMs can help first by visiting the WEB site and critiquing the presentation. Later there is the potential for LMs to undertake visits to local schools to promote its use in the classrooms.

3.3 Identification Of Engineering Milestones

The History Committee also has a very active Milestone Program whereby sites worldwide, which have significance for great achievements in our technologies, are marked. Since its inauguration during our Centennial year (1984), forty such events and sites have been identified and so honoured. For sure there are more yet worthy to be designated. A Section must be the sponsor of these and we suggest that it is an ideal project in which LMs can assist the Section in identifying candidates.

Action: Discuss these opportunities with the Section executives and offer LM resources to help advance these three projects.

Finally, Chair Ron and myself availed of the opportunity of being in Winnipeg to meet with John Plant, the Executive Director of the Engineering Institute of Canada (EIC), (a close sister organization) and Leonard Bateman the Chair of the EIC's Life Member Committee. The object was to explore the possibility of joint meetings where and when it would be of benefit to both parties.

All you LMs out there, look for an early contact from one of us as we set things in motion at the local level. Ron Potts <potts@mail.canicnet.com> will continue to guide this program in Central Canada and because of the geographical closeness to him of the Montreal and Ottawa Sections, he will take them under his wing as well. David Kemp <d.kemp@ieee.org> of Winnipeg has offered his services to direct the effort in Western Canada. Wally Read <w.read@ieee.org> will continue to push the program in Eastern Canada. We look forward to your participation. Until next time enjoy your "pay back time".

Wally Read IEEE Life Fellow
Newfoundland, Canada.

Additions to IEEE Canadian Review Editorial Staff

The Managing Editor of the IEEE Canadian Review welcomes the following two additions to the editorial staff:

As Associate Editor:

Shaowen Song completed a B. Sc. degree in electrical engineering and a M. Sc. degree in applied mathematics from Tianjin University in China. He received his Ph.D. in engineering from Memorial University of Newfoundland.

He is an assistant professor in the Department of Physics and Computing at Wilfrid Laurier University, Waterloo, Ontario, Canada.

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

As Assistant Editor:

Camille A. Rabbath obtained his Ph.D. degree from McGill University, Montreal, in 1999.

He is an adjunct professor at McGill University and a Defence Scientist at the Weapon Delivery Systems, Precision Weapons Defence Research & Development Canada - Val Cartier, Quebec.

His research interests include digital control of engines, sampled-data control systems analysis and design, distributed simulations, and multi-rate modeling, simulation and control.

The Software Engineering Body of Knowledge for Professional Engineering in Canada

by *R.D. Dony - University of Guelph, Guelph, ON*
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Abstract

In response to the need to define the academic requirements for licensing professional engineers in Canada, the Canadian Engineering Qualifications Board formed a committee whose mandate was to define the core and supplemental bodies of knowledge for Software Engineering Some of the issues and the outcome of the software engineering committee's deliberations are presented in this paper. After examining a number of inputs including national and provincial examination syllabi and curricula of accredited software engineering programs in Canada, a number of core topic areas were defined. These are: Discrete Mathematics, Data Structures and Algorithms, Software Development (includes Software Engineering Process, Requirements, Design, Construction, Testing, Maintenance, and Configuration Management), System Reliability and Safety, Digital Systems, Computer Architecture, Operating Systems, File and Database, and Systems and Control. These topics generally match well with the existing examination syllabi and curricula. The supplemental areas are less well-defined and include depth in core subjects, depth in areas of specialization, and breadth in application domains.

Sommaire

Dans le but de définir les exigences académiques nécessaires à l'attribution des permis d'ingénieur professionnel au Canada, le Bureau canadien d'accréditation des programmes d'ingénierie a formé un comité dont le mandat était de définir les connaissances de base et complémentaires en génie logiciel. Certains des points soulevés lors des délibérations du comité et les conclusions obtenues par ce même comité sont présentés dans cet article. Après avoir examiné un certain nombre d'éléments, notamment les programmes de formation canadiens accrédités en génie logiciel, les sujets suivants ont été établis comme étant des sujets de base: mathématiques discrètes, structures de données et algorithmes, développement de logiciel (incluant processus de génie logiciel, exigences, conception, construction, tests, maintenance et gestion de configuration), fiabilité et sécurité de systèmes, systèmes numériques, architecture d'ordinateur, systèmes d'exploitation, fichiers et bases de données, et systèmes et commandes. En général, ces sujets s'accordent bien avec les programmes d'examens et les curriculums existants. Les domaines supplémentaires ne sont pas aussi bien définis et inclus des approfondissements sur les sujets de base, détaillent des domaines spécialisés, et traitent de différents domaines d'applications.

1.0 Introduction

Provincial and territorial associations of professional engineers are responsible for the regulation of the practice of engineering in Canada. Each association has been established under an Act of its provincial or territorial legislature and serves as the licensing authority for engineers practicing within its jurisdiction. The Canadian Council of Professional Engineers (CCPE) is the national federation of these associations and provides a coordinating function among them. One of the means of providing this coordination is the generation of guidelines. Such guidelines are an expression of general guiding principles which have a broad basis of consensus, while recognizing and supporting the autonomy of each constituent association to administer its engineering act.

Two of the four working boards of the CCPE are the Canadian Engineering Qualifications Board (CEQB) and the Canadian Engineering Accreditation Board (CEAB)). The CEAB was established to accredit undergraduate engineering programs which provide engineers with the academic requirements necessary for registration as a professional engineer in Canada. The CEQB's primary role is to develop national guidelines on professional engineering qualifications, standards of practice, and ethical professional conduct. It is also responsible for the CCPE Examination Syllabus that describes an examination program to assess the academic qualifications of individuals who have not graduated from an engineering program that has been accredited by the CEAB.

In September 2000, the CEQB and the CEAB, discussed the idea of developing a body of knowledge for each engineering discipline. The body of knowledge for each discipline would consist of a Core Body of Knowledge (CBOK), a Supplementary Body of Knowledge (SBOK), and other basic science, mathematics and complementary knowledge specified by the CEAB and CEQB for all engineering disciplines. The CBOK for a discipline comprises all the material and areas that must be studied by each person in that discipline. Additional specialization within a discipline which is not part of the CBOK is the SBOK. A committee, whose members are the authors of the draft report [1] which this paper summarizes, was formed in February 2001 with the mandate to define the CBOK and SBOK for Software Engineering. At the same time, a parallel committee was formed to define the Chemical Engineering BOK. Some of the issues and the outcome of the software engineering committee's deliberations are presented here.

1.1 Definition of Software Engineering

The following definition of software engineering is adapted from the definition of professional engineering in the CCPE Guideline on the Professional Engineering Practice in Canada [2].

Professional software engineering involves any act of planning, designing, composing, evaluating, advising, reporting, directing or supervising, or managing software-intensive products or processes that requires the application of engineering principles, and that concerns the safeguarding of life, health, property, economic interests, the public welfare or the environment.

Software engineers are concerned with the analysis, design, programming, testing, system integration, commissioning, support and retirement of software systems, particularly those systems which are critical to public health, safety, and the environment. Software engineers apply engineering methods and discipline to produce reliable systems which are of known quality, and fit for intended use.

1.2 Scope

The report does deal with knowledge areas common to other engineering disciplines. Such topics would be analogous to the “Basic Studies” in the CEQB Syllabi, including such topics as differential equations, statics and dynamics, basic electromagnetism and even thermodynam-

Acknowledgement

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Editor’s Note: Due to the importance of this article on our industry, this article is reprinted in full. Your feedback is welcome.

ics or fluid mechanics for example. Such foundations in a broad range of basic sciences, both applied and engineering, allows a practitioner from any one discipline in engineering to be, at the very minimum, at least conversant with colleagues in other disciplines. As it is expected that many software engineers would apply their profession in the context of other engineering fields, this foundation is of particular importance. Of course, many of foundation areas will be common to one or two other disciplines, for example computer or electrical engineering.

The report is primarily concerned with the academic knowledge mastered by a software engineer. In pragmatic terms, this report enumerates those subjects which might be used as a basis for the evaluation of the background of a candidate seeking admission to the profession.

It is emphasized that a software engineer, in addition to such academic knowledge, is expected to have practical knowledge and experience in the various sub-disciplines of software engineering. This document does not attempt to address the nature and significance of these forms of software engineering knowledge. However the enumeration of topics within this document might facilitate future discussions of practical and experiential knowledge in specific sub-disciplines.

1.3 Use of Report

As a subcommittee of the CEQB, the focus of this work is directed at assisting the admissions process for professional engineering. In Canada, there are three criteria for admissions: minimum academic background, suitable work experience, and passing a professional practice examination. The committee's work focused mainly on the academic requirements for licensure by defining the minimum knowledge areas that a software engineer should possess. To that end, two of the more concrete applications of a body of knowledge for any engineering discipline are the CEQB syllabi, and the CEAB curriculum.

The CEQB examinations can be considered a rather direct embodiment of a BOK as there should be a straightforward mapping between knowledge areas and examination topics. However, technically, the CEAB criteria does not contain any reference to a BOK for a discipline, just general categories of subject material. Implicit in the process is the assumption that the Program Visitor has an idea of what the BOK should be for a program and judges the course offerings accordingly. If the BOK were to be made explicit and codified, the mapping between knowledge areas and course topics, again, should be straight-forward. Therefore it would be helpful if the portions of a discipline's BOK that map nicely to examination curriculum topics were arranged to facilitate this mapping.

Software engineers are concerned with the analysis, design, programming, testing, system integration, commissioning, support and retirement of software systems, particularly those systems which are critical to public health, safety, and the environment.

2.0 Previous Work

Before the committee's work, a number of organizations had began work in this area. The CEQB Syllabus for Software Engineering, item [3], was initially proposed as part of the 1998 syllabus. In response to concerns about the quickly evolving nature of the discipline, some associations/ordre developed modifications to the national syllabus [4,5].

During 1998-1999, a committee of Professional Engineers Ontario (PEO), the Engineering Disciplines Task Group (EDTG), developed a core body of knowledge guideline for use in evaluating CEAB graduates who have switched into the field of Software Engineering subsequent to graduating [6]. To reconcile the differences between these requirements and the original CEQB syllabus, PEO devised a new syllabus [4]. William's paper [7] discusses the rationale.

The report by *l'Ordre des ingénieurs du Québec (OIQ)* [8] is a comprehensive document that reports on the findings of the ad hoc group on software engineering. It discusses the definitions and features of software engineering, aspects of training, and presents a number of recommendations for the *ordre*. For the purposes of this report Table 3 on pages 15-16, summarizing topics for an education in Software Engineering and grouped into the CEAB academic units (AU) categories, is of primary interest.

Also considered for this work were the curricula of the first "Software Engineering" programs at Canadian universities that have been granted accreditation by the CEAB in 2001 McMaster University [9], University of Ottawa [10], and University of Western Ontario[11]. All three programs are offered through existing engineering faculties that currently have existing accredited engineering programs. As the first graduating classes for these programs was in 2001, they were visited by CEAB teams in the Fall of 2000 and were accredited by the CEAB in June, 2001.

The IEEE SWEBOK document[12] is the latest version of a project through the IEEE Computer Society, and managed through the *Université du Québec à Montréal*. The project has been sponsored financially by a number of companies and organizations including the CCPE. Its scope does not include the issue of the regulation of the practice of professional engineering. Its focus is on ten knowledge areas specific to the software development and maintenance process: requirements, design, construction, testing, maintenance, configuration, management, engineering process, tools, and quality. While the report goes into some depth into each of these topics, it does not deal with the larger issue of the supporting knowledge areas required for a regulated profession. For this report, the SWEBOK document was a useful input for the "Software Development" 3.3 area as developed below.

The final three items that were considered [6,13,14] are concerned with the evaluation of engineering experience in the software engineering field.

3.0 Core Body Of Knowledge (CBOK) For Software Engineering

3.1 Discrete Mathematics

For any in-depth treatment of software for both analysis and design, an additional set of mathematical tools are required in addition to the classical linear algebra and calculus topics. This area is termed "discrete mathematics" or "discrete structures." These topics are a common component of many Computer Science programs as they provide the mathematical foundations for the areas of data structures and algorithms.

Topic areas include: functions, relations, and sets, trees, graphs, logic, Boolean algebra, combinational methods, state models, proof techniques, basics of counting.

3.2 Data Structures and Algorithms

Both data structures and algorithms form the fundamentals of computer science and software development. For software engineering, the emphasis is on knowledge of the various basic structures and algorithms and their characteristics. Again, these topics are a common component of Computer Science programs. Knowledge of discrete mathematics is required.

Topic areas include: Queues, stacks, lists, heaps, trees, graphs, data abstraction, sorting, searching, parsing, pattern matching, divide and conquer, greedy methods, algorithm complexity, selection criteria.

3.3 Software Development

This broadly defined area forms the "core" of the unique discipline of Software Engineering. It is concerned with the application of the above theoretical foundations to produce specification-correct software in a real-world development environment. The area includes the software lifecycle of requirements, design, construction, testing, and maintenance. Also included is configuration management and software engineering process. Both the more formal academic concepts as well as the more practical, experience-oriented areas constitute knowledge in the area.

3.3.1. Software Engineering Process:

The Software Engineering Process is a systematic approach that starts at the conceptual phase (original idea) and concludes with an operationally reliable and maintainable piece of software. It includes the management functions of software development, quality, testing, and configuration management. The Software Engineering Process supports

a similar process at the Systems Engineering level and includes software engineering methods and tools.

Topic areas include: software engineering process concepts, process infrastructure, process measurement, process definition, qualitative process analysis, process implementation and change.

3.3.2. Requirements:

This topic covers the activities associated with software requirements in a manner that verifiably supports the subsequent phases: design, construction, test, operation, maintenance, etc. It includes the analysis of system level or other software architectures into which this design must fit.

Topic areas include: elicitation, analysis, requirements and specifications, functional and nonfunctional requirements, prototyping, formal specification techniques, validation.

3.3.3. Design:

This topic covers the activities associated with software design. Key elements are designing for testability, maintainability and quality.

Topic areas include: software architecture and structure, object-oriented analysis and design, component-level design, distributed models, design for reuse, quality analysis and evaluation, notations, validation.

3.3.4. Construction:

Topics include: reduction in complexity, anticipation of diversity, linguistic methods, formal methods, visual methods, validation, language evaluation and selection.

3.3.5 Testing:

Topic areas include: concepts and definitions, levels (requirements, design, construction, integration, operational), techniques, measures.

3.3.6 Maintenance:

This topic covers the activities associated with software maintenance. Maintenance is required to ensure that the software continues to meet its functional and quality requirements in a changing operational setting.

Topic areas include: documentation, requirements and specifications, functional and nonfunctional requirements, prototyping, formal specification techniques, structured design, object-oriented analysis and design, component-level design, distributed models, design for reuse, software maintenance, tools and environments.

3.3.7 Configuration Management:

Topic areas include: management of the software configuration process, configuration identification, configuration control, status accounting, auditing, software release management and delivery.

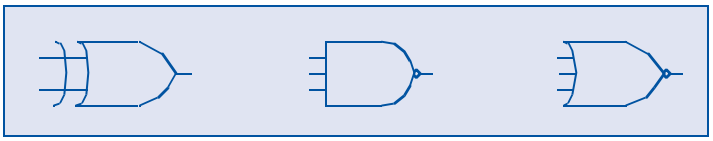
3.4 System Reliability and Safety

This area addresses the issue of reliability and safety from an entire system perspective. While quality and reliability concerns are of importance in all stages of the software development life cycle, it is important to emphasize the reliability and safety of the entire system, be it a physical realization or otherwise. For the professional engineer, this topic directly impacts the obligation to ensure the safety and well-being of the public through the design of verifiable, reliable software where the effects of software failure on the system may have safety implications. While many of the issues here are covered above, it has been enumerated separately to emphasize the obligation that the professional engineer has to produce safe and reliable systems.

Topics areas include: Formal methods and specifications, pre and post conditions and assertions, formal verification, uncertain and changing requirements, verification and validation, test plan creation and test case generation, black-box and white-box testing techniques, real-time and resource constraints, redundancy and fault tolerance, failure modes, probabilistic methods of analysis, quality measurements performance modelling.

3.5 Digital Systems

Knowledge of digital systems for a software engineer is required to ensure that computer is not merely a “black box” for running software. This area is a required component of both electrical and computer engineering (e.g. 98-Comp-A2). It builds on the introductory logic topics of discrete mathematics.



Topic areas include: design of combinational and sequential circuits, implementation using gates, logical system components, programmable logic devices and gate arrays, high-level description languages, small system design, data flow, signals, timing, basic microprocessor organization and interfacing.

3.6 Computer Architecture

This area further builds on the knowledge of digital systems as described above and, again, is common with computer engineering (e.g. CEQB syllabus examination 98-Comp-A3) but not at the same depth (e.g., just to the logic abstraction level, not the device level). The treatment of this topic from a computer science perspective typically does not go into the depth in the hardware organization that a prerequisite knowledge of digital systems allows.

Topic areas include: computer structure and processor architecture, CPU and memory organization, buses, computer interfacing, parallel and serial I/O, storage devices, instruction sets, addressing modes, registers, interrupts and I/O, special purpose processors, embedded systems.

3.7 Operating Systems

As most software runs under the supervision and resource control of operating systems, understanding the characteristics and limitations of operating systems and their effects on the execution of programs is necessary. The knowledge of these relationships is particularly important in control and real-time systems. Some areas of this topic are common with computer engineering (e.g. CEQB syllabus examination 98-Comp-A5) as well as computer science. Typically the former deals with the use and characteristics of operating systems while the latter may focus more on their design. Some concepts from computer organization (e.g. resources such as memory) are required.

Topic areas include: interprocess communication, synchronization, scheduling, resource allocation, memory management, multi-tasking and multi-processing, performance and measurement, real-time support requirements, deadlock, features of modern operating systems.

3.8 File and Database

Most software systems have some reliance on file and database systems. Further, the processing of large volumes of data may be required for safety critical systems. This area tends to be part of a core computer science program.

Topic areas include: data models, entity-relationships, mass storage devices, file structures, data base types (relational, hierarchical, network), file organization (sequential, indexed, direct access, hashing), query methods and languages, security and integrity, transaction processing.

3.9 Systems and Control

This subject area includes the fundamentals of stability analysis of feedback control systems. Since the need for regulation comes directly from the need to protect public safety, stability analysis is critical in the design of any software control system that interfaces to the physical world. This is a core subject in most electrical and computer engineering related disciplines.

Topic areas include: Models, transfer functions and system response, Root locus analysis and design, feedback and stability, Bode diagrams, Nyquist criterion, frequency domain design, state variable representation, PID control, digital control, Z transform, computer control interfacing and algorithms.

4.0 Mapping To CEAB Curricula And Examination Syllabi

Table 1 shows a set of general subject/knowledge areas common to many or all of the syllabi and curricula. For the three examination syl-

labi, labelled "CEQB" for the original CEAB 1998 syllabus, "PEO" for the Ontario revision, and "BC" for the British Columbia revision, the examination numbers are given that are concerned with the general areas listed on the left. The course numbers of the curriculum of the three accredited programs, McMaster University (MAC), University of Ottawa (UoO), and University of Western Ontario (UWO) are likewise categorized. The OIQ entries just specify whether or not the topic is included in its Table 3. As the SWEBOK document deals with only a subset of these topics in the software development area, albeit at a significant level of detail, it was not included in the table. References are made to specific examinations or courses that deal with the broad topic area.

At the broadest level, there appears to be a significant agreement between what the various sources consider as required knowledge areas for software engineering. As the field is evolving, it is expected that some differences do exist. The CEQB syllabus appears not to require discrete mathematics and elements of software testing and reliability. Both PEO and the McMaster curriculum require systems and control as do other software engineering programs seeking accreditation such as the University of Waterloo.

5.0 Supplementary Body Of Knowledge (SBOK) For Software Engineering

In addition to the core knowledge, it is assumed that an engineer will have additional knowledge. This additional knowledge makes up the SBOK. All of the SBOK topic areas require mastery of the topics in the CBOK. Areas may be deleted or added as technology and engineering techniques change over time.

The body of knowledge is augmented by the SBOK in a number of ways.

5.1 Depth in Core Subjects

Engineers may develop some of the knowledge areas in the CBOK to a greater depth. This would be analogous to advanced upper-year courses that further extend material established in earlier core courses.

5.2 Depth in Areas of Specialization

These areas are topics in software engineering that are in addition to the CBOK. Here, the practitioner applies advanced knowledge and skills in software engineering areas beyond the minimum core.

Examples include:

- Software Product Line Engineering,
- Software Process Assessment and Improvement,
- Software Estimation and Planning Tools,
- Concurrent Software Design,
- Real Time Systems Design,
- Human Computer Interface Design,
- Advanced Test System Design

5.3 Breadth in Application Domains

Software engineers may apply their skills in application domains outside of their specific discipline. In fact, this interface with other engineering disciplines is of particular importance to the professional software engineer and thus would require the software engineer to have a good working knowledge of the application domain. Since such areas would typically be related to other engineering disciplines, the practitioner would require a broader range of knowledge of the specific application areas.

Examples include:

- Industrial Process Control,
- Telecommunications (switching) Software,
- Avionics Software,
- Networking (protocol) and Distributed Systems software,
- Medical Components and Systems.

6.0 Summary And Conclusions

The recognition of Software Engineering as a distinct discipline within a licensed, professional engineering framework is a relatively recent development. However, the foundations of the discipline do have a much longer history. As a result, there is a general consensus as to what constitutes a core body of knowledge in the field. The topics include not only those concerned with the immediate development of software, and the software lifecycle, but topics such as digital systems, computer architecture and control systems. This is reflects an engineering philosophy, which requires that a software engineer be knowledgeable in all related aspects of systems and environments in which the software operates. Coupled with the implied basic sciences and mathematics, this breadth gives professional software engineers an academic foundation which ensures that the software-based products and processes they develop meet their professional obligations to uphold the public safety.

The various inputs to the committee's work all reflect general agreement as to the most important and central topics. Even the IEEE SWEBOK project, while not specifically addressing the issue of the requirements for licensing professional engineers in Canada, helped in specifying the software development topics. Of course, as the discipline evolves, the core body of knowledge must adapt accordingly. As this body of knowledge is maintained, the various inputs listed, and materials from their respective organizations, should be monitored for changes as well.

The supplemental body of knowledge is, on the other hand, not currently well defined. In general, a software engineer should have additional knowledge beyond the core topics - knowledge that includes

Table 1: Overview of Basic Topics in Software Engineering

General Area	CEQB[3]	PEO[4]	BC[5]	OIQ[8]	MAC[9]	UoO[10]	UWO[11]
Discrete Mathematics	-	BS17	-	Yes	2E03	MAT2343	SE251
Data Structures and Algorithms	A1, A4	A4	BS(A1)	Yes	2C04	CSI2114, CSI3105	CS027, CS210, CS340
Software Development	A5	A4	A3	Yes	2A03, 2B04	SEG2100, SEG2101, SEG3100	SE351, SE452, SE453
Testing, Reliability	-	A7	-	Yes	2F03	SEG4111	SE453
Digital Systems	A2	A2	BS(A2)	Yes	2D04	ELG1100	ECE339
Computer Architecture	A2	A3	BS(A2)	Yes	3G03, 3F03	ELG2181, CEG3391	ECE375
Operating Systems	A3	A5	A1	Yes	3B04	CSI 3310	SE201, CS305
File and Database	A6	-	A4	Yes	3H03	CSI 3317	-
Systems and Control	-	A1	-	-	3L03, 4A03	-	-

additional depth in one or more core topics, depth in one or more specialization areas, and/or breadth in application domains. There are already many software engineers with special expertise, or who are practicing in certain application domains. However this was not addressed at this time. This area will need to be developed in subsequent drafts, and input is sought from all readers of this initial draft. As with the core topics, the supplemental topics will also evolve as the discipline evolves, so review and maintenance of the document will apply here as well.

The management of software development including the entire lifecycle has not been explicitly included in this report. It is understood that project management techniques common across all engineering disciplines can be applied in software engineering. It is also understood that there may be situations unique to software engineering that requires alternative approaches.

7.0 Acknowledgments

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On the Challenges of Commercializing Technology Innovation

by *Paul Freedman*
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Abstract

While creating a product from technology innovation can pose enormous technical challenges, this article suggests that the real barriers to commercialization are primarily *market-related*. Here we'll highlight the give-and-take between supplier and customer that is key to market-creating innovation and new business wealth, as new products are defined and selling challenges are overcome.

Sommaire

Bien que la mise au point, sous forme commerciale, d'une innovation technologique puisse présenter des problémes techniques de taille, cet article argumente que les véritables défis de commercialisation sont ailleurs, sur le plan mise en marché. Or, c'est le va-et-vient entre le fournisseur de produit et ses (premiers) clients qui est au coeur de la réussite, au fur et à mesure que les caractéristiques du produit et les stratégies de vente se précisent.

1.0 Introduction

It's now recognized that technology innovation, and especially the commercialization of technology innovation, is key to future prosperity in the industrialized world, as the following quote suggests:

> *"Where does new wealth come from? Like a four year old asking how babies are born, it's a deceptively direct question that often disarms our conventional capacity to answer ... In the New Economy, the greatest rewards go to companies that create new business models -- ideas that spark new sources of revenue based on changing technology, demographics, and consumer habits. By definition, new business models destroy old ones, why is why creating new wealth is a threat to every traditional (unimaginative) business. Never before have strategy life-cycles been shorter and market leadership counted for less. Call it the First Law of the Innovation Economy: companies that are not constantly pursuing innovation will be overwhelmed by it." [8]*

In a previous article [7], we looked at how new (software) companies start-up, and the particular problems they face as they do their best to avoid bankruptcy and grow into successful businesses.

In this companion article, we'll look more closely at the commercialization of technology innovation that is often the raison d'étre of the start-up adventure. And while creating a product from technology innovation can pose enormous technical challenges, it turns out that the real barriers to commercialization are primarily *market-related*.

Unfortunately, marketing remains a mysterious and even suspicious subject for most technology people. So let's begin with [11] who reminds us that "marketing" means trying to have what someone wants to buy, as opposed to "selling" or trying to find someone to buy what you already have.

First Law of the Innovation Economy:

Companies that are not constantly pursuing innovation will be overwhelmed by it.

In what follows, I shall limit my remarks to technology innovation which leads to new *business products*. That's just because business research [1] suggests that when new companies succeed in commercializing technology innovation, they are overwhelmingly creating products for businesses, not consumers.

2.0 On technology innovation

One good starting place to better understand the commercialization of technology innovation is [3]. Although the author's focus is on how established companies in established markets come to lose their dominant positions to newcomers, he nonetheless describes in some detail just what technology innovation is and how new companies come to be founded and grow in step with markets that emerge for their new products. (Later in their evolution, such new companies grow "up-market" to invade and then dominate established markets, pushing aside the established players.)

In particular, Christensen suggests that technology innovation can take on two very different forms. First there is "sustaining" innovation, technology development which contributes directly to improving existing products and creating new ones for established markets. And this is what "industrial" R&D is all about, as companies struggle to grow their market share by better understanding and anticipating (existing) customer needs and refining their product offering accordingly.

Sometimes, university researchers contribute "indirectly" to this industrial R&D, perhaps by building a proof-of-concept prototype to evaluate the merits of a new approach to an existing problem. But sustaining innovation is simply too strategic to be out-sourced and that's why it's conducted in-house and in secret. As a result, university research is often perceived by business people as primarily serving a training function, i.e. creating new potential hires with advanced skills who can quickly become productive in industrial settings.

On the other hand, the results of much, if not most, university research is better described as "disruptive" innovation which provides tantalizing glimpses of new and possibly profitable future products. But such technology typically offers *less* of what products do now because they do things *differently*. Even with sufficient technical refinement, the disruptive innovation might only become a simpler, more convenient and more reliable product, providing less functionality and reduced performance. As a result, such a product would also have to command a lower selling price. For all of these reasons, established companies now selling products in established markets are not only *not* interested in such disruptive innovation (since it cannot contribute directly to their current business growth), they *cannot* be interested. This is the essence of Christensen's "innovator's dilemma."

Nonetheless, truly innovative new products do indeed see the light of day, largely thanks to the efforts of brand new companies or brand new divisions within existing companies. And before we look more closely at how markets emerge in response to the creation of their new products, we must stop to remember that technology innovation is just that, "technology". Indeed, this is why university researchers often talk of possible "applications" for their work. Consider, for example, new (mathematical and computing) technology to model and interpret partial information in a statistical way. Two possible "applications" might be image processing to improve quality control in a factory setting, and automated speech recognition as part of a smart telephone exchange.

Still, even a "technology" somehow adapted for an "application" isn't quite a "product". Using a convenient vocabulary from [13], such an applied technology is just a "device", because it only addresses a subset of the customer's needs. Part of the commercialization effort, then, is to define and create a "whole product" around the device that provides real added value to the customer. To return to our previous examples, we'd need to add all kinds of extra elements such as a user interface to configure the "device", a database for storing customer-specific device

parameters (appropriate factory parts, employee names, etc.), a different user interface for trouble-shooting problems by the customer, perhaps the means to provide technical support remotely (via modem) by the product supplier, and, of course, suitable documentation. Seen in this light, the commercialization of technology innovation will always require substantial "peripheral" technical effort to create an appropriate whole product.

3.0 On creating new markets

Returning to [3], recall that "disruptive" technology innovation offers a different set of attributes of little value to established markets and as a result, commercialization typically means finding different kinds of customers outside established markets and refining the product offering with them, with the hope that eventually, enough new customers will be found with enough shared characteristics so that a new, different, market will emerge, making the new venture (eventually) a successful business.

Not surprisingly, business history [1] teaches us that companies that were most successful at commercializing technology innovation were those that understood that the primary challenge was a marketing one: to "build" a market, i.e. to find enough customers, where product competition occurs along the dimensions favored by the attributes of the innovation. And that's why, as suggested in [11]:

> *"With few exceptions, [new high tech] companies are not battling to share markets. They are battling to create markets: to get prospects to want and use their [new] products and services."*

And while these new markets are emerging, little companies (with the right guidance) can be growing into bigger ones off the "radar screens" of established players which are concentrating their sights elsewhere, i.e. on established markets.

It's significant that the study described in [1] concludes by suggesting that creating new markets is significantly less risky, and more financially rewarding, than entering established markets against entrenched competition. Still, commercializing technology innovation typically involves substantial *market risk*: that an emerging market will not develop, or emerge too slowly, or never become big enough, to sustain commercialization efforts. (In contrast, entering established markets against entrenched competition involves substantial, sometimes insurmountable, *competitive risk*.)

But as emerging markets become big enough, there are typically overwhelming "first mover" advantages since there is rarely place for more than just a few players. Indeed, high tech is a "winner takes all" industry whereby the products of just a handful of players enjoy overwhelming dominance. As described in [9], this is especially true in the software industry, where a first mover can become an "industry standard" or reference. Then, as more and more customers choose that product, it becomes harder and harder for everyone else to choose anything else. Moreover, once the purchasing decision is made, customers become "locked in" and become "loyal" to the first mover, especially when conversion costs are high.

"With mottos like 'make a little, sell a little', and 'take small steps', 3M understood that big things often evolve from little things."

Still, the dot-com failures remind us that "being first to market", when there is no market, is a recipe for disaster. Indeed, pioneers will go broke when a market fails to develop, or more typically, when the market emerges too slowly i.e., remains too small for too long to sustain their commercialisation efforts. And the world is full of examples of new companies overtaking pioneering ones just as emerging markets became established and started to really grow [14]. And that's why first movers must create significant "barriers to entry" in order to make their market positions "defensible", i.e. only when it becomes extremely different to copy new products soon enough to "catch the wave" as the market emerges, can first movers enjoy overwhelming business success. And such barriers to entry are typically a combination of superior technology and especially, superior market knowledge as reflected in product features.

But the foregoing seems to suggest that right off the bat, we can see our way clear to finding those first customers and creating winning products they *will* purchase. The only worry seems to be where to look, and whether or not they are enough of them. Dream on!

Practically, there are other, much more fundamental, kinds of "market risk", as the following quotation from [6] makes clear:

> *"When a new venture does succeed, more often than not it is in a market other than the one it was originally intended to serve, with products or services not quite those with which it had set out, bought in large part by customers it did not even think of when it started, and used for a host of purposes besides the ones for which the products were designed."*

Now here's another variation on the same theme from [3]:

> *"Research has shown, in fact, that the vast majority of successful new business ventures abandoned their original business strategies and learned what would and would not work in the market. Guessing the right strategy at the outset isn't nearly as important to success as conserving enough resources so that new business initiatives get a 2nd or 3rd stab at getting it right."*

Remember: sales are, of course, the ultimate yardstick for "getting it right"!

And the importance of remaining focused on your *business*, instead of on your (first) product, is key, as suggested by [4]:

> *"Luck favours the persistent. This simple truth is a fundamental cornerstone of successful company builders ... If you equate the success of your company with the success of a specific idea, as many business people do, then you're more likely to give up on your company if that idea fails."*

This suggests that early products should remain simple and easy to change, as suppliers learn, along with their first customers, to determine appropriate product features, as emerging markets develop as part of the give-and-take between customer and supplier.

4.0 On financing imperatives

In [4], the authors review the continuing business success of 3M and observe that:

> *"With mottos like 'make a little, sell a little', and 'take small steps', 3M understood that big things often evolve from little things; but since you can't tell ahead of time which little things will turn into big things, you have to try lots of little things, keep the ones that work, and discard the ones that don't."*

Of course, new companies just starting out rarely have the financial means to "try lots of little things" but with sufficient patience and persistence, much can be done, one thing at a time.

But "start small, grow slowly" business adventures are of little or no interest to Venture Capital firms looking to invest in a massive way and hit home runs as quickly as possible e.g. after 3-5 years. Such investors will always prefer to place larger amounts with fewer companies than smaller amounts with many more companies, simply to make their own account management more efficient. (Of course, some time into the future, some of these companies might become sufficiently large as their markets become sufficiently established or at least "knowable", to present suitable investment opportunities.)

In contrast, consider the following business advice from [3]:

> *"I don't want my organization to have pockets that are too deep. While I don't want my people to feel pressure to generate significant profit (this would force us into a fruitless search for an instant large market), I want them to feel constant pressure to find some way – some set of customers somewhere – to make our small organization cash-positive as fast as possible."*

So in the beginning, financial needs must be small because the emerg-

ing market is small, increasing slowly as the company size grows in step with the size of the emerging market. As a result, it's hard for institutional investors, even those with "patient capital", to consider funding such new ventures since the financial investments at the beginning are so small.

Not only that, since the small company is growing in step with the market that its innovative products are creating, the company simply can't put to good use any sizable investment that might be made! Indeed, the only way to grow faster than "your" market would be to create multiple (innovative) products at the same time (ideally, variations on the same theme) to help create multiple new markets at the same time.

Still, this is counter to the "bowling alley" wisdom proposed by [13] which suggests that you ought to first concentrate your business efforts in one place, and then evolve "horizontally" to reach "neighbouring" markets with similar needs that can be met by derived products. This reasoning is predicated on the need to concentrate on the give-and-take as supplier and buyer together "discover" what to do. And as you might guess, it becomes harder and harder to do this right as the number of emerging markets increases. In practice, it's already hard enough to acquire the detailed "market" knowledge about just one set of customers!

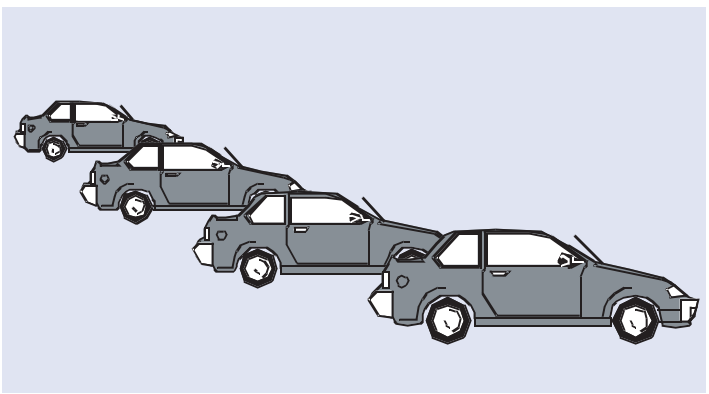
5.0 On business imperatives

Since "learning by discovery" is necessarily uncertain, proceeding as it does by trial and error, the supplier must be "small enough" with an appropriate cost structure (salaries, promotional budgets, overhead, etc.) that reflects the size of the emerging market. Only then are small opportunities and small victories important. And only then can a series of small victories gradually make it possible for small businesses to become profitable and grow.

Stated otherwise, new product development plans must be carefully "modulated" in order to grow in step with the size of the emerging market. And if your company is counting on sales revenue (as opposed to investors' capital) to stay in business, then you'd be wise to "innovate a little, sell a little", to paraphrase 3M's strategy! Note too that the "right" product possibilities will only "reveal" themselves to players engaged in this give-and-take, not bystanders, as companies work to better understand their new customers.

But what happens when even "innovate a little" requires a substantial investment in time and dollars? (This can happen when many inter-connected bits of new technology must be developed at the same time.) If eventual "payback" (sales revenue) can't really be estimated, then how can you proceed? Here I'd like to suggest that "co-development" is one answer, whereby the customer and supplier together contribute in a technical and especially financial way [12]. Now, with a stake in the outcome, the customer will likely work more closely with the supplier (over several iterations) to make the new product a success. Note too that the supplier's out-of-pocket investment becomes smaller and moreover, if all goes well, that first customer becomes the supplier's key industry reference and the means to sell to other customers with similar business needs.

In practice, the situation is a little more complicated. Remember that in general, a business product is typically purchased to become part of a different business product or service, on down the "value/buying chain" to the final end-user. Consider this: A sells a product to B who builds it into his product offering for C who then provides a service to D. As a result, there is room for the supplier (who is commercialising the technology innovation) to develop strategic alliances with *partners* in addition to customers (end-users). Indeed, a recent survey of world-class software suppliers [9] clearly found that one key to business success is precisely the concept of alliances among suppliers of complementary products and services.



(Over time, I have become a believer in this "ecology" of business idea, and interested readers might wish to turn to Jane Jacob's latest offering [10] a search for universal principles that characterize complex systems, both "natural" and "human made".)

This also suggests that the successful commercialisation of one technology innovation often depends upon a constellation of other things being "just right". Consider the following example from the early days of the century as described in [2]. Having "built a better mousetrap", key players in the newly emerging automobile industry (including General Motors and Goodyear) built "seedling miles" along proposed highway routes. Then, once there were enough cars on the road, i.e. once the emerging market grew large enough, governments were persuaded to take over. (The rest, of course, is "history", as more and more of the world gets paved over. But that's a topic for another article!).

As a result, you sometimes hear commercialisation failure blamed on being "ahead of the market", marketing-speak which suggests that the guilty parties neglected to ensure that all of the stars were in the appropriate constellation. (Think again of the nascent car builders and their need for roads, not to mention gas stations!)

There is a second way that small, growing (product-based) companies can better secure their future in the midst of market uncertainty. You might want to consider complementing your *product-based* sales revenues with *project-based* service/consultation revenues. In this way, as you continue to promote your new (innovative) products, you'll be able to keep your business afloat with other sources of funding. Ideally, the one flows into the other, instead of creating internal chaos.

6.0 On selling innovative products

So we've now seen that the creation of a (whole) product from technology innovation entails significant technical and especially marketing effort. Still, the challenges associated with *selling* that product can be even more daunting! Why? Because selling a truly innovative (think "market-creating") product means that before your potential customer can be persuaded to buy your product (so that money changes hands), you must first educate that potential customer about the *idea* of your product.

Of course, anyone with a product to sell can encounter selling problems. But established products have, in established markets, well-defined value/buying chains and so long as a new product simply enhances an old one, the purchasing decisions remain similar and the same people (e.g. in a purchasing department) follow the same procedures to obtain authorization, shipping details, etc.

Now consider selling a truly innovative product. First off, there is no established market (of course) so much effort must be devoted to identifying suitable potential customers. And in our over-worked world, those potential customers must now make time for something "new" in their busy day already filled with "ordinary" concerns (think existing products for existing markets). Here's where your powers of persuasion and perseverance are put to the test, as you "push open" doors that open just a crack, in order to earn an opportunity just to present your innovative product and begin the selling process.

But even here, the traditional purchasing dynamic breaks down. Faced with a truly different kind of product, many more people now must "climb onboard". This means that you'll need to make your new product available in some kind of "evaluation mode", and *cheaply*, so that your potential customer can call in everyone who might have something to say about it. And the larger the price tag, the more people consulted, and the longer the evaluation will be, stretching into weeks if not months! Remember that in many cases, your selling price (for the new product) will be just a small part of the real cost to your customer, who must struggle to change his business practices and learn to do things differently after the product purchase.

Worse, in many if not most cases, your potential customer will also seek guidance from *his own* customers, since the modern business-to-business world is, as previously noted, full of "value/buying chains". So let's return to A who sells a product to B who builds it into his product offering for C who then provides a service to D. Now consider that you just won't get very far with A until B and perhaps C have had a chance to speak up (and talk with A).And then, in many cases, you'll discover

that having pushed open the door, your product is not suited to this potential customer so that instead of selling (earning money to pay down your expenses), you're back to marketing (spending money to learn more about what the "right" product might be).

And so companies operating in emerging markets struggle with two kinds of problems: proving to potential customers that their new products will provide real added value, and quickly building a critical mass of customers with sufficiently common needs *and buying patterns* so that enough sales can be made. To address these problems, such companies often look to strike alliances with established players in order to gain product credibility and accelerate product promotion through 3rd party distribution. And as we've noted already, if you're lucky, such distributors will also be co-development *partners*, sharing the technical and financial risks associated with your commercialisation efforts.

Finally, let's not forget that electronic connectivity is making the world a smaller place all the time. According to one recent estimate [5], 30% of all products and services today are involved in international trade. By 2020, this is expected to rise to 50%. Practically, there is both an upside and downside to this "global village". On the upside, when markets are emerging, they are now emerging on a global scale, so that in your early days, you might have just a handful of customers "nearby" but enough other customers "far away", all sharing similar needs, to keep you in business. This suggests then that right from the start, you ought to think about how your new (innovative) product could be sold (and delivered and maintained) to customers who are far away. Now for the downside: while you're busy in your own corner of the world, someone else might be busy in another corner of the world chasing down something very similar!

Of course, in the old (pre-Internet days), we relied on things like physical distances, oceans, and language barriers to keep such companies and their products separate. But now, with electronic connectivity and he overwhelming use of English as the global "lingua franca", that unknown competitor, regardless of his native language, will be creating an English language version just as you are doing now! On the other hand, even here, this one world/one language can work in your favour because customers in his home country might just be ready to buy your (English language) product as is!

7.0 Conclusions

In this article, I've tried to make the case that while creating a product from a technology innovation can pose enormous technical challenges, the real barriers to commercialization are primarily *market-related*. As we've seen, the give-and-take between supplier and customer is key to market-creating innovation and new business wealth. And this is necessarily a perilous exercise, all the way from defining a winning set of product features to overcoming technical hurdles to addressing selling challenges! As a result, companies grow in step with the markets they are creating for their new products, and for the most part, this means that they grow slowly. So be patient, work hard, keep the faith, and remember: "Luck favours the persistent" [4]!

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About the author

Paul Freedman holds degrees in Engineering Physics and in Electrical Engineering from the University of Toronto, the University of British Columbia, and McGill University.

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Competency- and Project-Based Programs in Electrical & Computer Engineering at the Université de Sherbrooke

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Abstract

The Department of Electrical and Computer Engineering at the Université de Sherbrooke has totally redesigned its electrical engineering and computer engineering programs. Based on recent research advances in cognitive science as applied to student learning, these curricula have led to new instructional models. The programs were built on a competency-based framework, following an original learning approach that combines problem-based and project-based learning. The purpose of this paper is to provide a brief overview of the new curricula framework; to discuss the learning principles involved in the construction of pedagogical activities, and to present program structure.

Sommaire

Le Département de génie électrique et de génie informatique de l'Université de Sherbrooke a effectué une réforme majeure de ses programmes de baccalauréat. S'appuyant sur des recherches récentes en sciences cognitives appliquées à l'apprentissage de l'étudiant, ces programmes ont mené à de nouvelles pratiques pédagogiques. Les programmes ont été conçus dans un cadre de formation par compétences utilisant une méthode d'apprentissage originale qui combine l'apprentissage par problèmes et l'apprentissage par projets. L'objectif de cet article est de faire un bref survol du cadre de ces nouveaux programmes, de discuter les principes d'apprentissage utilisés pour la construction des activités pédagogiques et de présenter la structure des programmes.

1.0 Introduction

The engineering profession is going through exceptional change. It requires an increasingly broad range of skills and know-how to solve increasingly complex problems in a rapidly changing economic environment. Companies are looking for engineers with a harmonious balance of sophisticated technical competencies and refined intra- and interpersonal skills in communication, teamwork, management, creativity, social responsibility, and sensitivity to ethics and sustainable development. Several Canadian and American studies have identified serious gaps between the objectives of engineering programs and the needs of an economy in full transformation [1].

Three years ago, the Department of Electrical and Computer Engineering of the *Université de Sherbrooke* reviewed its Bachelor of Engineering degrees. While graduates have a 100% employment rate and employers have a deep appreciation of graduates' technical knowledge, some conclusions drew our attention. Students start their engineering study with curiosity and enthusiasm. They are eager to design products, to build systems, and to work on real engineering projects. However, the first year comprises mainly courses in fundamental sciences and mathematics, which, although essential, offer little contextualization with real engineering problems. In fact, students perceive engineering as difficult and very demanding. A detailed analysis revealed that the programs consist of a succession of courses that students must work through one after the other. This structure leads students to compartmentalize concepts and fails to facilitate their use in later courses. In fact, students rarely have to integrate material from more than one subject to solve an engineering problem as it really appears. This fragmentation of the corpus of knowledge favors superficial learning limited in space and time. It is thus necessary to repeat a given concept several times whenever it is needed. Finally, we noticed that the design process, hallmark of engineering, is especially concentrated in the program's final year as a capstone design project, but that significant dimensions such as multidisciplinarity, ethics, and social and economic aspects were underrepresented.

Determined to improve undergraduate engineering education, the Department of Electrical and Computer Engineering of the *Université de Sherbrooke* undertook a major redesign of its programs and adopted a new learning paradigm that will have fundamental and long-lasting impact on the quality of its graduates. This ambitious and innovative reform reconstructs all of our current engineering education practices and takes careful consideration of the many elements affecting the quality of engineering education. To achieve this large-scale endeavor, we defined two structuring frameworks. The first specifies the outcomes the students should be able to demonstrate upon completion of their studies, that is the competency-based structure. The second-the learning framework-is based on recent research in learning theory and provides for the detailed design of all educational activities and the development of an effective assessment scheme.

In fact, students perceive engineering as difficult and very demanding.

This paper presents a general overview of the main characteristics of these frameworks and presents some key steps leading to implementation of these new programs.

2.0 Curricula Framework

"Conventional" engineering programs give priority primarily to knowledge acquisition. In doing so, they neglect not only the process of personal and social construction of knowledge, but also the development of professional competencies. While not completely ignoring competencies, they focus on allowing students to develop a deep knowledge base before they are able to think about applications and their integration in competence. Electrical engineering and computer engineering programs at the *Université de Sherbrooke* reverse this procedure by putting the gradual development of the professional skills students need to remain in the foreground of training. Competence can be defined as a complex ability to act founded on the effective mobilization and use of a set of resources. The central idea of this ability to act brings out that each competence is embodied in action and that it allows an individual to implement a set of reflections, processes, strategies, and actions to solve a given task. The ability to act helps distinguish competence from a simple procedure, which distinguishes competence from becoming synonymous with know-how. The ability to act thereby invests competence a comprehensive role and character. From this perspective, a curriculum can contain only a limited number of competencies, each of them integrating a very high number of resources. In addition, ideas of mobilization and use are capital because a competence does not constitute a kind of algorithm memorized and practiced repeatedly in order to ensure its perpetuity and reproducibility. An ability to act is very flexible and adaptable to different contexts and various problems. This flexibility and adaptability justify the importance of the mobilization. A competence concerns heuristics more than an algorithm. Many and varied resources are required when implementing a competence, with knowledge constituting a very significant part of these resources. While referring to the cognitive resources, authors emphasized the fact that a competence is a system of knowledge that is declarative (know factual information), conditional (know how to use the knowledge in specific ways), and procedural

(know when and where to apply this knowledge) that is organized in operating plans that allow, within a family of situations, problems to be identified and solved through effective action. This second definition, complementary to the first, brings out that knowledge is an indispensable resource for competencies and, consequently, it should occupy a very important place in a competency-based engineering curriculum.

A competency-based curriculum, also referred to as outcome-based education, specifies the outcomes students should be able to demonstrate upon completion of their studies and orients educational practice towards ensuring that students achieve those outcomes. That is, instead of determining whether students graduate based solely on the number of accumulated credits, graduation would be contingent upon demonstrating mastery of a defined set of competencies [2]. Designing a competency-based program is a top-down process. The first and most important step is to identify the competencies that each student should be able to demonstrate upon graduation, that is, those expected from an engineer at the start of his or her professional career. The second stage is designing a curriculum map. This tool assigns the final competencies of each session of the program in order to ensure a gradual and controlled development of each competence throughout the curriculum. The last stage is the specific design of specific learning activities to acquire these kinds of knowledge and skills. Each activity must describe:

1. The competencies it addresses and the mastery level,
2. The learning context most suited for the development and expression of the competence (course, tutorial, project, teamwork, individual reading), and
3. The mechanisms and criteria required to assess each competence.

In practice, engineering competencies have a holistic meaning but, for the purpose of our programs, competencies are classified in four main categories:

- Electrical engineering scientific and technical competencies,
- Design competencies,
- Interpersonal competencies,
- Intrapersonal competencies.

Examples of Key Competencies:

- Solve complex electrical-engineering problems in the field of signals and systems, analog and digital electronics, electrical energy, automatic control, and communications,
- Plan and manage engineering project,
- Work effectively on disciplinary and multidisciplinary teams in varied contexts,
- Exercise capacities of analysis, abstraction, synthesis, and creativity.

Le terme "contextualization" est un terme technique courant des sciences de l'éducation utilisé pour décrire le processus d'enseignement et d'apprentissage.

The term "contextualization" is a technical term used in educational sciences for explaining the processes of teaching and learning.

3.0 Learning Paradigm

Competency-based education is grounded on cognitive sciences, in particular, the constructivist philosophy of teaching and learning. Our electrical engineering and computer engineering programs have been designed according to this theory. Each student learns through a personal construction of knowledge and competence that progressively leads him or her to become an independent, self-governed learner. The learning framework is based on fundamental principles suitable to competency-based education [4]:

- The first is that any learning requires the support of previous knowledge and conceptions,
- A second principle stipulates that the hierarchical organization of knowledge plays a very important role in the professionalization of students. It is crucial, in learning, that students connect pieces of knowledge, that they determine hierarchical relationships, and that they recognize the professional situations in which this knowledge should be applied,
- The third principle emphasizes the fact that learning viability requires strong initial contextualization. It is of prime importance that learning be based on complex situations that yield meaning,
- A fourth principle stipulates that transferability of learning be supported by actions of decontextualization and recontextualization. Consequently, it is important for students to regularly reuse their newly acquired knowledge in contexts that are different from the initiating contexts and that students be guided and supervised in their first attempts at recontextualization. Considering that learning instances are not isolated entities but rather constitute resources for comprehension and action,
- The fifth principle emphasizes the fact that the new learning instances should be built to closely connect with cognitive strategies (How to judiciously use knowledge and skills? How to put them into action?) and metacognitive strategies (How to self-regulate the implementation of cognitive strategies, knowledge, and skills?).

By taking these principles as a frame of reference for learning and the way individuals learn, a team of faculty members systematically revised educational activities, their orientations, and interrelations.

4.0 The Program

A competency-based curriculum requires a new pedagogical approach. It appeared almost impossible to preserve a curriculum that gave priority to quite distinct activities such as lectures and laboratories, which stress adding knowledge rather than integrating it into competencies. All things considered, it was a question of privileging a curricular structure that directly supports the personal and social construction process of the knowledge and competencies required to intelligently practice engineering. Given the principles stated above, the revised programs were designed with a composite approach of project and problem-based learning referred as APPI (French acronym for *Apprentissage par Problèmes et par Projets en Ingénierie*, which can be translated as project- and problem-based learning in engineering). These cooperative programs last eight academic semesters, alternating with four internships beginning after the third semester. Each semester is organized around a theme (i.e., signals and systems, computer architecture, electrical systems, etc.) and basically includes two types of activities: several two-week, problem-based learning units and a design project, which extends over the entire session (Figure 1). The project is worth 3 credits the first year and 9 credits the fourth year, for semesters of 15 credits. So, during the curricula, the focus on solving problems decreases to give more liberty to students to apply their competencies to projects. A faculty team is in charge of all activities during a given semester.

Our curricula are built on problem-based learning (PBL). They are organized around problem scenarios rather than disciplines or subjects as in a traditional program. PBL is also the principal mode of knowledge acquisition. Each problem is formulated so that the solving process leads students to discover what of their existing knowledge can be used,

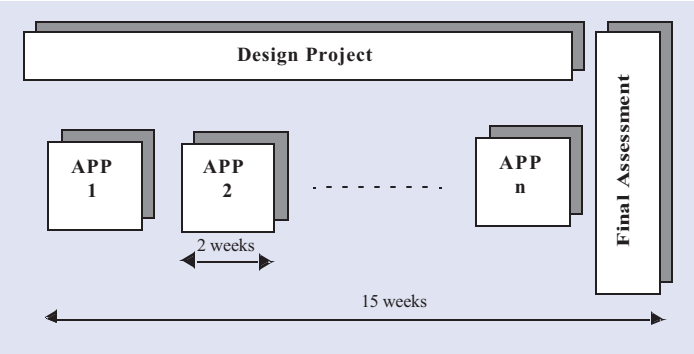

Figure 1: Semester structure

what they need to learn, and what skills are required to manage the situation effectively.

This learning contextualization provides for better knowledge organization, ensuring the recall and application of that information in subsequent situations. It provides realistic applications and the portability of skills across experiences, while increasing relevance for learners. PBL facilitates the learning paradigm shift from passive to active learning. It encourages students to take more responsibility for their own learning. This means that professors, after the beginning of the program, should not provide information that they feel is required by students in their studies, nor suggest reading or study assignments.

According to this paradigm, students must learn to determine what they need to learn, based on what they already know, and seek out suitable learning resources. Professors become "resources", coaches, or tutors. In our programs, PBL takes place in small groups (typically comprising 12 students) within a tutorial setting. Under tutor guidance, students gradually develop their self-study skills, which is absolutely essential in a profession in which new problem types and new information grow at a frantic pace. Problem construction requires a particular attention. Problems must issue from real engineering situations and allow students to access, study, and integrate information from different disciplines. Problems must be designed to reinforce the learning process rather than ensure total coverage of knowledge. At the end of each PBL unit, students should reflect on what they have learned in terms of concepts and principles, and determine if anything is missing in their understanding of the problem. This important stage allows students to translate procedural knowledge acquired during problem solving into declarative knowledge for reuse in other problems. Concept maps are very useful tools in this process. Student collaboration is also an important characteristic of PBL. Naturally occurring during group discussions with the tutor, it facilitates individual learning and develops teamwork skills, which are essential for engineers. Tables 1 and 2 show the typical organization of a PBL unit (grey zones are related to project activities). A PBL unit starts with a tutorial meeting, which has a structure, adapted from [4]. During a tutorial, students:

a) explore the problem and identify issues;

b) formulate "what the problem is";

c) identify pertinent knowledge acquired previously;

d) identify what is not known and what new information is needed; and

e) as a group, prioritize the learning needs, and set learning goals and objectives.

The tutor's role is crucial. He or she acts as an expert, asking questions, providing real-time validation of the students' prior knowledge, and ensuring that the learning goals and objectives are well identified. The rest of Week 1 is occupied with self-study, group problem solving, and laboratory work under the guidance of teaching assistants and teachers. During group problem-solving activities, students practice problem-solving procedures. Supervisors for the activity do not present solutions to problems, but offer real-time validation of the solution presented by students to their peers. Working on solving the assigned problem continues during Week 2; additional problem solving and laboratory sessions are provided. During the second tutorial meeting in Week 2, students review the hypotheses that were generated in Tutorial

I; report through interactive discussions on what they have learned; solve the problem; determine if anything is missing; and assess the new knowledge, the problem's solution, and the effectiveness of the process used. Here again, the tutor's role is crucial. By asking many questions, he or she validates the new knowledge, decontextualizes it, and brings students to exchange on their learning strategies. Formative assessment is then carried out so that students can monitor their individual learning achievement. The PBL unit ends with summative assessment to measure the student's individual problem-solving skills, self-directed learning skills, and ability to recall and apply declarative and procedural knowledge associated with the unit topic. Seminars or workshops on specific topics supplement tutorial learning. At the end of each unit, the faculty team and a student representative meet to critically review the unit.

PBL is very effective for learning declarative and procedural knowledge in fundamental and engineering sciences. However, this learning method is not well suited to allowing design and project management skills to be developed at the desired level throughout the program. For that purpose, project-based learning provides an authentic engineering environment and promotes "real-world" skills intended to simulate professional situations. Though the end product is the driving force in project-based learning, the content knowledge and skills acquired during the production process are important to the approach's success. To reach this objective, there is a common project each semester. For example, first-year projects are designed to introduce students to the profession of engineering and to represent a normal engineering environment. They provide the context for developing the following skills: nature of engineering design, project management, manufacturing and quality, social and technical roles of the professional engineer, written and oral communication, team building, and health and safety. All projects are team-based and a project-review meeting is held each week with a faculty member.

5.0 Assessment

Assessment plays a determining role in a project- and problem-based curriculum and therefore must be consistent with the competency-based philosophy. Since competency is a transparent concept in that we cannot directly evaluate it, we can only observe its outcome in a given context. Competencies must be evaluated in terms of behaviors that can be demonstrated and observed in a professional context. So, assessment

Table 1: PBL Unit - Week 1

Monday	Tuesday	Wednesday	Thursday	Friday
Tutorial I (1h30)	Personal Study	Lab (3h)	Project and Lab (3h)	Solving Group Problems (3h)
Personal Study			Personal Study	Personal Study
		Problems solving (3h)	Project Review (2h)	

Table 2: PBL Unit - Week 2

Monday	Tuesday	Wednesday	Thursday	Friday
Personal Study	Personal Study	Personal Study	Project and Lab (3h)	Delegate meeting(1h)
			Personal Study	Personal Study
Problems solving (3h)	Seminar (1h)	Tutorial II (1h30)	Project Review (2h)	Summative assessment (3h)
		Formative assessment (3h)		

forms and methods must include a greater emphasis on performance-based methods. Competency-based education imposes the development of non-traditional assessment techniques, which represent a major challenge for the faculty [5]. Students need feedback about how and what they are doing, and they must learn how to use feedback to improve performance. Assessment must document and promote the development of their knowledge and skills to effectively reason and solve engineering problems. We designed an assessment plan with the following characteristics:

- Assessment must be carried out according to explicit and public performance criteria, and should take place in a context familiar to the student.
- Assessment activities need to be diverse enough to provide relevant and meaningful feedback to all involved.
- Assessment must present a matrix linking intended outcomes to the learning activities in which outcomes are to be attained.
- Measures must be identified for assessing each outcome.
- Assessment is mainly individual.
- Assessments should come in various forms: multiple assessors (students, peers, teachers), different units of assessment (individual, team, class), and various types (exams, oral presentations, discussions, technical reports).

6.0 Conclusion

The electrical engineering and computer engineering programs at the *Université de Sherbrooke* have been redesigned in very innovative ways, in both learning and teaching processes. The design and implementation of these curricula are very ambitious and complex, representing a major challenge for the faculty team. Two of the important issues of this plan are critical. The first one is the choice and development of a learning framework. This required adopting a paradigm often referred to in education, which shifts the focus from faculty and teaching to students and learning. With the help of colleagues from the Faculty of Education, we derived a series of learning principles based on research in cognitive science. Then, we put them into practice in a conceptual framework for the detailed design of all educational activities. The result is competency-based curricula, using a learning approach that combines problem-based and project-based learning.

While it is too early to assess the new programs, which started in September 2001, student feedback after two semesters has been very positive.

7.0 Acknowledgements

This work is the result of exceptional teamwork and the authors would like to acknowledge the total commitment of their colleagues to this project over the past three years. Special thanks are due to C.-A. Brunet, R. Fontaine, R. Lefebvre, R. Thibault, S. Bourque (SSE), and R. Hivon (Faculty of Education). This work was supported in part by the *Université de Sherbrooke* (under the major teaching innovations program).

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About the authors

Gérard Lachiver is a Professor in the Electrical and Computer Engineering Department at the Université de Sherbrooke. As past chairman of the department, he was leading a team in charge of reforming the undergraduate programs in electrical engineering and computer engineering. In addition to his research in intelligent control of complex systems with applications in automotive and power systems, he is also interested in developing strategies for improving teaching and learning in engineering education. He can be reached at lachiver@courrier.usherb.ca.

Daniel Dalle is a Professor in Department of Electrical and Computer Engineering at the Université de Sherbrooke (Québec) and he is Director of the Computer Engineering Program. His research interests was previously in the field of physiological signal processing. His interests are in the development of learning methods in engineering. His teaching includes digital circuits, computer architecture and software engineering. He is a member of IEEE and of the Ordre des Ingénieurs du Québec.

Noël Boutin is a Professor in the Department of Electrical and Computer Engineering at the Université de Sherbrooke, in Québec Canada. He received B. Ing (1973) and M. Sc. A. (1975) degrees in Electrical Engineering from the Université de Sherbrooke. His technical interests include RF circuit design and communication systems. His pedagogical interests include the development of the human dimension in engineering undergraduate students.

André Clavet is a professor in the Department of Electrical and Computer Engineering at the Université de Sherbrooke, in Québec Canada. He received B. Ing (1973) and M. Sc. A. (1975) degrees in Electrical Engineering from the Université de Sherbrooke. His technical interests include DSP systems, signal processing and control systems. He is mainly involved in pedagogic experiments on cooperative and autonomous learning and in research on source separation in complex signals.

François Michaud is an Associate Professor in the Department of Electrical Engineering and Computer Engineering at the Université de Sherbrooke. He holds the Canada Research Chair in Mobile Robotics and Autonomous Intelligent Systems. His research activities, supported by CRC, NSERC, CFI and FCAR, include mobile robotics (learning, group and social behavior), intelligent systems, fuzzy logic and applied artificial intelligence. He is actively involved in the engineering educational reform underway at Sherbrooke, mainly by developing a mobile robotic platform for introducing EECE and design to freshmen students.

Jean-Marie Dirand is a Professor in the Department of Electrical and Computer Engineering at the Université de Sherbrooke, in Québec Canada. He received a Ph. D. (1969) degree in applied mathematics from Université de Nancy (France). His research interests include Artificial Intelligence and Intelligent Learning Environments. He develops a WEB based shell to create tutorials, in particular a C++ programming course.

Candidates for Election as President Elect of the IEEE 2003

Position Statement of Vijay K. Bhargava

Our IEEE and the services it provides to its members are the awe of the association business. But like the Bob Dylan song "the times they are a-changin'" and the IEEE is not immune to them. We need to improve our member services and benefits, innovate in the development and delivery of intellectual property products and guide the process leading to fiscal responsibility.

We need to expand membership beyond the traditional field of electrical engineering. There are tremendous opportunities in the information technology and related areas. Members need electronic access for timely authoritative information through publications, conferences, standards and courses. Cross reference links to other publishers, multimedia enhancement, IEEE digital library for members, search & alerting capability, and IEEE job bank should make IEEE even more attractive to members.

Our technologies are increasingly interdisciplinary. We must encourage societies to bring out products that address these needs and give practical information to engineers in industry. Identification and promotion of emerging technologies is a must to position ourselves as a dominant player.

Fiscal responsibility increases the value of IEEE membership. It entails cost cutting and looking at ways of increasing revenues. The challenge is to accomplish this without losing the IEEE as a volunteer organization. We need to identify and sun-set activities that have outlived their purpose to maintain a positive income stream. We need to spend on new initiatives that will lead to new income streams, and services that our members desire.

Biography:

Vijay Bhargava is President of Binary Communications, specializing in innovative error control coding products.

He received his Ph.D. from Queen's University (1974) and holds a Canada Research Chair in Wireless Communications at University of Victoria. He has held visiting appointments at École Polytechnique de Montréal, and around the world.

He is co-author of *Digital Communications by Satellite* (Wiley: 1981) and co-editor of *Reed-Solomon Codes and Their Applications* (IEEE Press: 1994). He is an Editor of IEEE Transactions on Communications. Vijay has published in coding, satellite communications, CDMA wireless system and is leading a major R&D program in broadband wireless systems.

A Gold Medal recipient from the Science Council of BC, he was elected IEEE Fellow for work in error control coding devices. He was recently elected Fellow of the Royal Society of Canada & Canadian Academy of Engineering.

For further information, please visit my web site at http://www.ece.uvic.ca/~bhargava/ieee

Position Statement of Luis T. Gandia

The world is going through a transformation - a transformation that affects both the industrial and the economic world. Our planet is being fundamentally reshaped by the information and technology revolution, which is supplanting the industrial revolution.

The IEEE, as the world's largest technical organization must take a leadership role in managing this revolution. We must be prepared to offer our members, the products and services necessary to survive in today's high technological world, and to grow and prosper within it.

IEEE is doing an excellent job in serving researchers and academics with excellent tools, publications and programs. However, we are not meeting the needs of our industrial membership, our design and practicing engineers. Programs, publications and services geared toward this creative and innovative group must be expanded.

During my 46 years of experience as a professional engineer and more than 30 years of dedicated involvement in international voluntary organizations, I have learned to interact with my peers, hear their concerns with deep interest, and then act. We must listen if we are to know about the needs of our members.

Biography:

Mr. Gandía received his B.S. in Electrical Engineering from the University of Puerto Rico.

After serving in the Army as an artillery officer, he joined a construction company, as a practicing engineer. In this capacity he was responsible for the design and construction of a number of high voltage distribution lines and substations.

He is a Professional Engineer since 1956.Using the knowledge acquired and from further studies in business administration, management and finances, he organized his own business in 1962. The business has grown considerably because of his ability to work with, motivate and understand people.

For more information regarding my qualifications and achievements, please visit http://luistgandia.com.

Position Statement of Arthur W. Winston

As President, I look forward to enhancing membership value, attracting new members, and improving our relationship with industry. I look forward to improving the trust and communication among our organizational units and with staff.

My platform will address:

- Enhancing membership value
- Improving the retention rate of members including students
- Improving efficiency of Board operations
- Providing financial planning and stability
- Restoring industrial acceptance & support
- Stimulating educational activities and career development
- Improving trust and communication
- Enhancing the image of the profession
- Ensuring volunteer input and participation and on a global basis

I will bring very important views and experience to the IEEE Presidency:

- A strong sense of the central role played by the volunteers
- Technical and business management experience
- Success in handling diverse and difficult situations
- Balanced industry and academic background
- A proven track record of getting things done
- A strong desire to increase benefits of IEEE membership

I have the vision, drive and experience needed to lead the IEEE, and am willing and able to dedicate the time, energy and attention required by this most important position. I respectfully ask and thank you for your support.

Biography:

Dr. Winston is an IEEE Life Fellow with extensive IEEE experience up to and including VP and is a member of several societies. He was born in Canada and is a graduate of the University of Toronto where he placed first over 800 engineering students and was awarded 8 merit scholarships. He received his Ph.D. from MIT. He is Director and Professor of The Gordon Institute of Tufts University, a graduate program devoted to the study and practice of engineering management. He was the major architect of the program and was awarded the IEEE Educational Activities Award for Major Innovations in Education. He has 40 years of industrial, academic, and senior management experience including responsibility for the Temperature Measurement System for the Apollo spacecraft.

For further information, please visit my web site at http://www.arthurwinston.com.

Un vent de compétitions pour les clubs étudiants de l'ÉTS

Université du Québec
École de technologie supérieure

Montréal, le 29 mai 2002 - Les clubs étudiants de l'École de technologie supérieure (ÉTS) se préparent pour les compétitions prévues cet été aux États-Unis. À l'horaire, des compétitions de calibre international qui souligneront encore une fois la performance et la qualité des projets étudiants de l'ÉTS. Suivez de près ces engins en version améliorée…

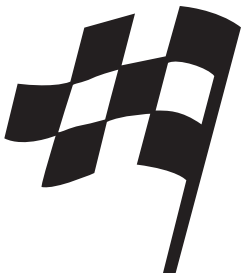
Mini-Baja vous en mettra plein la vue sur terre comme sur l'eau. Ce véhicule tout-terrain amphibie de l'ÉTS a décroché la deuxième position lors de la compétition 2001 Mini Baja East, à Colombia, en Caroline du Sud, et s'est retrouvé en troisième position sur 125 équipes inscrites lors du 2001 Mini-Baja Midwest à Troy, en Ohio. Ces résultats lui ont permis de remporter la coupe Dayton pour la meilleure équipe 2001 toutes compétitions confondues. Le Club a démontré à nouveau ses talents lors de la compétition de la Society of Automotive Engineering (SAE), division Est, à Morgantown en Virginie, du 8 au 13 mai derniers alors qu'il s'est classé en 3e position au classement général. Nous pouvons en espérer autant pour la compétition de la division Centre qui se déroulera du 30 mai au 3 juin à Milwaukee au Wisconsin. Ces épreuves reposeront sur l'endurance du véhicule, sa force et sa manoeuvrabilité tout en respectant la limite de puissance du moteur imposée à 10 chevaux. Le véhicule devra notamment remorquer un autobus sur une distance de 40 pieds!

Mini-Baja: Stéphane Boulet (à droite sur la photo), Alexandre Frigon (capitaine de l'équipe, au centre de la photo) et Martin Dubé (dans le véhicule)

En plus du Mini-Baja, un autre club participera à une compétition de la SAE. Le club de la Formule SAE, une voiture de course monoplace, cylindrée au maximum à 600 cc, s'est rendu à Détroit, du 15 au 20 mai derniers, où quelque 125 équipes du Canada, des États-Unis, du Mexique, d'Europe, d'Asie et d'Australie se sont affrontés. L'an dernier, le club a obtenu la première place au classement canadien de la Formule SAE.

Formule SAE: David Arsenault (Responsable chassis/suspension du club Formule SAE)

Un bolide à faible consommation d'essence…le rêve ou la réalité? Eh bien, une équipe d'étudiants de l'ÉTS a mis beaucoup d'énergie à concevoir et fabriquer un tel véhicule, baptisé Évolution, afin de participer, pour la première fois, à la compétition du Midwest Supermileage de la SAE en 2001. Il s'agit d'une course se déroulant sur une piste ovale et dont le but est de compléter 6 tours de 2,6 km à une vitesse moyenne de 24 km/h, et ce, avec un seul gallon d'essence. Cette année, le club étudiant mettra son véhicule à l'épreuve les 7 et 8 juin à Kalamazoo, au Michigan, dans le cadre du SAE Supermileage.



Connaissez-vous l'histoire de Capra, la chèvre de montagne qui gravit les pentes abruptes de la robotique mobile ? Capra, c'est le robot marcheur quadrupède, dynamique et autonome de l'ÉTS qui a fait sa première sortie lors de la compétition Unmanned Ground Vehicule 2001. Cet été, le Intelligent Ground Vehicule Competition Coronado Spring accueille le robot du 4 au 10 juillet, en Floride. Le robot devra alors compléter un parcours gazonné entre des lignes tout en évitant des obstacles pour aller le plus loin possible. Un second parcours évaluera sa rapidité et sa précision…Bonne chance à Capra!

Vous imaginez-vous enfermé dans un sous-marin de 12 pieds de longueur, de 24 pouces de hauteur, d'environ 20 pouces de largeur, et ce, tout en pédalant pour pouvoir avancer? Les étudiants de l'ÉTS, eux, se sentent tout à fait à l'aise avec cette idée et nous l'ont démontré lors du 6th International Submarine Races 2001. La quatrième version de leur sous-marin à propulsion humaine, Omer 4, a inscrit un record du monde de vitesse deux fois plutôt qu'une avec une vitesse ayant atteint 7,014 nœuds, puis 7,19 nœuds. L'équipe a également mérité le prix pour la meilleure utilisation de matériaux composites! Omer 4 plongera à nouveau à Escondido en Californie du 17 au 21 juillet pour rivaliser avec une dizaine d'équipes. Plusieurs modifications ont été apportées au sous-marin tels l'ordinateur de bord, la direction électrique et la nouvelle hélice.

Après Évolution, le bolide à faible consommation d'essence, voici maintenant une embarcation non polluante. Photon, un bateau de performance à propulsion solaire, a remporté le premier prix pour le système électrique au Solar Splash 2001. Il s'agissait d'une première pour l'ÉTS, d'ailleurs seul établissement universitaire à représenter le Canada lors de cette compétition internationale. Photon retournera à Buffalo du 19 au 23 juin à l'occasion du Solar Splash 2002 muni d'une coque entièrement redessinée et d'un nouveau système électrique. L'équipe est parée pour aller de l'avant!

Une compétition vibrante! SONIA, le robot sous-marin autonome de l'École, retourne pour une deuxième année à l'International Autonomous Underwater Vehicule Competition qui se tiendra à San Diego du 31 juillet au 4 août. L'ÉTS est la seule école québécoise à participer à cette course dont la mission consiste en l'évaluation de la profondeur des objets artificiels sur lesquels repose un code barre unique.

Sous-marin SONIA: Francis Lauzon, membre du club étudiant SONIA

L'École de technologie supérieure a acquis une réputation enviable lors des compétitions universitaires des dernières années. Seule école d'ingénieurs exigeant de ses étudiants qu'ils soient aussi technologues, l'ÉTS forme des professionnels reconnus pour leur approche pratique et innovatrice. L'été 2002 sera l'occasion, pour eux, de nous démontrer, une fois de plus, ce dont ils sont capables !

CCECE' 2002 - Winnipeg, May 2002: A Pictorial Essay

1. The CCECE 2002 was held at the historic and picturesque Fort Garry Hotel in Winnipeg.

2. Conference delegates were welcomed on the Sunday at the Front Desk by Grace McCaskill (fourth from right) and her many assistants.

3. The Reception was an occassion to meet the delegates, local personalities and network.

The next day, it was down to work. The Plenary session was followed by the Presentation of papers, the Poster sessions, the Exhibition and the Banquet.

5. Poster Sessions

4. Plenary Session was set off by Dr Kinsner, Chair of the Conference.

6. The Exhibition included a number of well known book publishers and local manufacturers

Congratulations to the Organising Team on a job well done!

7. The banquet was the setting for the presentation of the IEEE Canada Awards (shown on pages 28-30).

8. Musical Entertainment was a highlight of the evening - replenishing the soul, as Chairman Kinsner put it.

9. Tour of the ECE department of the University of Manitoba.

IEEE Canada

Vehicular Technologies Bursary 2002

Purpose: To support IEEE student members of Canadian Universities or Colleges who wish to attend & present a paper at a Vehicular Technologies Conference or other IEEE Conference related to Vehicular Technologies.

Schedule:

Call for applications	May 2002
Application deadline	November 1st, 2002
Selection of recipient(s)	November 2002
Region ExCom approval	December 2002
Recipient notified	December 2002

Eligibility: Candidates for this subsidy shall be IEEE Student Member in good standing in a Canadian University or College.

Scope: Each travel subsidy will be up to 50% of actual travel costs, based on submitted receipts in accordance with the current IEEE Canada Travel Expenses Guidelines, up to a maximum of $1500 per student, per calendar year. More than one bursary could be awarded per year, but the total amount should not exceed $1500 per year.

The application will contain at a minimum the following:

- Name of conference or IEEE Activity,
- Paper title and abstract or detailed explanation of reason for attending the IEEE activity,
- Proof of acceptance for presentation or attendance of IEEE activity,
- Budget of anticipated travel costs.

Applications will be evaluated based on the following criteria:

- Relevancy of the conference/activity with Vehicular Technologies technical field(s),
- Sponsorship of the conference/activity by the IEEE,
- Presentation of a paper accepted by the conference committee,
- Relevancy of the paper presented to Vehicular Technologies technical field(s).

Submit Applications:

Nominations will be directed to the Regional Student Activities Coordinator at the following address:

Dominic Rivard, 1815 de Longueuil, Trois-Rivières, QC G8Y 1M4
email: d.rivard@ieee.org

IEEE Canadian Foundation

Information for Sections and Councils in Canada

The foundation asks all sections to help us publicize our activities to student branches in the following ways:

- Place a link on your section website www.ieeecanadianfoundation.org
- Ask your student leaders to add this link to their branch web sites.
- Ask your student leaders to use our web site to update information about their branch using our on-line form.
- Remind your student leaders that we fund:

1. **IEEE Canadian Foundation Scholarships** - up to 10 per year,
2. **IEEE McNaughton Learning Resource Centres** - to establish, or upgrade, and
3. **IEEE Special Grants** - for special projects.

- Section Chairs - Please frame and present the certificate to the Scholarship holder within your section at a suitable IEEE (Section or Branch) Meeting.
- Promote the giving of donations to our foundation (tax receipts issued) in your newsletters.
- We have a PowerPoint presentation on our website to provide an introduction to our foundation. Please view our website at your next Section executive meeting so you are familiar with who we are and what we do.

In 2001, the **IEEE Canadian Foundation** awarded $71,000 in grants and scholarships.

The **IEEE Canadian Foundation** promotes active student branches, rewards IEEE student volunteer efforts with individual scholarships and funding for interesting projects, and adds value to the IEEE experience. These activities promote IEEE memberrship. We hope you will make our activities an integral part of your Section membership development program.

Please let us know how we can improve what we do. If you have any questions about the **IEEE Canadian Foundation**, please Contact:

President:	Bob Alden,	r.alden@ieee.org
Treasurer:	Luc Matteau,	l.matteau@ieee.org
Disbursements:	David Whyte,	d.whyte@ieee.org
Donations:	John Mowbray,	john.mowbray@ieee.org

or the entire nine-member board at icfbod@ieee.org

IEEE

IEEE RAB Achievement Award - 2001

Vijay K. Sood (right) received the award from Ray Findlay (left), President of IEEE during the recent CCECE'2002 Conference held at the Fort Garry Hotel in Winnipeg, MB on the 13 May 2002.

To recognize individuals involved with Regional Activities Board (RAB) and/or the Regional Network who are recognized for singular achievement in the development and completion of (a) project(s) or activity(ies) which are directed to the fulfillment of one or more of the goals and objectives of RAB. This award is designed to recognize those substantive projects or achievements of a relatively short nature (one to three years) but which have left an undeniable imprint on the fabric of Regional Operations.

Vijay K. Sood (SM'IEEE),

Managing Editor - IEEE Canadian Review

"For sustained outstanding contributions and service to Region 7 (IEEE Canada) by publishing and promoting the *IEEE Canadian Review* as a national journal for Region 7 members."

IEEE Canada Volunteer Awards presented at the Region 7 meeting held in May 2002 at the Delta Hotel in Winnipeg, MB

IEEE Canada

Cathie Lowell (left), Office Administrator of IEEE Canada, and Mo El-Hawary (right) presented a plaque to **Celia Desmond** (centre), out-going President of IEEE Canada. The plaque is inscribed: "In recognition of her valued contributions as a leader and for distinguished service as IEEE President, Director, Region 7 IEEE".

Congratulations, All!

President of IEEE Canada, Mo El-Hawary (left) presented **Brent Petersen** with the Student Branch Growth Award for the University of New Brunswick.

Mo El-Hawary (left) presents the Section Growth Award to **Kodjo Agbossou**, Chair of the St. Maurice Section.

On the occassion of the 50th year of the formation of the Hamilton Section, Mo El-Hawary (right) presents a banner to section members. Receiving the banner are **Bob Alden** (from left to right), **Ray Findlay**, **Cathie Lowell** and **Scott Lowell** (Chair of the Hamilton Section).

IEEE Canada Awards presented at the occassion of the CCECE'2002 Conference held on 13 May 2002 at the Fort Garry Hotel in Winnipeg, MB

IEEE Canada

McNaughton Medal is IEEE Canada's Highest Merit Award. This year the medal is presented to:

Dr. Prakash Bhartia,

Director General, Defence Research Establishement (DREO), Ottawa.

"In recognition of exceptional creativity, innovation and leadership in the research and development of microwave and millimeter wave transmision lines, devices, components, antennas and systems".

President of IEEE Canada Dr. Mo El-Hawary (left) presents the McNaughton Award for 2002 to **Prakash Bhartia**.

Wallace S. Read Service Award

Ray Findlay is congratulated by Wallace S. Read (left to right) and Abdel Sebak on receiving the Wallace S. Read Service Award. Mo El Hawary is on the extreme right. Dr. Findlay received the award "For sustained outstanding contributions to IEEE Canada".

Outstanding Engineer Award

Ted Sargent (left) makes his acceptance speech for the award which he received "For groundbreaking research in applying new phenomena and materials from nanotechnology towards transforming fibre-optic communications systems into agile optical networks". Mo El-Hawary (centre) and Abdel Sebak (right) look on.

Prix Jean Jacques Archambault

Eric Holdrinet (adroit) a reçu le Prix d'Excellence du Conseil de l'Est du Canada (renomme Prix Jean Jacques Archambault): "Pour le leadership professionnel et le support apporté aux membres de l'IEEE de l'Est du Canadien, la section de Montréal et la Région 7".

Outstanding Engineering Educator Award

John E. Quaicoe (extreme right) receives the award from Mo El-Hawary (center) and Rob Menzies (left). The inscription on the award reads: "Contributions to engineering education, commitment to student learning and growth, and sustained accomplishments as an effective and caring educator".

Ted Glass Western Canada Council Merit Award

Neale Partington received the award "For leadership and continuing service to the IEEE and the South Saskatchewan Section in establishing the first Bulletin Board for the Section". Seen in the picture are Bill Kennedy (left to right) Neale Partington, Abdel Sebak and Mo El-Hawary.

Fessenden Medal

Maier Blostein received the Fessenden Medal "In recognition of visionary and inspirational leadership in university-based telecommunications rersearch." Seen in the picture are Vijay Bhargava (left to right) Abdel Sebak, Maier Blostein and Mo El-Hawary. (*My apologies for the photo quality!)*

CCECE 2003 - CCGEI 2003
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Président du congrès
Guy Olivier, École Polytechnique

Co-président du congrès et du programme
Vijay Sood, Hydro-Québec (IREQ)

Président du programme technique
Samuel Pierre, École Polytechnique

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Publicité
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Cours et sessions spéciales
Éloi Ngandui, UQTR

Représentant des étudiants
Mehdi Lebiad, Alstom

Président IEEE Canada
Mohamed El Hawary

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www.ccgei03.polymtl.ca

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IEEE Conseil de l'est canadien
IEEE Section de Montréal
IEEE Section du St-Maurice
IEEE Section de Québec

IEEE Canada

CCGEI 2003

Pour une technologie équitable

Congrès canadien en génie électrique et informatique
4 au 7 mai 2003, Hôtel Delta Centre-Ville
777 Université, Montréal, Canada

APPEL AUX COMMUNICATIONS

Le congrès canadien en génie électrique et informatique 2003 de l'IEEE offre un forum pour la présentation de travaux de recherche et de développement dans les domaines du génie électrique et du génie informatique provenant tant du Canada que de partout ailleurs dans le monde. Des communications en français ou en anglais sont sollicitées sur des sujets qui incluent, mais ne sont pas limités à :

- Ingénierie biomédicale
- Instrumentation et mesure
- Communications et systèmes sans fil
- Traitement de signal et conception de filtres
- Antennes et EMC/EMI
- Micro-ondes et RF
- Électromagnétisme, optique et photonique
- Automatique
- Contrôle de processus/Automation industrielle
- Robotique et mécatronique
- Électronique de puissance
- Production de l'énergie et énergies renouvelables
- Machines électriques et entraînements
- Circuits, Systèmes et ITGE
- Microélectronique et Optoélectronique
- Télédétection et applications
- Réseaux et systèmes informatiques
- Informatique nomade
- Systèmes à base d'agents et sur Internet
- Calcul haute performance
- Génie logiciel
- Systèmes intelligents
- Réseaux neuronaux et logique floue
- Bases et exploration de données
- Calcul évolutionniste
- Réalité virtuelle et vie artificielle
- Simulation et visualisation
- Interaction personne-machine
- Nanotechnologie et nanorobotique
- Systèmes en temps réel et embarqués
- Architectures avancées d'ordinateurs
- Bioinformatique

1.0 Soumission de la communication régulière :

Veuillez soumettre par courrier électronique un résumé de 300 mots de votre communication en français ou en anglais à ccece03@congresbcu.com. Votre soumission doit inclure un sujet, trois mots clés et le nom de l'auteur principal avec son adresse électronique et postale ainsi que son numéro de téléphone et de télécopieur. Les versions finales devront être soumises électroniquement en format pdf.

2.0 Soumission de propositions de tutoriaux et de sessions sur invitation :

Les propositions pour les ateliers, les cours intensifs et les sessions sur invitation seront acceptées jusqu'au 10 janvier 2003. Prière de contacter le responsable du comité des cours et sessions spéciales à l'adresse du secrétariat du congrès afin d'obtenir des instructions détaillées.

3.0 Compétition de communications par des étudiants :

Afin d'être éligible à la compétition, le premier auteur doit être un étudiant. La communication soumise doit être clairement identifiée "Compétition de communications par des étudiants". Les résultats de la compétition seront basés sur l'évaluation des textes complets. Des versions étendues des textes seront publiées dans la Revue canadienne de génie électrique et informatique, sujet à l'acceptation par la Revue.

4.0 Expositions industrielles :

Veuillez contacter le responsable des liaisons industrielles et des expositions afin d'obtenir des informations au sujet des présentations industrielles durant le congrès.

5.0 Dates importantes :

Date limite pour la soumission des résumés de communications : le vendredi 29 novembre 2002

Date limite pour la soumission de session spéciale : le vendredi 10 janvier 2003

Avis d'acceptation: le vendredi 10 janvier 2003

Date limite pour la soumission de la version finale : le lundi 3 mars 2003

Si vous êtes intéressé par CCGEI 2003 et voudriez être ajouté à notre liste de distribution, veuillez contacter le secrétariat du congrès à l'adresse ci-contre. Notre site Internet sera mis à jour régulièrement.

ÉCOLE POLYTECHNIQUE MONTRÉAL

IEEE Montréal

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CCECE 2003

Towards A Caring and Humane Technology

Canadian Conference on Electrical and Computer Engineering
May 4 to 7, 2003 Delta Centre-Ville Hotel
777 University, Montréal, Canada

CALL FOR PAPERS

The 2003 IEEE Canadian Conference on Electrical and Computer Engineering provides a forum for the presentation of electrical and computer engineering research and development from Canada and around the world. Papers are invited in English or French to include but not limited to the following topics:

- Biomedical Engineering
- Instrumentation and Measurements
- Communications and Wireless Systems
- Signal Processing and Filter Design
- Antenna & EMC/EMI
- RF & Microwaves
- Electromagnetics, Optics and Photonics
- Control Theory and Applications
- Process Control/Industrial Automation
- Robotics and Mechatronics
- Power Electronics and Systems
- Power Systems and Renewable Energy
- Electrical Machines and Drives
- Circuits, Systems and VLSI
- Microelectronics and Optoelectronics
- Teledetection Remote Sensing and Applications
- Computer Networks and Systems
- Mobile and Pervasive Computing
- Agent-based and Internet-Based Systems
- High-Performance Computing
- Software Engineering
- Intelligent Systems
- Neural Networks and Fuzzy Logic
- Database and Data Mining
- Evolutionary Computation
- Virtual Reality and Artificial Life
- Visualization and Simulation
- Human-Machine Interactions
- Nanotechnology and Nanorobotics
- Real-Time Embedded Systems
- Advanced Computer Architecture
- Bioinformatics

1.0 Regular Paper Submission :

Please submit only by e-mail a 300-word abstract either in French or English of your paper to the ccece03@congresbu.com. Your submission should include the topic three keywords and the name of a contact person with e-mail, postal address, as well as a fax and phone number. The final paper should be submitted electronically in pdf format.

2.0 Workshop, Tutorial, and Invited Session Proposal Submission :

Proposals for invited sessions, conference workshops and tutorials will be accepted before January 10, 2003. Please contact the Tutorials and Special Sessions Chair at the Conference Secretariat address shown on the left for detailed instructions.

3.0 Student Paper Competition :

To be eligible, the first author of a paper must be a student. The submitted paper summary must be clearly marked "Student Paper Competition". The competition results will be based on reviews of the full papers. Extended versions of the winning student papers will be published in the Canadian Journal of Electrical and Computer Engineering subject to the final editorial acceptance by the Journal.

4.0 Industrial Exhibits :

Please contact the Exhibits Chair at the Conference Secretariat for information about industrial exhibits.

5.0 Important Dates :

Paper abstracts must be received by :	**Friday November 29, 2002**
Special Session proposals must be received by :	**Friday, January 10, 2003**
Notification of acceptance will be sent out by :	**Friday, January 10, 2003**
Final papers must be received by :	**Monday, March 3, 2003**

If you are interested in CCECE 2003 and would like to be added to our mailing list, please contact the Conference Secretariat at the address on the left. Check our Web site for news and regular updates.

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