THE IMPORTANCE OF NETWORKING IN PHYSICS EDUCATION: MULTIPLE HEADS ARE BETTER THAN ONE

by Marc Nantel

The world of physics education is full of opportunities and challenges. For example, whereas every week new discoveries capture the public's imagination, it is ever difficult to recruit students into physics undergraduate programs; the teachers and university professors who actively pursue physics education research are developing great methods and resources to facilitate learning in physics, but their discoveries are not widely known and too rarely implemented; while new programs in physics can be expensive to start and could benefit from free industry equipment donations, many such potential partnerships go unrealised. Better communication between physicists and their principal audiences (public, industrial and governmental) and between physics educators themselves (across all levels of the educational system) can go a long way in capturing opportunities and reducing the impact of the challenges. It is becoming increasingly important that there be effective networking tools in the education community, and this paper presents a few examples of such tools that have brought good results in photonics education for all involved (locally, on the national scale, and globally). These tools - based on the ideas of networking clusters - are easily implemented and have had major impacts on several programs in photonics and in the science & technology awareness communities.

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INTRODUCTION

An educator in physics has a question about curriculum development, about the way to best convey a particular concept (in lectures or in the lab), about which book to use for a new course to mount or a continuing one just taken over. Where does one start? With the people one knows, those in the department or collaborators from other institutions. If this doesn't provide the information needed, one can follow it up with a web-search and a literature search. This progression can be somewhat limiting, time-consuming and tedious. Information is important, but knowing where to get it and actually having a dialogue with the source of this information is even more important. What if one could tap into a large reservoir of knowledge and experience in one's field just by sending an e-mail? This could certainly be useful.

Networking is done at many levels, in many fields. A "network" according to the meaning in this article is a web of interconnected people sharing an interest in the success of a particular enterprise. Networking in physics education takes place in Canada in various ways. There is an Association of Physics Teachers in some provinces: British Columbia has the BCAPT [1], Manitoba has the MAPT, Ontario has the OAPT [2], and so on. Some are Canadian chapters of the American Association of Physics Teachers (AAPT) [3], like those in BC, Alberta [4] and Ontario. Most intend to have membership cutting across all levels of the education spectrum: the OAPT, for example "is an organization consisting of physics educators from secondary schools, colleges, and universities", according to its webpage [2]. Some have list-servs, some have newsletters, some hold annual meetings, some do all three. These provincial associations provide a way for the interested physics teacher to exchange with colleagues at the local level and are very broad (covering the whole of physics education). At the national level, there is the CAP's Division of Physics Education, which holds sessions and workshops at the CAP Annual Congress, and encourages publication of physics education papers in "Physics in Canada", amongst other things [5].

Physics educators can benefit from being better connected to each other, not just to information. These connections should happen through all levels (from grade school to grad school). Continuing education and science & technology outreach should be included, as well as funding agencies, industry and any player with a stake in the success of physics education as a whole. It helps for these connections to have a particular subject or emphasis in common to focus the motivations of the various participants. This paper presents a model for networking in physics education that has been tried in Ontario for the photonics education and training community in particular, but that could be extended to any subject.

WE HAVE SEEN THE LIGHT: THE EXAMPLE OF PHOTONICS

Photonics is part of our everyday lives, and has been for a while. It can be defined as the generation, transmission, manipulation, detection, and utilization of light information

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and energy [6]. Obvious early examples are photography, microscopy and lenses for vision correction. The laser now finds applications at the supermarket, in the doctor's office, on manufacturing production lines, in entertainment, in the military and in telecommunications. Add to this all the other components of photonics -- lighting, imaging, projection, biophotonics, spectroscopy, etc. -- and it becomes clear that it is a crucial strategic technology globally [6]. While the exponential growth of the telecommunications industry in the 1990s stopped early in the 2000s, there is still a great need for photonics-knowledgeable personnel at all levels, from assemblers and technicians to engineers and research scientists.

During the unsustainable growth period of the late 1990s, immense pressure was put on education systems in several regions globally to feed the need for employees, mostly for the large telecommunications companies (Lucent, JDS Uniphase, Nortel Networks, for example). Very few North American regions had the programs in place to respond to this demand (though Québec City and Rochester, NY were well positioned) but, in Ontario for example, several new programs at the technician/technologist, bachelor's and continuing education levels have been implemented to fill the demand. Some have survived, some have not, but it remains that there was a sudden increase in the photonics education and training activity in the province, which gave this community a strong need for coordination. Several other regions of the world saw similar changes [7,16], and it became crucial to establish links of communication and networking mechanisms for the teachers and researchers involved in these efforts.

THE ONTARIO PHOTONICS EDUCATION AND TRAINING ASSOCIATION (OPETA)

In Ontario, the growth of photonics education and training picked up pace starting in 2000. Addressing the need for technicians and technologists, Photonics Research Ontario (PRO, Toronto), Niagara College (Welland) and Algonquin College (Ottawa) established together 2- and 3-year programs at the colleges in a 4-year, $7.6-million curriculum-development and implementation project mostly funded by industry and the government of Ontario [8]. Vitesse (Re-Skilling) Canada (Ottawa) [9], the Canadian Microelectronics Corporation (CMC, Kingston) [10], the University of Toronto's Professional Development Centre (PDC, Toronto) [11], the University of Waterloo's epSTAR (Waterloo) [12] and Algonquin College were starting continuing education programs to provide photonics training for scientists and engineers already possessing degrees to facilitate their slide into this sector with huge personnel demands. McMaster University (Hamilton), Carleton University (Ottawa) and Wilfrid Laurier University (Waterloo) were putting together new undergraduate degrees and specializations in photonics through their Engineering Physics, Physics, and Physics and Computer Science departments, respectively, to address the need for engineers and scientists [13].

Out of chaos, a solution

All this activity featuring several new players in photonics education made for a rather confusing state of affairs from industry's and the student's points of view: What are all these programs? Which one is best for my needs? What are the differences between them? From the point of view of the educational institutions implementing the new offerings: What are these other programs? Are they going to target the same student pool as ours? How are we in competition for funds and industry support? Because of Photonics Research Ontario's position as the Ontario Centre of Excellence mandated to support the growth of photonics in the province, it was involved -- in one way or another -- with most of these new education and training programs. In order to focus the various stakeholders on the main task at hand -- providing high-quality photonics workers to industry and good careers for our students -- a "summit" of all known Ontario non-graduate program providers was called by the author for 6 June 2001. At this summit, participants from universities, colleges and independent curriculum providers exchanged information about their respective programs and networked extensively. It was quickly realized that each had much more in common than was thought, including the challenges of teacher and student recruitment, and access to resources and funds. A main point emphasized at the summit was the almost non-existent voice the photonics education and training community had in the spheres of politics and the general public. In light of all of this and the success of the summit, all participants agreed to form an association to pursue together the common goal of providing photonics education and training in Ontario. This is how the Ontario Photonics Education and Training Association, or OPETA [14], came to be.

OPETA: a photonics education and training "cluster"

In the beginning, OPETA was little more than 14 people from 9 institutions, held together by a desire to establish healthy high-quality programs in photonics. Even as such, OPETA was the start of a photonics education "cluster". A cluster is a group of local companies, educational institutions and other stakeholders rallying around a particular sector of the economy or industry [15]. By pooling resources, a cluster can network, share best practices, influence local politics, and lobby municipal, provincial or federal levels of government. One of the essential aspects of a cluster is that it be local, regrouping members from within a 50 to 100-km radius, typically (in OPETA's case, this is expanded to the whole of the province of Ontario). Other examples of photonics education clusters include the National Association for Photonics Education and Training (NAPET) in Singapore and Project PHOTON in New England (USA) [16]. One of the main tenets of clustering is that competitors are better served working together for the growth of the whole of their sector, to increase the size of the sector instead of solely trying to get a bigger piece it.

In the early days of OPETA, the author became the de facto Chair of the fledgling association, an appointment that has since been renewed three times. The Chair is the extent of the formal structure of the cluster: ad-hoc committees are struck for special purposes (organizing the Annual Meeting, distributing donations, etc.), and their make-up changes from one time to another to facilitate a wider involvement

from the whole OPETA membership. OPETA received funding from the Ontario Ministry of Economics Development and Trade through the "Photonics Education and Training for Critical Skills Shortages" project that established the 2-year Technician and 3-year Technologist programs at Niagara and Algonquin Colleges. This funding amounted to about $20,000 over 4 years. While this financial support is helpful, an association like OPETA can operate successfully with almost no cash, counting on in-kind donations from its members (to host the meetings, the webpage, etc…). As of November 2004, OPETA counted 64 members from 53 academic, governmental and industrial organizations; see table 1 for a complete list.

Communication is the key to successful networking

Because networking is a key component of a cluster's activities, much effort was spent in the early days of OPETA to establish efficient and successful means of communication, both internal and external. These are centered around a three-pronged approach including regular face-to-face meetings, a list-serv, and a webpage.

The most important regular events organized by OPETA are its meetings. These are held for the OPETA members to network face-to-face every 3-4 months, rotating throughout the province. Much gets accomplished in these meetings, including setting the priorities for the year, striking committees to address particular issues or events, and keeping each other informed of recent progress in our respective programs. Meetings are usually scheduled as half-day events, with lunch and coffee breaks provided by the host institution or OPETA's budget.

TABLE 1

OPETA member organizations, as of November 2004, showing the diversity in geographical representation (much of Ontario, some in Nova Scotia and British Columbia, and one in Scotland), educational levels (Outreach, Grade/Middle/High Schools, Colleges, Universities, Continuing Educations) and sectors (educational, governmental, industrial).

Colleges	Government/Clusters	Continuing Education Providers
Algonquin College (Ottawa, Ontario)	Canadian Microelectronics Corporation (CMC)	epSTAR
Canadian College of Business and Computers (Toronto, Ontario)	Centre for Microelectronics Assembly and Packaging (CMAP)	Lightguide Systems
Durham College (Oshawa, Ontario)	Canadian Photonics Consortium (CPC)	Physiciens Sans Frontières
Fanshawe College (London, Ontario)	Canadian Department of Foreign Affairs and International Trade (DFAIT)	Valkom
George Brown College (Toronto, Ontario)	Strategic Microeletronics Consortium (SMC)	Vitesse (Re-Skilling) Canada
Niagara College (Welland, Ontario)	Ontario Ministry of Economic Development and Trade (MEDT)	
	National Capital Institute for Telecommunications (NCIT)	
Universities	Industrial Research Assistance Program (NRC - IRAP)	**S & T Outreach Organizations**
Acadia University (Wolfville, Nova Scotia)	Ottawa Centre for Research and Innovation (OCRI)	Let's Talk Science
Carleton University (Ottawa, Ontario)	Ottawa Photonics Cluster (OPC)	Scientists in School
Dalhousie University (Halifax, Nova Scotia)	Ontario Photonics Technology Industry Cluster (OPTIC)	Science and Technology Awareness Network (STAN)
McMaster University (Hamilton, Ontario)	Photonics Research Ontario (PRO)	
Queen's University (Kingston, Ontario)	Ontario Centres of Excellence, Inc. (OCE)	
Simon Fraser University (Vancouver, British Columbia)	Ontario Research and Development Challenge Fund (ORDCF)	**Grade/Middle/High Schools**
Strathclyde University (Glasgow, Scotland)	Ontario Institute for Studies in Education (OISE)	The City School (Toronto, Ontario)
University of Guelph (Guelph, Ontario)	Global Photonics Education Network (GPEN)	Dennis Morris High School (St Catharines, Ontario)
University of Ottawa (Ottawa, Ontario)		John Paul II Catholic Secondary School (Scarborough, Ontario)
University of the Ontario Institute of Technology (Oshawa, Ontario)	**Companies**	Queensway Christian College (Toronto, Ontario)
University of Toronto (Toronto, Ontario)	Air Products and Chemicals	Toronto District School Board (Toronto, Ontario)
University of Waterloo (Waterloo, Ontario)	JDS Uniphase	University of Toronto Schools (Toronto, Ontario)
University of Western Ontario (London, Ontario)	Optiwave	
Wilfrid Laurier University (Waterloo, Ontario)		

The second means of direct communication established in the week following OPETA's inaugural meeting was the list-serv. A list-serv is a single e-mail address to which any member from the list sends an e-mail that will reach all the other members of the list. It is the simplest way to reach everybody at the same time. When meetings have to be set, policy has to be discussed, new resources have to be publicized, it is a very useful tool. The OPETA list-serv is easily the communication tool with the most return on investment. In order to have a web presence for the outside world, OPETA established its webpage at www.opeta.ca. The webpage serves as a resource centre for the members, with documents, links, forms and other information posted for their viewing. The webpage also serves as a recruiting tool.

OPETA accomplishments

Of course, the explosion of photonics education and training programs that led to the formation of OPETA mostly took place before the telecom slow-down. Some of these programs were mothballed or considerably altered in view of the change in demand from that dominating sector of the Ontario economy. However, even in this climate, together the members of OPETA saw through several key initiatives that strengthened the entire community.

Equipment donations

One of the most immediate results of the telecom downturn was the abrupt need for the large companies that were downsizing to get rid of its superfluous equipment. After the lay-offs following the reductions in sales, companies like JDS Uniphase, Nortel Networks and Bookham Technologies, for example, were left with millions of dollars in equipment left unused. This equipment not only occupied precious space that could be put to other use, but it also devalued with time, bringing down the book value of the companies. When faced with a slumping share value, it was imperative for these companies to part with this equipment. While donating this equipment to educational institutions seems like an ideal solution, it can involve much work and complication due to the large number of potential recipients and the need to coordinate shipping, 3rd-party valuations, tax receipts and good-corporate-citizenship publicity pieces.
OPETA helped JDS Uniphase avoid most of these difficulties by taking ownership and distributing upwards of $3-million CDN of equipment donated by the company to its membership. Lasers, optical spectrum analyzers, detectors, telecom testing equipment and more, were donated by JDS Uniphase in the Summer of 2002 to OPETA, which promptly took delivery of it all, stored it and had its value appraised. In the Winter of 2003, OPETA had a competitive call for proposals among its members to distribute the equipment fairly and equitably. These donations in several cases formed the basis of laboratories for new photonics programs at Niagara and Algonquin Colleges, the Canadian College of Business and Computers, Wilfrid Laurier University, McMaster University, the University of Waterloo, Carleton University and Acadia University.

Strong from its experience with JDS Uniphase, OPETA was able in 2003-2004 to provide a similar service when Bookham Technologies decided to drastically reduce its operations in Ottawa. In this case, most of the equipment was for thin-film and clean-room applications. Upwards of $1-million in clean-room furniture, evaporators, pumps, spare parts, etc., was distributed through OPETA to 14 academic institutions across Canada. Most of the equipment was new. Again, these donations have gone a long way to make possible the establishment of new laboratories at colleges and universities.

Advocacy for members

Several letters were written by the author as Chair of OPETA to support the proposals of new photonics programs at colleges and universities in Ontario, or to support grant applications for the funding of such programs. Since the founding of OPETA in 2001, no fewer than 5 programs have started in photonics: the Optical Fibre Diploma at the Canadian College of Business and Computers, the Education Program for Photonics Professional (EP3) at the University of Waterloo, the Honours B.Sc. in Photonics at Wilfrid Laurier University, the Engineering Physics Degree in Photonics Engineering at McMaster University, and the joint Bachelor of Applied Technology in Photonics at Niagara and Algonquin Colleges. All of these were supported by OPETA, mostly through equipment donations and letters.

Events

OPETA members have also used the network to organize a conference (the Photonics/Optics Education and Training conference of Photonics North 2004, 29 September 2004, Ottawa, ON), workshops (at the 2003 Ontario Association of Physics Teachers' Annual Conference, May 2003, London, ON), OPETA Annual Meetings (Ottawa in 2002 and 2004, London in 2003, all co-located with major conferences), and several multilateral discussions leading to articulations between colleges and universities to handle student exchanges and credential recognition.

Other clusters springing from the OPETA experiment

The OPETA model was applied by the author to the formation of two more networks in Ontario: the Laser Microprocessing Network of Ontario (LMNO) and the Science and Technology Awareness Network (STAN) [17]. LMNO regroups 24 company and university scientists interested in keeping contact in the field of laser microprocessing and the network has held two full-day workshops since its inception in March 2003. STAN hosted its first conference in November 2004 in Ottawa, and as of November 2004 counted 61 members on its list-serv from a broad range of sectors supporting science and technology awareness.

None of the above accomplishments would have been possible without the networking tool that is OPETA. Millions of dollars worth in equipment donations to educational institutions likely would have been lost, several discussions currently under way about program articulations between colleges and universities would not be taking place, and each institution setting up new photonics programs would be isolated.

THE GLOBAL PHOTONICS EDUCATION NETWORK (GPEN)

As part of the Education and Training in Optics and Photonics (ETOP) conference held in Singapore in November 2001, a panel discussion entitled "Global Networking to Promote Local Technician Education -- Problems and Solutions" was held. Members from 9 countries (including Canada) exchanged views on the subject and agreed to form a global network to address local issues in photonics education and training [18]. This led to the creation of the Global Photonics Education Network (GPEN), an example of networking not unlike OPETA but on a worldwide scale.

Since the panel, a discussion forum was graciously provided by SPIE on their webpage (http://spie.org/app/forums/, and then "Technician Education") and a list-serv similar to OPETA's was established to facilitate exchanges between GPEN enthusiasts. A GPEN draft plan was written and suggests a possible way to go for the Network, and it was discussed at several international meetings [19].

One recurring theme from the first roundtable panel discussion and subsequent exchanges dealt with the crucial role clusters could take in the formation and operation of the GPEN. It seems clear that a well organized global network in photonics education would be most useful if it can facilitate access to the diversity of global best practices for the local educational leaders explicitly interested in strengthening the business base of the local photonics industry clusters. Because of the inherently local nature of industry clusters, the GPEN, by virtue of its vision of providing the global photonics education infrastructure, could be the facilitator to build a "cluster of clusters", or a "supercluster". By promoting excellence in local technical and advanced education, by providing easy access to sharing global best practices, GPEN will naturally facilitate the start and growth of local photonics industry clusters. GPEN can provide useful resources to new and existing local chapters of SPIE, OSA, IEEE, etc., which, in turn, nurture local industry clusters. However, more focused organizations designed specifically to promote local photonics education for the specific purpose of accelerating the growth of local photonics industry would be an important approach for many countries.

CONCLUSION

Presented above are two examples of networks to facilitate communications between photonics educators. One of the characteristics that make them special and contribute to their success is the focus on a particular subject (photonics) instead of a more broadly defined discipline; this makes for members with more in common and overlapping concerns/interests. OPETA, the local photonics education cluster in Ontario, is slightly more mature in its evolution, having a full set of communications means (list-serv, webpage, regular meetings), a well-defined vision, and a series of accomplishments that have clearly benefited its membership. OPETA is an example of the power of association in a field that is developing, and a credit to the effort that its membership invests in it. GPEN is more embryonic but already has a list-serv and a discussion forum serving its membership. By the very nature of the fact that it is a global network, it is more diffuse and is taking more time to establish itself. Nonetheless, as more local photonics education clusters like OPETA take shape around the world and feed into the GPEN network, the latter will gradually gain strength and momentum, achieving its goals for the global photonics education community. These informal groupings of like-minded individuals are highly dependent on the participation of all of their members, with benefits such as those outlined above as the ultimate reward. The specific examples provided here could well be adopted by others as models for successful networks in a limitless number of areas of interest in physics education.

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