

photonics

Industrial innovation at the speed of light

It may sound like science fiction, but, in fact, photonics – and its suite of advanced technologies premised on the science of generating and harnessing light – is all around us. Without photonics there wouldn't be iPods, MRIs or those sleek, ultra-capable mobile phones we depend on daily.

Yet Canadian experts say these and other current photonics applications are just the beginning of a new generation of photonics-enabled industrial innovation – an emerging domain in which Canadians have a competitive edge and significant economic potential.

The global photonics industry is expected to reach \$1.28 trillion within a decade; today, in Ontario alone, photonics' activity accounts for more than 10,000 high-value jobs and \$3 billion in revenues annually.

Canada owes part of its success in the sector to efforts dating back nearly 60 years.

"Modern photonics research in Canada began in the early 1950s with the research of Dr. Gerhard Herzberg and his colleagues at the National Research Council in Ottawa," says internationally renowned laser expert Professor Paul Corkum.

"He won a Nobel Prize in 1971 for developing molecular spectroscopy, which allowed us to learn about the structure of molecules," explains Prof. Corkum, program leader of the National Research Council Canada Atomic, Molecular and Optical Science Group. "Today, spectroscopy allows much more sophisticated medical diagnoses, optimizes production for industry and measures the composition of pollutants in the atmosphere."

The market potential of lasers exploded with the development of optical fibres, he says. "Suddenly, laser light could be delivered along glass 'wires' into your body or under oceans. It became possible to attack cancer with light, and to send messages at light speed from continent to continent."

The combination of lasers and optical fibre has become the central nervous system of technologies that monitor stress on aircraft wings, the health of pipelines and the strength of bridges, he says. But the future of Canadian photonics may be even more revolutionary.

"Toronto's Dwayne Miller has used laser light to create an electron camera so fast and high resolution that he can

watch atoms move in solids," says Prof. Corkum, whose team at the NRC-University of Ottawa Joint Laboratory for Attosecond Science is creating the world's shortest light pulses. (An attosecond is 1/1,000,000,000,000,000,000 of a second). "This is a strong, deep area of Canadian science, and each of these advances could lead to as yet unanticipated industries."

Yet, as heady as that untold potential may be, photonics is already a source hope for current challenges. "Efficiently converting sunlight to solar energy is a mixture of a photonics and a materials science problem that, when solved, will go a long way towards eliminating the risks of global warming," says Prof. Corkum.

"The catalyst in this mix is cheaper, faster image processing," says David Dalrymple, the Midland, Ont.-based manager of global marketing and business development at ELCAN Optical Technologies. With more than 1,300 employees, ELCAN is a global leader in custom-engineered optomechanical design and manufacturing. Its customers span the medical, defence and security, industrial, commercial and entertainment sectors.

"Without the advent of

powerful and affordable computing capabilities, we would be stuck at the limits of analogue optics. But with signal processing, we can reach power levels and resolutions that are fuelling all these new applications," says Mr. Dalrymple.

Part of Canada's promise in this sector is an effective research-to-market network that bridges academic, government and industrial efforts. In Quebec City, Canada's largest optics research centre – INO – has been instrumental in creating 25 "spinoff" companies successfully operating today.

"Our job is to make technology work for industry," says INO vice president of business development Simon Labbe, who notes that INO's focused research efforts have so far resulted in "over 4,000 custom R&D contracts for small and large Canadian businesses and 39 technology transfers as well as new high-tech startups in the industry."

Public education is also an INO focus. "Photonics is an enabling technology; it facilitates or allows increased performance in ways that could not be done before, or at a lower cost," says INO chief technology officer Dr. Pierre

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Galarneau, noting that industry leaders are often unaware of what optics can do. "For example, there is an antioxidant found in cranberries that is very good for cancer prevention. We're now using a hyper-spectral sensor to determine the right level of this antioxidant for the harvest."

Dr. Douglas James, chairman of the Canadian Institute for Photonic Innovation, and a contributor to Making Light Work for Canada, a comprehensive survey published by the Canadian Photonics Consortium, agrees that broader awareness is a key to leveraging photonics technologies to the fullest extent possible.

"We found a degree of disconnect between the photonics community and the wealth-creating industries of the country. There is a thirst for knowledge about photonics, but at the moment, there is limited visibility at the higher levels of government and business."

Like others in the sector, Dr. James is committed to shedding light on Canada's industrial potential in photonics, a sector that might well help Canada develop the kind of knowledge-based economy often touted as key to Canada's future competitiveness. ■

ELCAN Optical Technologies

Canadian optics innovator demonstrates the power of light

Situated on the southern shores of picturesque Georgian Bay the quaint community of Midland, Ont., hardly invokes notions of high technology. Yet, here amid this community of about 16,000 residents, ELCAN Optical Technologies operates North America's largest and most fully integrated optical manufacturing facility.

ELCAN, which also operates facilities in Texas and Spain, specializes in the design and manufacture of precision electro-optical systems, subsystems and components for medical, defence and commercial applications. Acquired by the Raytheon Company in 1997, ELCAN employs over 900 people in its Canadian photonics manufacturing facility alone.

"Our business model is based on being fully vertically integrated," says David Dalrymple, manager, Global Marketing and Business Development. "Raw hunks of metal



In Midland, Ont., ELCAN Optical Technologies runs North America's largest fully integrated optical manufacturing facility. The company designs and builds precision electro-optical wares for medical, defence and commercial applications, many of them custom-built, one-of-a-kind technologies. PHOTOS: SUPPLIED

and chunks of glass go in the back door, and the world's most advanced electro-optical systems come out the front. Almost everything we make has never been made by anyone before, and many products are made exclusively by ELCAN for global markets."

The company provides high-volume, contract manufacturing supported by design and engineering services to

assist its customers. "In terms of determining the final cost of a new product, materials and labour are important, but design is the most significant cost driver. Everything flows from designing it right for manufacturability," says Mr. Dalrymple. "The Midland facility is the largest of our three operations, and for many photonics innovators it is a world-class destination to

develop their new ideas."

There is a technological 'renaissance' happening in new medical and bio-sensing photonics, says Mr. Dalrymple. "Many non-invasive and minimally invasive diagnostics use photonics, and surgical lasers are standard operating room instruments. Analyzers that allow health care practitioners to simply and quickly scan a pin-prick of a patient's blood,

on-site in the practitioner's offices, are on the threshold of commercialization."

ELCAN plays an important role in a robust photonics industry network in Canada. Partly because of the concentration of engineering resources and reputation garnered by ELCAN's almost 60 years of operation, young photonic startups are strengthened by their association with the

organization. Mike Riggan, general manager of ELCAN in Midland, says, "We are seen by our customers' stakeholders as a big plus, with a lot of strength to put behind the development and market penetration of new medical products. Larger companies will outsource to us because we have sophisticated quality and program management systems in place."

The organization's latest cutting-edge technology is 'cluster computing' capability, supported by a very high-speed, 128-node parallel processor, specifically focused on optical design challenges. "By linking computers together in parallel, cluster-computing unleashes an enormous simulation capability. As a result, it can optimize your design, manufacturing and assembly process for optical components – before any mould is cast or any lens is ground. Cluster-computing takes optical design to new frontiers," says Dr. Riggan. ■