Shedding Some Light on Photonics

April 2008 Research Brief

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Photonics involves the process of generating and harnessing light and other forms of radiant energy whose basic unit is the photon,[1] which carries electromagnetic radiation of all wavelengths including gamma rays, X-rays, ultraviolet light, visible light, infrared light, microwaves and radio waves.[2]

Prior to the use of the photon in photonics, the electron was the center of the world in electronics. Technology in the 20th century was dependent on the development of electronics, which includes the control, manipulation, transfer and storage of information using electricity. Electronics, conducting electricity over metal wires, has been fundamental in the development of the transistor and microprocessors, which has led to many advances with computers and automation.[3]

Photonics is similar to electronics in that it involves the control, manipulation, transfer and storage of information. But instead of utilizing electricity, photonics uses light. Optical fibers are used to transmit the light and information.

Research with photonics was first conducted in the 1950s, but the experiments with sunlight and mercury arc lamps were not successful. The discovery and use of lasers in the 1960s brought some advancement,[4] "and its impact in telecommunications was enabled by the perfection in the late 1970s of low signal loss optical fibers for long haul undersea and terrestrial communications."[5] A major breakthrough came in 1999 when a "laser time division multiplexing system" was created that quadrupled information transmission sent over a fiber-optic cable, making data transmission much faster and inexpensive.[6]

[1] The Photonics Dictionary, Laurin Publishing
[2] http://en.wikipedia.org/wiki/Photon
[3] http://www.answers.com/topic/electronics?cat=technology
[4] Encyclopedia of Emerging Industries, Grey House Publishing
[5] http://www.lightexpress.soton.ac.uk/photonics.php
[6] Encyclopedia of Emerging Industries, Grey House Publishing

In Thomas Friedman's book *The World Is Flat*, it is suggested that the use of personal computers and fiber-optic cables to transmit information leveled the playing field between industrial and emerging countries.

It is not surprising that an area expected to have many applications for photonics in the 21st century is in telecommunications, particularly optical fiber systems.[7] Other possible applications, based on recent developments in the industry, include biochips, neuroscience, pharmaceuticals, cytometry (sorting microscopic particles in a fluid stream), orthopedics, gene chips, prosthetic devices, ceramics, computer processing, imaging and printing.[8]

What are some exciting photonics developments on the horizon?

- The area of optoelectronics is a potential application, which involves photonics and microelectronics. Products using optoelectronics include advanced liquid crystal displays, high efficiency silicon solar cells and medical eye surgery devices.
- The transition from copper wires to fiber optic cables is expected to occur on a much larger scale once transmission of information is needed to exceed 10 Gbit/s[9] -- telecommunications industries would see changes at that time.[10]
- Optical storage technology has grown considerably since the 1980s and has the potential to grow further. Spintronics is a new field that incorporates photonics, electronics and magnetism, and may have the capability of making computer processing faster.[11]
- Video displays have been changed dramatically by electro-optics – the flat panel display has revolutionized the television and computer monitor industries. Other applications may involve high-definition television with two-way communications.[12]
- Photonics research is also underway to discover military applications. Weapons systems based on light may be more reliable in battle conditions.[13]

[7] Encyclopedia of Emerging Industries, Grey House Publishing
[8] Encyclopedia of Emerging Industries, Grey House Publishing, according to Insight Research Corporation
[9] gigabit per second
[10] Kevin Krewell, Electronics News, 11/1/05.
[11] Encyclopedia of Emerging Industries, Grey House Publishing
[12] Encyclopedia of Emerging Industries, Grey House Publishing
[13] Encyclopedia of Emerging Industries, Grey House Publishing

The U.S. is a large consumer of photonics technologies, in addition to researching its applications for approximately 50 years. Since photonics has many applications in many industries, there is no single set of industry codes (SIC or NAICS[14]) that encompass the sector in its entirety. And many activities are still emerging and do not have industry codes assigned to them. However, a number of industries can be analyzed that encompasses most of the photonics activities, although the industry definition may not be comprehensive.[15]

The table below shows that there were almost 15,000 establishments related to photonics in the U.S. in 2008. Connecticut had 247 photonics establishments, which was almost two percent of the photonics establishments in the U.S. More than 3,700 people were employed in these photonics industries in the state. The average number of employees per photonics establishment – 16 – was slightly below the national average of 23. The April 2008 Map of the Month shows the states' share of photonics establishments for all 50 states. On a per capita basis, Connecticut's photonics employment approximates the nation, and is the 14th highest in the nation.

Photonics Establishment and Employment in the U.S. and Top 15 States, 2008

State	*Photonics Estabs*	*% U.S. Photonics Estabs*	*Photonics Emp*	*Photonics Emp per 1 Million Population*	*Avg Photonics Emp per Estab*
Minnesota	299	2	18,667	3,591	66
New Hampshire	131	0.9	3,728	2,833	30
Rhode Island	57	0.4	2,983	2,820	54
Massachusetts	532	3.6	14,200	2,202	28
New York	1,034	6.9	33,832	1,753	35
California	2,985	20	61,641	1,686	22
Pennsylvania	513	3.4	16,990	1,367	35
New Jersey	544	3.7	10,954	1,261	21
Indiana	254	1.7	7,600	1,198	31
Oregon	221	1.5	4,301	1,148	21
Arizona	364	2.4	7,274	1,148	21
U.S.	14,898	100	327,850	1,087	23
Maryland	237	1.6	6,106	1,087	28
Illinois	543	3.6	13,793	1,073	27
Connecticut	247	1.7	3,749	1,070	16
Nebraska	49	0.3	1,845	1,040	39

Source: D&B Sales & Marketing Solutions, 2008 Q2 Data

[14] Standard Industrial Classification or North American Industry Classification System
[15] See Appendix A for a list of the SIC codes used in this analysis.

The Connecticut Optics and Photonics Association (CTOPA) was founded in 2007 to promote the industry in the state. A number of companies have already joined this group along with higher education institutions and nonprofit organizations. A selection of companies involved in CTOPA include Trumpf Inc., which makes lasers for factory equipment; Coherent, which makes industrial lasers; Nufern, which makes fiber-optic lasers; and Ciencia, which focuses on fluorescence sensing instruments. Photonics companies in Connecticut are involved in, but not limited to, laser material processing, laser manufacturing lenses for biomedical equipment and lithography.[16]

The objectives of the CTOPA include marketing, networking, strategic partnering, education and representation.[17] An education committee has been formed with the support of Congressman Joe Courtney, who is a member of the US House Education and Labor Committee. The education committee will develop a more integrated approach with middle schools, high schools, higher education institutions and companies to facilitate a better match between the local workforce skills and business needs in this industry.[18] Anastasios Mauridis, a PhD student at the University of Connecticut (UCONN) and founder of CTOPA, agrees that by bringing together the local firms, Connecticut could generate new optics businesses and promote the commercialization of research at higher education institutions.[19]

In summary, the photonics industry has a presence in Connecticut and the potential for product development and business creation is positive. Many applications of the research are being developed and have yet to be discovered within this interesting field of science.

[16] Anastasios Maurudis, CTOPA
[17] http://www.ctopa.org/
[18] Anastasios Maurudis, CTOPA
[19] Jonathan G. Fox, "Focusing On Commerce Like A Laser Beam," *Hartford Business Journal*, 11/26/07, http://www.hartfordbusiness.com/news3780.html

Appendix A: SIC Industries Involved in Photonics

3671 Electron tubes
3699 Electrical equipment and supplies, nec
3827 Optical instruments and lenses
3861 Photographic equipment and supplies

3211-00 Flat glass
3211-01 Transparent optical glass, except lenses
3211-02 Strengthened or reinforced glass
3229-02 Optical glass
3229-03 Industrial-use glassware
3674-03 Light sensitive devices
3679-00 Electronic components, nec
3679-01 Electronic circuits
3679-04 Electronic crystals
3679-05 Electronic switches
3679-99 Electronic components, nec
3826-01 Spectroscopic and other optical properties measuring equipment
3826-02 Analytical optical instruments
3826-06 Instruments measuring magnetic and electrical properties
3841-01 Ophthalmic instruments and apparatus

3229-0401 Fiber optic strands
3357-0102 Fiber optic cable (insulated)
3541-9904 Electron-discharge metal cutting machine tools
3559-9910 Electron tube making machinery
3559-9918 Optical lens machinery
3559-9938 Fiber optics strand coating machinery
3577-0503 Optical scanning devices
3652-9901 Compact laser discs, prerecorded
3661-9908 Fiber optics communications equipment
3674-9908 Optical isolators
3679-0203 Recording and playback heads, magnetic
3679-0204 Recording heads, speech and musical equipment
3695-9901 Optical disks and tape, blank
3821-0113 Laser beam alignment devices
3825-0209 Electron tube test equipment
3826-9904 Colorimeters (optical instruments)
3826-9909 Laser scientific and engineering instruments
3826-9911 Particle size analyzers
3826-9912 Perimeters (optical instruments)
3841-0420 Surgical lasers
3845-9901 Laser systems and equipment, medical
5049-0104 Optical goods
7374-9905 Optical scanning data service
7699-0106 Optical instruments repair