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ABSTRACT

This document addresses the challenges and opportunities technological advances are presenting in education. Using the example of Photonics (defined as the generation, manipulation, transport, detection and use of light information and energy whose quantium unit is the photon) the report illustrates the need for up-to-date educational curricula. Opportunities must be created for education and industry to cooperate in all facets of training. Group partnering, external communication, and sharing information and expenses are integral to an easy interchange among interdependent parties. Also important is the implementation of a national interactive network to sustain curriculum currency, such as curriculum morphing, a method wherein practitioners view curriculum materials on the Web and collaborate with each other to suggest changes. Once approved by experts in the field, these changes are implemented into the Web version of the curriculum materials. Such a methodology may also benefit other areas, particularly in the crucial 9-14 grade years. Tech Prep, an example of an articulated program of study currently being implemented for this age group, presents material in a contextual format. (YKH)

FAST TRACT TO CURRENCY

through Curriculum Morphing

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This column is about the challenges and opportunities technological advances are making for the education enterprise. More pointedly, this article proposes an answer to the question - How do we ensure our curricula are adequately current in an emerging technology? - One that is undergoing explosive growth with demands from industry for qualified workers[1],[2]. Besides attempting to answer that question, let's choose the emerging field of Photonics as an appropriate example.

"A new report by a committee of the National Research Council has predicted that harnessing the properties of light will lead to a technology revolution, having a pervasive impact on life in the next century"[3], one might call it the Age of Light. The report "Harnessing Light", Optical Science and Engineering for the 21st Century, is available on the web [4] "It describes optics as a critical enabler for technology that promises to revolutionize the fields of communications, medicine, energy efficiency, defense, manufacturing and the frontiers of science. A few key areas of importance with some example applications are:

- Biomedical - Laser Surgery, Diagnosis
- Communication and Information - Fiberoptics, Information Superhighway (FTTH)
- Manufacturing - Process Control, Materials processing
- Defense - Night Vision, Displays
- Education/Research - New Materials, Quantum Discoveries
- Environmental/Energy - Remote Sensing, Illumination

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[1] Leoma News, Pacifica, CA: The Laser and Electro-Optics Manufacturers Association, Spring 1998
[2] National Photonic Skill Standards for Technicians CORD, Waco, TX:1995
[3] "Harnessing Light": Optical Science and Engineering for the 21st Century, National Academy Press, 2101 Constitution Ave., NW, Lockbox 285, Washington, DC 20055 (1-800-624-6242)
[4] Web Site: http://www.napiedu/newbooks/ndex.html

The release of this seminal report is creating focused collaborative efforts among different elements of the Optics and Photonic community, e.g. the professional, industrial, educational and economic sectors. A prime example here in the United States is the Coalition for Photonics and Optics (CPO). The International Community is also very interested in the report to heighten awareness of the power and future of photonics and optics, especially in developing nations. Additional indicators of the heightened interest in Photonics and Optics are the Dept. of Labor, Photonic Skill Standards: NSF Advanced Technical Education (ATE)[5] Program on Scientific and Technical Education in Photonics (STEP), all of which are focused on developing an articulated curriculum from secondary to post secondary to university level programs. These are all programs of the not-for-profit Center for Occupational Research and Development (CORD), the original developer of the highly successful Laser Electro-optic Technology (LEOT) curriculum materials over 20 years ago. Other indicators are the recent award to Monroe County Community College for the training of photonic and optical technicians to support the DoE Inertial Confinement Laser Fusion Program (National Ignition Facility) at Lawrence Livermore National Lab and the marshaling of resources to support a community college (San Jose Community College) in the Bay Area by the Laser Electro-Optic Manufacturers Association[1]. By these indicators the need is well established and recognized.

Truly, the next millennium will be the Age of Light - and leaders like Arpad Berg formerly of AT&T Bell Labs and presently Executive Director of the Optoelectronics Industry Development Association (OIDA), predicts we will be out of qualified photonic workers by the year 2000. OIDA expects the U.S. Photonics industry to double every 4 years to $500 billion by 2013, thus we must address this shortage of qualified workers now [6]. This concern is echoed

[5] Frontiers, Newsletter of the National Science Foundation March/April 1998, pg. 2

[6] Arpad Berg, Executive Director Optoelectronic Industry Development Association, Washington, DC, March 17, 1998; Remarks at Coalition for Photonics and Optics Mtg.

by the CPO as well and as such, it is looking for ways to connect their members to the education community to address this impending problem. This anxiousness on the part of the community is further exasperated by the need for up-to-date curricula. Because of the very nature of the beast, a mechanism to not only ensure curriculum currency, but to create dialog[7] opportunities for the education enterprise and industry to cooperate, is demanded, whether it be in curriculum development, teaching, hands-on-labs, or task analysis. Nothing much is going to happen in the future except through partnering and alliancing of groups that are interdependent upon one another for their success. That's why external communication through the sharing of information and expenses, i.e. the management of data and information flow, will be so important. Modern vehicles such as the Web, Teleconferencing, Distance Learning, etc. are all being investigated with a goal to enhance facile interchange among key players.

As to currency, one of the two principal aims of a CORD Curriculum Morphing Project[7] , is to transform a 25 year old laser electro-optic technology (LEOT) curriculum (used at about 50 post secondary and four year academic institutions) to one for todays need along with a mechanism for continuous updating.

Thus the other principal goal is the implementation of a national interactive network to sustain curriculum currency. No longer can we count on revisions which appear every 3-5 years, thus Curriculum Morphing, a concept funded by the Fund for Improvement of Post-Secondary Education (FIPSE). It is exploring the use of the world wide web, e-mail and other modern day communication methods, e.g. teleconferencing to improve and speed-up the revisions process by doing it almost in real time. The test case: Photonics, of course, the goal, a living curriculum.

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[7] Using a Morphing Process to Transform a Photonics Curriculum; CORD, Waco , Tx; funded by US Dept. of Education, Fund for Improvement of Post Secondary Education (FIPSE)

Revision in the old way generally meant searching out a cadre of expert writers in the field. But who are the individuals who know best whether present materials are adequate? Industry for one, if we engage them. However, it is the instructor that on a daily basis is interacting with the future industrial base to define the needs or task requisite for the new practioners. The instructors are the intermediary who on a daily basis are at the contact point with the students and photonics employees of the future. Why not tap into them, using today's evolving information technology.

The basic morphing process works this way: Practitioners who teach photonics view curriculum materials on the web, talk to each other and with employers. They submit their suggested changes or their lessons learned e.g. a new lab procedure, via e-mail to a Technical Review Committee (TRC) (see Figure 1). The TRC is composed of photonics experts in education and business from across the country. These experts review each suggestion and use on-line conferencing to "discuss" possible changes. Relevant and appropriate changes resulting from this discussion are immediately incorporated into the web version of the curriculum materials, and the process continues.

The TRC membership is comprised of the following:

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Center for High Technology Materials
University of New Mexico, NM

Darrell Hull, Senior Associate
CORD
Waco, TX

Nick Massa, Program Coordinator, LEOT
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Jack Ready, Consultant
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Photonics Research Center
University of Connecticut

Fred Seeber, Professor of Photonics
Director of Photonics Technology
Camden County Community College, NJ

M. J. Soileau, Director
CREOL
University of Central Florida, FL

A diverse, experienced group of opticists and educators.

Although this is an experiment in progress, it is believed that such a methodology for other exploding technical fields may also benefit, particularly in the targeted 9-14 grade year educational period when career selections are most frequently made. Given this requirement at such a critical educational period in a student's life, an articulated program of study is presently sweeping the U.S. and many foreign countries that provides solid math and science to the neglected majority of students by presenting the material in a *contextual* format. In this situation, we first had to develop a core of transportable application oriented modules for use across the nation. You may know it as "Tech Prep" including:

Principals of Technology (Applied Physics)
Applied Math
Applied Communication
Applications in Biology/Chemistry

The transportability issue for a core foundation is important because individuals are expected to have (on average) 8-10 jobs in their lifetime. The material is taught contextually, i.e. in the manner in which it is used. This approach enhances one's ability to cross train into other fields, or for transition or professional development in a continuing education vain.

All approaches can be used, for example, by technically oriented individuals, from other industries in decline to others who will be more mobile or rapidly move into new emerging fields like nanotechnology, medicine, remote sensing, space, etc. We see good things coming from this effort.

Let me end by adding a statement from a recent press release[8] :
"Next Millennium may bring "Age of Light" If you are annoyed by the Age of Electronics, hold on. The next millennium may usher in the Age of Light. Electrons, particles of electrical energy, have been the workhorses of the modern age, making possible everything from telephones to computers. Unfortunately, electrons are looking a little creaky these days - you can't push enough of them through cooper wires fast enough to keep up with the insatiable demands of the Internet. Neither will cable modems or even wireless connections, provide sufficient capacity for all the date-transmission needs of the future. Enter photons, particles of light, which are exponentially more efficient carriers of data. Wall street is already impressed with Photon Valley, which is not a region of California but a nationwide collection of more than 3,200 companies racing to bring photonics to the Information Superhighway."

For further information on these matters, contact:

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or visit the Curriculum Morphing Web site at http://www.cord.org/cm/new/cm-new.htm.

[8] "Photons: Coming Even Faster to A Computer Near You", Patricia King, Newsweek, 04/20/98 p. 13

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