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### **Optical standards: the missing link in optics and photonics educational programs**

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#### **Abstracts**

Educational programs in optics and photonics contain superior fundamental and specialized courses, and yet optical standards and standardization aspects are often missing from the curricula. Although international standardization aims at eliminating technical barriers to trade, many graduates learn about industry standards during their first job. This presentation provides an overview of existing standards in optics and photonics and latest developments in the field. It provides information about the international organizations involved and the specialty areas covered by standards. Courses or educational modules covering existing industry standards and international standardization efforts may become a valuable addition to educational programs in optics and photonics.

#### **Summary**

##### **Introduction**

Many of today's educational programs in optics and photonics contain first-class fundamental and/or specialized courses, and yet optical standards and standardization aspects of optical engineering often remain missing from the curricula. Although the purpose of international standardization is to eliminate technical barriers to trade, many graduates only learn about industry standards during their first or second "real world" job. This presentation provides an overview of the existing standards in optics and photonics and the latest developments in the field. It provides information about the international organizations involved in this effort and the various specialty areas in optics and photonics covered by standards. Courses or educational modules covering existing industry standards and international standardization efforts may become a valuable addition to educational programs in optics and photonics.

##### **The role of industry standards**

The main goal of international standardization is to eliminate technical barriers to trade. There are hundreds of international standards for terminology, requirements, interfaces, test methods and product safety, that apply to complete systems, devices, instruments, optical and photonic components, auxiliary devices and accessories, and materials. In addition to traditional fields like lighting, photography, cinematography, telescopes, microscopes, geodetic and surveying equipment, ophthalmic and medical optics, there are newer fields such as fiber optics and free space telecommunication systems, lasers and other electro-optical devices and systems. A brief survey of university and college curricula in North America has revealed that standards and standardization aspects have very limited coverage. Except for black body emitters, optical frequency standards and interferometer calibration, there was practically no other content on industry standards. Yet knowledge of relevant industry standards is essential for optical engineers, supporting their efforts in commercializing new technologies or developing new products. Failing just one specification of a product performance standard may lead to significant delays in bringing the product to the market, additional costs, losses and may even result in the collapse of a start-up venture. Some products are subject to legal regulations, e.g. medical, lasers, or electronic products incorporating lasers or LEDs. In such cases, standards help manufacturers to show compliance with the relevant regulations and represent an important mechanism for accessing the market or gaining competitive advantage. Failure to meet existing product safety standards may result in legal action against the product manufacturer.

### Standardization organizations and specialty areas

The standardization efforts are coordinated by international organizations such as ISO, IEC, CEN, CENELEC, CIE and all the work is done by members of technical committees (TC) specializing within particular technical areas. Participating countries are represented by members of the national standards organizations or members of the national subcommittees for the respective TC, SC or working group (WG). The specialty areas include traditional technologies such as cinematography, photography, geodetic and surveying optical instruments as well as new technologies such as fiber optics and lasers. Table 1 presents an overview of the various specialty areas, technical committees, and selected market indicators where available.

Table 1. Standards in Optics and Photonics and related technical fields

Committee	Scope or specialty area	Market indicator (Billion US)	Comment
ISO/TC 36	Cinematography	20.3	Note 1
ISO/TC 42	Photography	11.87	Note 2
ISO/TC 171	Document management (micrographic and electronic)	1.03	2003
ISO/TC 172	Optics and photonics	75	Note 3
ISO/TC 172/SC1	Fundamental standards		
ISO/TC 172/SC3	Optical materials and components	5.8	Note 3
ISO/TC 172/SC4	Telescopic systems	6.0	Note 3
ISO/TC 172/SC5	Microscopes and endoscopes	2.2	Note 3
ISO/TC 172/SC6	Geodetic and surveying instruments	4.6	Note 3
ISO/TC 172/SC7	Ophthalmic optics and instruments	31.9	Note 3
ISO/TC 172/SC9	Electro-optical systems	24.5	Note 3
CEN/TC 123	Lasers and laser-related equipment		
CEN/TC 170	Ophthalmic optics		
IEC/TC 76	Optical radiation safety and laser equipment		
IEC/TC 86	Fiber optics for telecommunications		
IEC/TC 100	Audio, video and multimedia systems and equipment		
CIE Division 2	Physical measurement of light and Optical Radiation		
CIE Division 6	Photobiology and Photochemistry		
CIE Division 8	Image Technology		
Note 1: Worldwide box office receipts for 2003			
Note 2: Imports of digital cameras and printers in 2000 to USA			
Note 3: Market share estimates are from the COSE Report "Harnessing Light"			

The presentation contains further details about the standards and publications within selected technical fields (lasers, electro-optics and laser product safety) as well as information about recent changes and developments. Including topics on standards and standardization in educational programs in optics and photonics would help complement the existing curricula with valuable industry-driven content.