

# PHOTONICS: LIGHTING OUR FUTURE

# NPI

## WHAT IS PHOTONICS?

Many modern-day technologies – your phone, computer, TV – are made possible largely by photonics.

Optics and photonics are the science and application of light. Specifically, photonics generates, controls and detects particles of light to advance manufacturing, robotics, medical imaging, next-generation displays, defense technologies, biometric security, image processing, communications, astronomy and much more. Photonics technology is lighting our future by solving the challenges of a modern world. It enhances our quality of life; safeguards our health, safety and security; and drives economic growth, job creation and global competitiveness.

## A LESSON IN HISTORY

A 1998 report from the National Academy of Science presented a comprehensive view of the potential impact of optics and photonics on health care, manufacturing, defense, communication and many other industries.

Since the release of the “Harnessing Light” report, many countries have significantly increased their national commitments to the optics and photonics industries. For example, in 2011, Germany committed nearly €1 billion (\$1.3 billion in USD) to photonics research and development (R&D) over 10 years; China began funding several programs targeting photonics supply chains; and the European Commission, as part of its new Horizon 2020 program, has directed €1.6 billion (over \$2 billion in USD) to photonics-related R&D over the next seven years, and has designated photonics as one of only five key enabling technologies for future prosperity.

Historically, the US has been a leader in photonics R&D; but the current US share of the global photonics industry is only 17 percent – behind Japan and with increasing competition from Europe, South Korea, Taiwan and China. Global competition is putting our nation’s leadership position at risk, causing a substantial loss of global market share to overseas competitors as well as thousands of US jobs.

## THE NATIONAL PHOTONICS INITIATIVE

Now is the time for the United States to make photonics a national priority. In 2012, the National Research Council released a sequel to “Harnessing Light” that called for a National Photonics Initiative (NPI) to increase collaboration and coordination among US industry, government and academia to identify and further advance areas of photonics critical to regaining US competitiveness and maintaining national security.

New opportunities in these fields — including high-efficiency lighting, genome mapping, high-tech manufacturing, nuclear threat identification, cancer detection and new optical capabilities vital to supporting the Internet’s growth — offer the potential for even greater societal impact in the next few decades. The NPI advocates for US investment in photonics to grow our economy, protect and improve the lives of our people, and position the United States as a global technology leader. The time is now to light our future.

# PHOTONICS: LIGHTING OUR FUTURE WITH INNOVATIVE APPLICATIONS

## DEFENSE & NATIONAL SECURITY

Optics and photonics greatly enhance the United States' ability to gather intelligence, defend its citizens and protect troops in the field. Optical sensing technology makes surveillance and reconnaissance possible, and identifies chemical, biological and nuclear threats. Photonics makes laser-guided weapons more accurate, provides lasers for critical missile defense capabilities and permits personalized use of flexible display technology, keeping our troops informed and safe during operations with night vision, GPS and physiological feedback.

## HEALTH CARE & MEDICINE

From laser eye surgery to CT scans, photonics is responsible for medical advances that impact millions of lives. Photonics-based health care tools offer sensitivity, precision, and speed, which enable rapid diagnosis and effective therapy — key ingredients for high-quality, cost-effective care. Further investment in biophotonics will result in smaller, more portable, automated, point-of-care diagnostic devices that have the potential to improve outcomes and the ability to reach patients who lack access to care.

## COMMUNICATIONS & INFORMATION TECHNOLOGY

The next time you send an e-mail, Skype with your family or post on Twitter, remember that without photonics, the Internet as we know it would not exist. Optics and photonics increased the internet's capacity by nearly 10,000-fold over the past two decades. Bandwidth demand is expected to grow another 100-fold, and possibly more in the near future. Without improvements to address the cost, power consumption, data rate and size, demand will outstrip capacity, which may lead to higher costs and constrain the

greater US and global economy. Strategic investments are needed to advance the infrastructure of the Internet-based economy.

## ENERGY

The application of photonics in the renewable energy sector has the potential to create significant job growth and increase the efficiency and safety of US energy production and consumption, reducing our reliance on foreign oil. The oil and gas industry increasingly uses optical systems to monitor wells, thereby increasing production and mitigating risks. Additionally, solid-state lighting, such as LEDs, developed through photonics research, could cut US lighting electricity usage by about 45 percent by 2030, with forecasted energy savings of \$30 billion dollars at today's energy costs and a reduction of greenhouse gas emissions equivalent to 40 million cars.

## ADVANCED MANUFACTURING

Advanced manufacturing is vital for our country's economic well-being and sustained job growth. Though the majority of display and photonics component manufacturing has moved overseas, the US can be a leader in new areas of manufacturing involving next generation high-power and low-cost ultrashort pulsed lasers, as well as 3D printing, which allows machines to make a range of customized products directly from electronically transmitted designs. These advanced printers can create objects ranging from prosthetic limbs and functional human tissue to jet engine parts and shoes. The US can and should be competitive in custom, precision and high added-value manufacturing.

## EDUCATION & WORKFORCE DEVELOPMENT

Invigorating technical education through hands-on learning will foster an education pipeline to prepare the optics and photonics workforce and improve the translation of research to innovative commercial applications for the benefit of the nation's economy, security, health and competitiveness. The current demand for hands-on learning at the community college and undergraduate levels will increase dramatically with the application of optics and photonics technologies in next generation products and services across economic sectors. Investment in programs that provide these experiences for students pursuing post-secondary degrees and certificates will invigorate technical education in the US.

## QUANTUM SCIENCE & TECHNOLOGY

Many quantum innovations rely on photonics-enabled technologies. R&D in optical science continues to develop new enabling technologies for a wide range of basic studies and applications in quantum science. Advancements in quantum science and technology (QST) will improve security and privacy in digital communications systems; enhance navigation in demanding environments; advance sensors for geological resource exploration; and, drive superior computational capabilities for complex simulations and modeling of new pharmaceutical drugs and solar-energy-harvesting materials. Support for such enabling technologies has a two-way benefit: commercial products will drive the development of quantum technologies, and the developing quantum arena will provide market space for these products.