Unrestricted Markets and Safety Regulations: Where's the Right Balance?

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How does Florida Photonics Cluster contribute to the innovation process?

An effective innovation process has many components, including effective mechanisms for communication and partnership formation among companies, universities, and government organizations. The Florida Photonics Cluster (FPC — www.floridaphotonicscluster.com) is an important part of the innovation process in Florida and the USA since it is designed to support the growth and profitability of the Florida photonics industry through the strength of a unified voice, and to make Florida the place to go for photonics solutions. The FPC is dedicated to enhancing the photonics industry through effective collaboration by bringing together the knowledge, expertise, and service that each organization has.

What are the specifics of the innovation system in the US?

There is no "national system" for innovation in the US in the sense of having all the elements for innovation integrated and centrally managed as a single "system". The main principles that drive innovation in the US are:

•Free market competition;

•Constant exploration of new technologies, new marketing approaches, and new management techniques for people and business (marketing, finance, etc.);

•Government involvement through a) laws and regulations where required to assure open markets (no monopolies) and product safety; b) funding of research and development in areas identified as important to the US people and both the US and international economy;

Innovation in a technology-based industry like photonics requires a number of components including the following (all of which are abundant in the US, although more is always needed):

•Continuous investment in research and development, from basic science to prototype products. This investment needs funding from private investors, industrial companies, and government at local, state, and national levels;

•Strong, effective partnerships between industrial organizations (companies and trade associations) that can bring new products to market and universities that conduct much of the leading-edge technology research;

•Capital resources from private equity organizations, lending institutions, and company funds to enable new start-up companies to form, to foster growth of small to medium size companies, and to fund expansion of manufacturing facilities and development of new markets for a company's products.

How does the legislation regulate the innovation process?

In the US, government legislation or regulation is designed to foster and promote innovation in the private sector while also preventing abuses and assuring safety. It is a continuous effort to find the right balance between free enterprise and unrestricted markets and regulations to assure fair and safe treatment of the public (consumers and investors). Laws and agencies to enforce them, on disclosure to investors, control of intellectual property (patents and company-confidential information), requirements to form new companies, product safety and liability, etc., are all in place and always being evaluated.

Other types of legislation create funding and other resources that support the innovation process. Examples include federal funding for both government agency research (e.g., NASA, National Institute for Standards & Technology — NIST, Deptment of Defense — DoD) and for contracts with private companies. Of particular value to startup and small-to-medium enterprises (SMEs) are federally-funded programs like Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) that fund early-stage R&D projects at small technology companies and encourage industry-university partnerships (often required to receive such funds). The SBIR/STTR program (www.sbir.gov) funding is administered through several federal agencies including many Department of Defense agencies, National Science Foundation, NASA, NIST, and others. This process helps assure innovation that serves the needs of the funding agency and that also has commercial applications.

What are the major participants in the innovation process in the US?

The list of participants in the whole USA is quite long, but the general categories are listed below:

•Federal government agencies — funding; R&D tax credits; regulations; safety rules; etc.;

•Companies in the photonics industry, from component suppliers to systems integrators — conduct and fund research and development projects;

•Regional and state economic development organizations — fund innovation projects and provide other assistance, particularly to SMEs;

•Universities — conduct research & development projects, often partnering with companies; provide educated workforce; license technology patents; provide resources to help companies such as business incubators, seminars, etc.;

•Trade associations and professional societies — create networks for communication and partnership building;

advocate for industry needs; provide education resources and assist in developing needed product and education standards.

How important is the government role compared to that of the market forces?

Both are essential to become and remain competitive in a market and/or technology area, particularly in a field as rapidly growing and developing as photonics. The government plays a very important role as outlined above, and the market forces are essential for identifying the needs, the products, and services that are required to meet those needs. The continuing and necessary dialog is what role the government and the market forces should each play, how much regulation and government oversight is needed, all of which changes as an industry or technology evolves and matures.

What are the latest trends in innovation policy?

The negative trends in the US, mainly caused by the recession, include:

•Reduced R&D funding from both private and government sources;

•Reduced education funding at all levels;

•A slow-down in hiring by technology-driven companies, although the photonics industry appears not to have been affected as much as other industries. This is because of the pervasive and increasing use of photonics in every application from medicine to energy to manufacturing to defense and security.

The positive trends, at least in the photonics industry, include:

•Continuing emphasis on photonics as one of the primary areas for investment and development. This is evident at all US government levels (federal, state, regional), at companies, and with venture capital investment. This is also evident in many other countries, which is a positive trend for the photonics field and industry, but a challenge to each country, including the US, to stay competitive in a rapidly changing technology-driven market;

•New technology being developed and new applications are being found, with reports coming out weekly;

•A current initiative by the National Research Council, "Harnessing Light II" will update a 1998 study (see www.nap.edu/catalog.php?record_id=5954) to identify and recommend high-impact initiatives that the government should take to drive the future of the US industry in the vital field of photonics (see www.sites.nationalacademies.org/PGA/biso/ICO/PGA_047366 for an independent view of the importance of this new study).

What may be achieved through these changes?

If the negative trends are not stopped and reversed in the US, the country will continue to see more jobs, products and services produced by other countries. This will lower the US standard of living and reduce the opportunities for young people entering the workforce.

The positive trends, if they continue as I think they will, will indeed make the XXI century "the age of photonics" in the same way the XX century was "the age of electronics." New photonics technologies such as nano-photonics and efficient, low-cost solar cells, and new applications of photonics in medicine, manufacturing, defense, and other applications will open new markets and continue to create opportunities for entrepreneurs to start new businesses.

What helps and what hinders the development of innovation system in the US?

The things that help innovation in the US include the following:

•A free and open, democratic society that values exploration and informed risk-taking;

•A democratic government, elected by the citizens, that listens and responds to new ideas and to criticism of practices and policies that hinder innovation;

•Funding for education and research by government at all levels — federal, state, county, city;

•World-leading colleges and universities for creating the workforce needed for innovation and for conducting advanced research and development;

•A commitment to collaboration among the parties involved in innovation — companies, universities, government agencies, trade and professional organizations;

•Relatively easy access to business development and venture capital resources for guiding and funding new companies and expansion of SMEs;

•Too much outsourcing of manufacturing or product development.

The things that can hinder innovation in the US include the following:

•Reductions in R&D funding — by government and companies;

•Over-emphasis on competition at the expense of mutually beneficial cooperation;

•Not enough young people electing to pursue science or engineering careers.

In which areas the results of innovation have been most impressive? More specifically, how impressive the results of innovation in your area?

Although there are many areas of impressive innovation, in my opinion, photonics is at the top of the list for both technology advancement and new products. Of course, I may be a bit biased with this opinion, but photonics is now found in almost every application you can name, including energy, biotech/medicine, computers and information technology, defense, manufacturing, consumer products, and others. Here are some specific examples of where innovation in photonics has made a great impact, and will continue to do so:

- Telecom is perhaps the most widely recognized application area with fiber optics and laser sources and detectors as the fundamental, enabling technologies;
- Defense: night vision equipment, laser target designators and range finders, laser-guided bombs, vision systems for remotely-piloted vehicles (RPVs);
- Aerospace: fiber optics on aircraft (replacing copper wires in control systems) and photonics sensors for speed control, engine control;
- Consumer products: LCD and plasma TVs and other displays; traffic lights; CD and DVD players and recorders; data storage devices for computers; displays for cell phones; remote control devices (e.g., TV remotes);
- Semiconductor manufacture: light sources for lithography used in making all types of chips and devices, and enabling ever-smaller devices and the continuation of Moore's Law;
- Energy: LED light sources; solar cells; large mirrors for collecting and focusing the sun's rays into thermal generation of electricity;

• Astronomy: ground-based (like the Keck and European Southern Observatory) and space-based telescopes (like the Hubble) using large, segmented primary mirrors and adaptive optics to control the telescope and remove atmospheric turbulence distortion;
• Medicine: surgery (radial keratotomy perhaps the best known, but other surgery also like vascular, and other minimally invasive techniques); diagnostics (small cameras, displays, specialized sensors for analysis, etc.);
• Manufacturing: lasers used for welding, cutting, hole drilling in almost any high-volume or specialized manufacture such as automobiles, jet engines, etc.; automatic inspection and sorting equipment.

How important are technological (innovation) parks?

Technology (or innovation) parks are another essential resource for innovation. They provide easy and affordable access to facilities and to business resources such as financial and strategic planning. The parks are often located close to major universities in the US, which provides easy access to consultants, facilities, and new employees. They are also a key resource for new startup companies, particularly spin-offs from universities.

Could you dwell upon the most improved innovation parks in the US?

There are many fine examples in the US, but the one I want to speak to is in Central Florida. This innovation "park" has a number of components, which are relatively new, but have rapidly become world leaders and a benchmark in innovation. I rank Central Florida as one of the most improved innovation "parks" in the US. Here are the elements that support and drive innovation in many areas, including photonics:

1. University of Central Florida (UCF) — www.ucf.edu
2. CREOL — The College of Optics and Photonics — www.creol.ucf.edu
3. UCF Business Incubation Program — www.incubator.ucf.edu
4. UCF Venture Lab — www.venturelab.ucf.edu
5. Florida High Tech Corridor Council (FHTCC) — www.floridahightech.com
6. GrowFL Economic Gardening Program — www.growfl.com
7. Florida Virtual Entrepreneur Center — www.flvec.com
8. Metro Orlando Economic Development Commission (MOEDC) — www.OrlandoEDC.com
9. Enterprise Florida Inc. (EFI) — www.eflorida.com
10. Florida Research Consortium — www.floridaresearch.org
11. Florida Photonics Cluster (FPC) — www.floridaphotonicscluster.com

What is your forecast for the development of innovation system in the US?

The elements of the US innovation "system" discussed here will continue to develop and evolve. The history and tradition of the US in being a leader in technology development and deployment will continue and grow even stronger with time. The current innovation "parks" will continue to develop and evolve as new technologies are discovered and new companies to commercialize the technologies are created, and new "parks" will be created.

What research or technological achievements may assure a technological breakthrough in the years to come?

Many people have said it in different ways that "It's hard to make predictions — especially about the future." But my "fearless forecast" is that breakthroughs in photonics will produce the most significant changes in our world in the next 10—15 years. Some of the areas to watch are the following:

•Nanophotonics, perhaps "picophotonics". Research in this area will impact nearly every application of photonics, but perhaps most significantly in life sciences — medicine, artificial limbs, artificial intelligence, robotics;

•Solar cells for energy generation. New and renewable energy sources are a critical worldwide need that will only increase with time. Solar energy is the future for meeting our energy needs;

•Application of photonics in medicine and life science areas;

•Biophotonics and Medical Diagnostics — new optical techniques such as optical coherence tomography and multi-spectral molecular assays for analyzing tissue structures and biochemistry both through molecular analysis of samples and in-vivo will both expedite and improve the accuracy of diagnoses thus improving patient outcomes while lower associated costs.

And in closing, watch Florida continue its development as a leader in technology innovation, including photonics. Although the past isn't a predictor of the future, the rapid and world-leading developments of the past 10—20 years in Florida will continue. This is demonstrated for the photonics field by comparing the Florida photonics industry in 1998 to what it was in 2008 (all numbers from a survey and study funded in 1998 by USF's Office of Economic Development and by the FHTCC in 2008 — www.floridaphotonicscluster.com/files/PhotonicsClusterStudy2009.pdf).

Here are the comparisons:

Item	1999	2009
Number of companies	148+	271+
Photonics-specific annual sales	Over $2B	Over $3.6B
Impact on Florida annual sales	Over $4B	Over $7.2B
Number of jobs produced	11,000	27,000
Number of optics professionals	3,400	5,700
Annual university research funding	$12M—$15M	$20M+