



# EMERGING TECHNOLOGIES 3.0

A reporting analyzing emerging technologies for  
assisting in the development of future Career  
Technical Education programs for California  
Community Colleges

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## **BACKGROUND**

This report was prepared by the Center for Applied Competitive Technologies (CACT) at El Camino College (ECC), under the 2012-13 HUB grant from the California Community College Chancellor's Office, Economic & Workforce Development (EWD) program.

The ECC CACT helps area manufacturers and aerospace companies compete successfully in changing markets and the global economy. Through technology education, manufacturing training and services that contribute to continuous workforce development, the CACT provides expertise in technology deployment and business development. Services include onsite training, low-or-no cost technical assistance, and educational workshops, as well as information on how to qualify for state funds to assist with retraining employees and upgrading equipment.

The EWD is an integral part of the California Community Colleges, investing funding and resources in key industry sectors. EWD's industry-specific programs invest in the skills of California's workforce – now and in the future – through highly specialized industry training, technical consulting and business development. The end result is the ability for businesses to better understand the trends and labor market pertaining to their industry, and make informed decisions about how to grow and compete.

## EMERGING TECHNOLOGIES

*“The goal of this airplane is not just to go from one point to another, but to fly as long as we wish, promote renewable energy and ambitious energy policies.”*

-- Bertrand Piccard, Solar Impulse Founder



**CREDIT: Solar Impulse/Jean Revillard**

### Solar Powered Airplanes

As its name implies, solar powered airplanes are airplanes that use solar energy as their primary power source. Several flights have already been taken, including a 2012 flight that marked the first intercontinental flight by a solar-powered airplane. Back in 2001, a pilotless solar powered airplane was developed and successfully flew by work from NASA and AeroVironment.

### Quantum Dots

Quantum dots are tiny semiconducting particles developed through nanotechnology processes. They have a variety of applications, including an improved range of color for televisions, increased solar cell efficiencies, and enhanced cancer detection/treatment, with other potential applications not yet realized.

### Cryogenics

Cryogenics is a branch of physics that looks to understand low temperature phenomena. (Note: although cryogenics has been around for some time, the industry has matured to a level that warrants addressing.) At this temperature, several unique commercial applications are available, including food transportation, MRI functions, and many other electronics-related applications. Cryogenics is also utilized in space exploration, and energy production/storage. In other words, cryogenics is employed through various industries for a variety of functions.

### Holographics

Holographics is the creation of a three-dimensional image via optical/laser-based technologies. Applications are numerous, including art, medicine and education. While there is a growing demand for holographic technology, the cost to develop this technology, coupled with a limited demand, keeps mass production from becoming a reality. Although it is still somewhat confined to the R&D stage, a few companies are trying to become the leaders in low-cost holographic technology.

### Graphene

Graphene is an atomic-scale material in sheet form that's composed entirely of carbon atoms. The applications for such a material are off-the-chart, including improved energy storage, drug delivery, computer chips, and water filtration. Governments, including the UK, have invested substantial amounts in trying to be the ones who reap the economic benefits of this potential game-changing material.

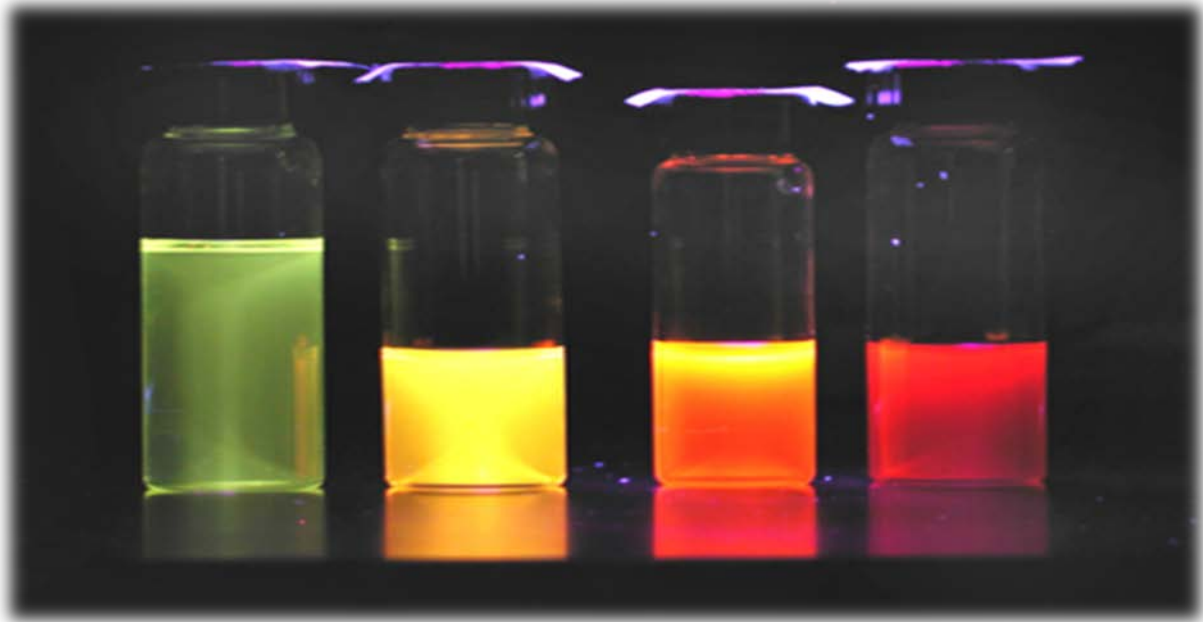


**CREDIT: Eric Raymond**

## INDUSTRY OVERVIEW

*“Displays are a potential market that could help quantum-dot companies find traction.”*

-- Jonathan Melnick, Lux Research



CREDIT: NASA

### Solar Powered Airplanes

*Economic* – Because no business has yet to commercially sell solar powered airplanes, no economic data is currently available. Different types of solar-powered airplanes have been developed, but are still in the testing stage and have a long way to go to ensure safety.

*Employment* – No economic data was found.

*Wages* – No wage data is currently available.

*Growth Projections* – No data was found. However, if solar-powered airplanes can be proven to be both reliable and safe, future growth projections may be substantial.

### Quantum Dots

*Economic* – No economic data was found. Quantum dot manufacturing is still in its infancy, but is growing rapidly. However, according to *BBC Research*, in 2010 the biomedical sector was the largest producer of quantum dots, and generated nearly \$50 million in revenue.





*Employment* – No economic data was available.

*Wages* – No wage data was found.

*Growth Projections* – No data was available. However, quantum dots are emerging as a viable tool for a variety of functions. One can expect sustained growth from quantum dot production and use in the near future and beyond.

### Cryogenics

*Economic* – No specific industry data was found. Although cryogenics is part of daily operations for several industries, the lack of data may be due to a combination of factors, including the ease of access/use, and of the apparent finite amount of applications.

*Employment* – No employment data was found.

*Wages* – According to job listings at glassdoor.com, cryogenic technician salaries are listed around \$50,000/yr.

*Growth Projections* – No data was found.

### Holographics

*Economic* – As is the case with cryogenics, no specific industry data was found. This is due to several factors, but perhaps most largely attributable to the technology having yet to mature, the high cost of components, and degree of difficulty in sustaining a quality holographic projection.

*Employment* – No employment data was found. However, technology will eventually mature to the point where holographics technology can be developed for specific consumer functions at a relatively low cost per unit. Once that takes place, employment in holographics will skyrocket.

*Wages* – No wage data was found.

*Growth Projections* – No data was found. However, given the potential applications for this technology, expect sustained growth once the technology matures.

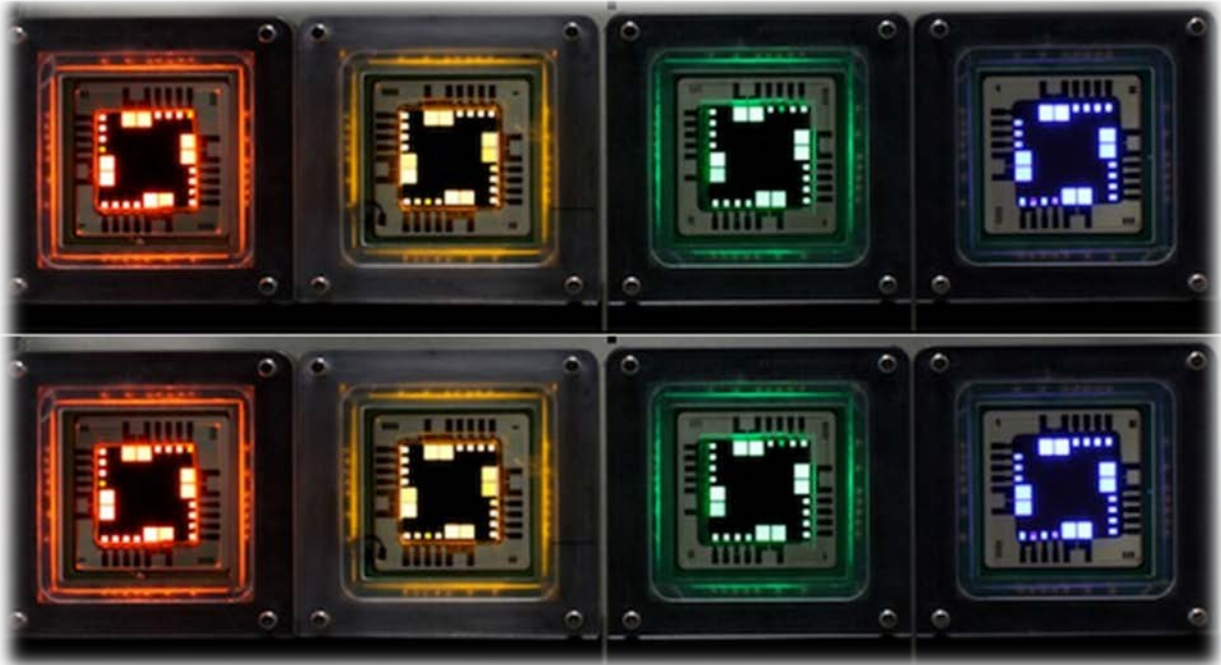
### Graphene

*Economic* – Graphene is still in its R&D stage. Consequently, no economic data exists. That being said, the potential applications of graphene have led some scientists/economists to speculate that graphene may very quickly become a billion dollar once the manufacturing costs are overcome.

*Employment* – No employment data is available.

*Wages* – No wage data was found.

*Growth Projections* – If the issues within graphene applications can be overcome, growth projections will not be quantifiable. That is how impacting this material may be in the future.



Quantum Dot LED Display. CREDIT: QD Vision



## WORKFORCE REQUIREMENTS

*“...it's been the ambition of millionaires to have their heads, frozen in liquid nitrogen and at some point in the future.”*

-- Dr. Michio Kaku, Physicist



**CREDIT: Cryogenics International**

### Solar Powered Airplanes

Those involved in building solar-powered aircraft can be split between hobbyists and professionals. Since these airplanes have yet to be sold, there are no established or identifiable workforce requirements. However, it is clear that the predominate knowledge required for such an operation would be of an aviation nature.

### Quantum Dots

Most of the people developing quantum dots have a Masters degree or higher. Because quantum dots are still in their infancy, there are no specific degrees to obtain. Since quantum dots are developed through a nanotechnology process, the degree most suited for this area is in nanotechnology, which exists at both the Masters and PhD level. (Note: nanotechnology was a previously-highlighted area within the 2012 “Emerging Technologies” report, available on the CACT website.) Currently, no technical degrees are available.

### Cryogenics

Those working in the cryogenics usually have a combination of skill-sets and certifications,

which are required to work in this area. Those conducting high-level cryogenics research have at least a Masters degree, and it's related to cryogenics, such as physics. Those at the technician level generally have an A.S. degree, but with additional on-the-job training, and various certifications.

### Holographics

Those involved in developing holographics technology generally have substantial skill-sets, particularly in the areas of optics and high-precision electrical engineering/integration. Various science-related degrees allow for someone to work on holographic devices, including physics, optics, and electrical engineering. Currently, no technical degrees are available.

### Graphene

Because graphene is still in the research stage, no degrees specific to graphene currently exist, nor are there any identifiable skill-sets required. Those conducting graphene research (largely taking place in academia) usually have a PhD, which can be in several areas, including: materials science, chemical engineering, electrical engineering, physics, and others. No technical degrees are available, nor are they likely to be developed in the near future.

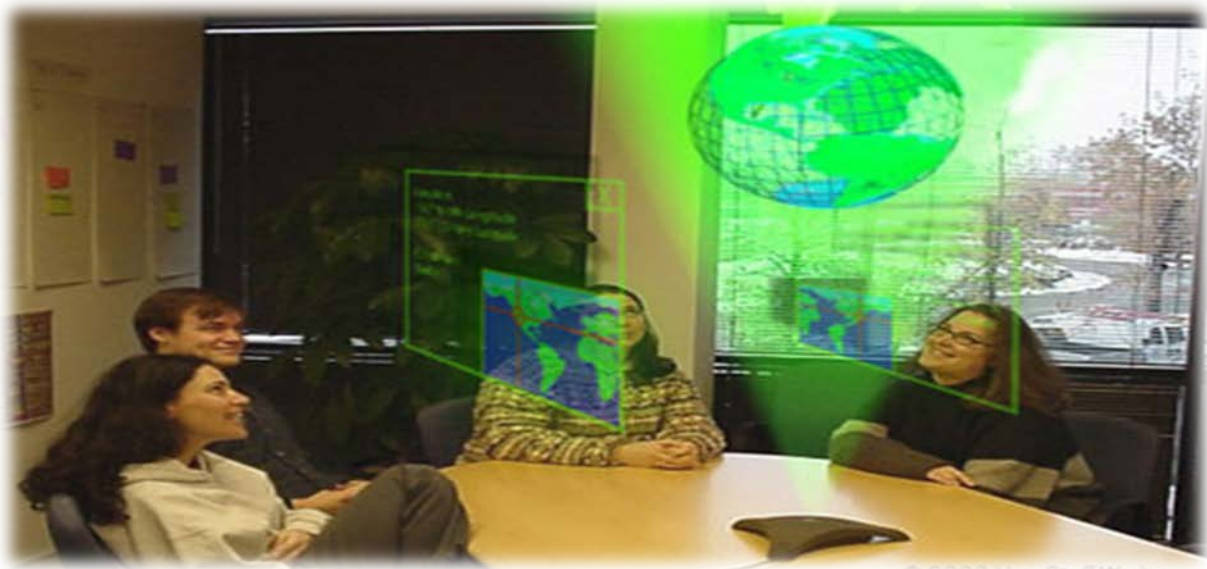


**CREDIT: [hplusmagazine.com](http://hplusmagazine.com)**

## RECOMMENDATIONS

*“It all depends on the applications. If we can develop [it] with good applications, we invest more.”*

-- Ryoji Chubachi, Sony



CREDIT: howstuffworks.com

### Solar Powered Airplanes

Arguably, the primary consumer for this product would be an individual taking a leisure trip (with a limited range). The area of commercial viability (i.e. cargo, large-number of passenger) has yet to be explored with any meaning. Case-in-point: the first around-the-globe flight is scheduled for 2015 by Solar Impulse. As such, the workforce needs are not addressable at this time. That being said, there is significant economic opportunity to encourage the manufacturing of solar powered airplanes in California. Manufacturing of airplanes has some of the highest economic output markers. This means that several jobs would be created for one aircraft manufacturing job. Given California's reputation for clean energy, flight infrastructure, weather, and workforce availability, California can maximize economic opportunity by offering tax and regulatory incentives to companies who will eventually manufacture solar-powered airplanes.

### Quantum Dots

The potential applications for quantum dots are impressive, but quantum dots are still limited by the cost and procedure for producing high quality quantum dots en masse. In many regards, quantum dots have a similar problem to the production of carbon nanotubes. With quantum dots still being in the R&D stage, this is a wait-and-see approach, for the potential applications of successfully overcoming these limitations could yield large economic growth for those involved.



in its manufacturing. Once quantum dot processes are robust and efficient, they could be integrated into a nanotechnology A.S. degree (since quantum dots are developed via nanotech processes) which currently exist at a few community colleges.

### Cryogenics

While cryogenics is not necessarily an emerging technology, it is maturing, and the use for cryogenics technology continues to grow. While there are no identifiable CTE programs, the California Community College system may be in a position to offer certification for those involved in the handling and transportation of cryogenic materials/fluids. California's reputation as a "green" state also plays into a rationale for the development of cryogenics, as it is utilized for liquefied natural gas (LNG) and for energy storage of renewable energies that are dependent upon certain weather. As such, its use for various processes is an opportunity for California to encourage economic output through incentives for boosting cryogenic use, which will also help in its continued development.

### Holographics

Since holographic-related jobs are limited and require substantial knowledge, the workforce component cannot be addressed at this time. However, the promises of holographics technology should not be ignored. A significant amount of economic revenue will be generated from companies developing holographics technology in the near future. Consequently, it would be worthwhile for California to explore incentives for companies conducting R&D in this area, for any company that successfully develops holographic technology will be in business for years to come.

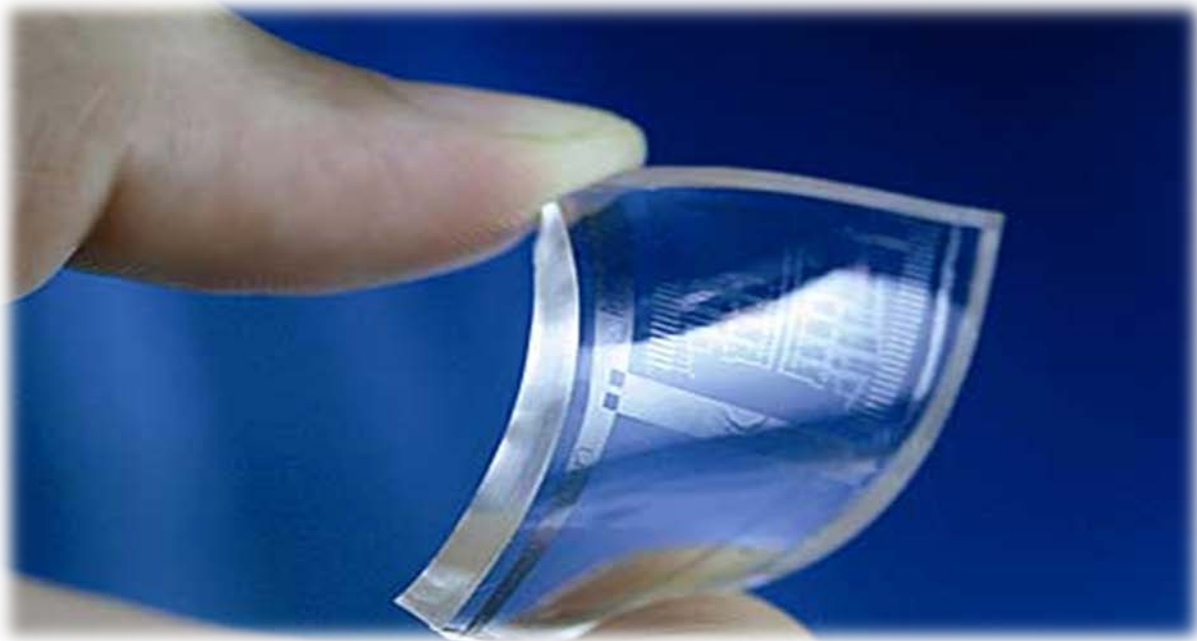
### Graphene

Of all the potential areas that can maximize economic output, graphene wins hand-down. If the promises of graphene eventually become a reality, the impact on society may not be possible to quantify. Because of this potential, various governments have been sponsoring funding of graphene research. The UK in particular has invested large amounts to develop graphene, for those companies who succeed will generate substantial amounts of economic output. As such, California should consider tax and regulatory incentives to businesses conducting graphene research, as well as offer in-house grants through the UC/CSU system for academic researchers.

## RESOURCES & LINKS

*“Using graphene -- either as an alternative to, or most likely as a complementary material with -- silicon, offers the promise of much faster future electronics, along with several other advantages over the commonly used semiconductor.”*

-- Steve McGaughey, Beckman Institute for Advanced Science & Technology



CREDIT: Ji Hye Hong

BBC Research

<http://www.bbcresearch.com/>

Glass Door

<http://www.glassdoor.com>

Indeed

<http://www.indeed.com>

Lux Research

<http://www.luxresearchinc.com/>