



EMERGING TECHNOLOGIES 2.0

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

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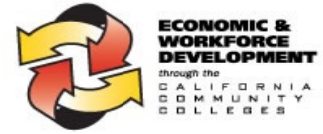


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BACKGROUND

This report was prepared by the Center for Applied Competitive Technologies (CACT) at El Camino College (ECC), under the 2010-11 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.

IDENTIFIED INDUSTRIES

“The future of how you use these unmanned systems or remotely piloted systems is really unlimited. We need to open our minds and think more about capability and impact we are going to achieve as opposed to how we've done business in the past.”

-- Lt. General David Deptula



Credit: USAF

Unmanned Vehicles

Unmanned vehicles are just that, vehicles that can guide themselves to destinations and perform programmable functions. This category includes unmanned aerial vehicles, unmanned ground vehicles, and unmanned underwater vehicles. Areas related to this industry include robotics, computer programming, electrical/mechanical engineering, and geospatial technologies.

Nanotechnology

Nanotechnology refers to atoms and molecules being manipulated for purposes of developing a variety of devices. There are several applications of nanotechnology products, including medical and environmental, but are projected to have the most profound impact in electronics.

Aerogel Manufacturing

Aerogel is the least dense solid known. It is 99.8% air, and has the highest insulation properties known. Existing products utilizing aerogel include clothing, shoes, blankets, and various thermal

insulation applications for several industries, including military and energy. Aerogel has also been used for space-based functions: to capture intact comet particles and serve as thermal insulation for a Mars rover.

Swarm Engineering

Swarm engineering (also referred to as swarm robotics) refers to a group of autonomous vehicles (water, ground or air) working together to perform a specific task, which may include mapping, navigation, and search & rescue. It encompasses a variety of fields, including engineering, computer programming, robotics and math.

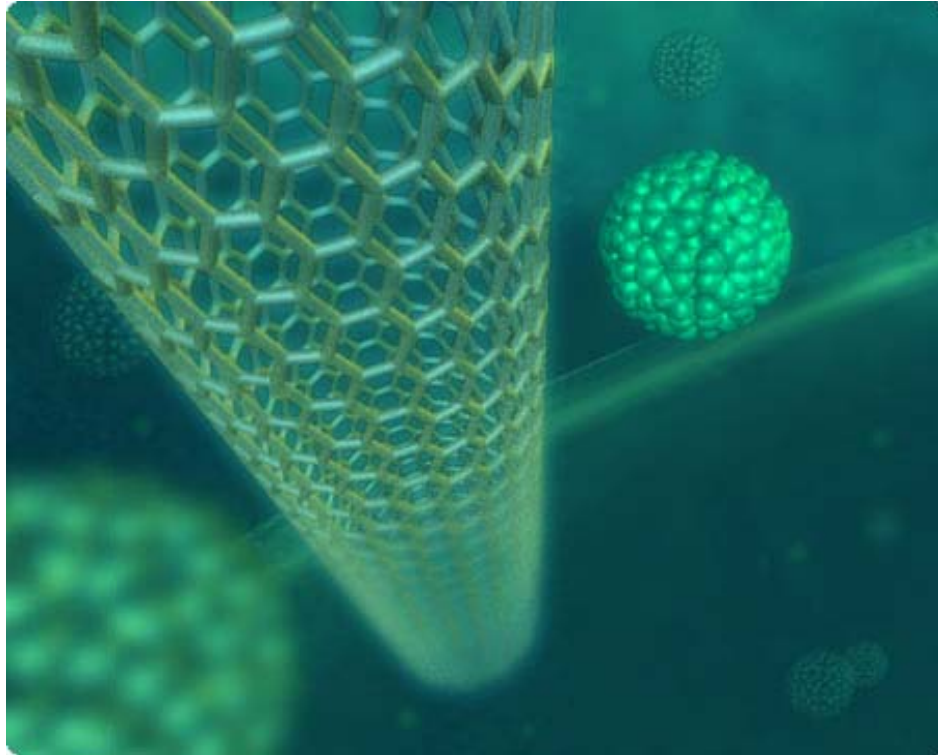
Quantum Computing

A combination of physics, math and engineering, quantum computers are computers that utilize quantum phenomena for performing data-related functions. They have the potential to perform at speeds that are unfathomable to many, and data storage levels that defy logic. The number of potential applications are many, including cryptology, genetic programming, magnetic imaging, various forms of modeling, and special-effects processing, just to name a few.

INDUSTRY OVERVIEW

“Every industry that involves manufactured items will be impacted by nanotechnology research. Everything can be made in some way better—stronger, lighter, cheaper, easier to recycle—if it’s engineered and manufactured at the nanometer scale.”

-- Stan Williams, Director – HP Quantum Science Research Group



Credit: bionicme.com

Unmanned Vehicles

Economic – According to a Lucintel report, UAV industry generated \$3.4 billion in 2008.

Employment – No direct data was available; however, these jobs are directly related to aerospace, manufacturing and the corresponding industry codes.

Wages – According to one trade expert, starting salaries can range from \$50,000 to over \$100,000 per year. According to an industry trade group, a few positions can exceed \$125,000/yr.

Growth Projections – According to a Lucintel report, global annual spending is expected to approach \$6 billion by 2014. According to Market Research Media, the UAV industry is projected to reach nearly \$19 billion by 2018.

Nanotechnology

Economic – According to Electronics.ca Publications, the global nanotechnology market in 2010 was estimated at more than \$15 billion.

Employment – According to one National Science Foundation estimate, there were 160,000 nanotechnology workers in 2008.

Wages – Range from entry-level earnings through a CTE program to researcher earnings topping \$100,000/yr.

Growth Projections – The National Science Foundation has projected nanotechnology to be a \$1 trillion market by 2015, whereas Lux Research has projected it at \$2.6 trillion by 2014.

Aerogel Manufacturing

Economic – According to a report by BBC Research, the global aerogel market was worth more than \$80 million in 2008.

Employment – There are currently no employment numbers for the aerogel industry.

Wages – There are currently no wage data for aerogel manufacturing. However, based on job openings and other descriptors, it can be estimated that salaries range from \$50,000/yr to over \$100,000/yr.

Growth Projections – According to a report by BBC Research, the global aerogel market is expected to reach nearly \$650 million by 2013.

Swarm Engineering

Economic – Swarm engineering is a culmination of various fields that have yet to materialize into an independent industry. As such, no economic data was found.

Employment – Due to the fact that swarm engineering is an application of various fields, no economic data was found.

Wages – When considering that most people working in developing swarm engineering probably have (at a minimum) a Bachelor's degree in science, engineering, math, robotics or computer programming, it can be estimated that salaries range from \$50,000/yr to well over \$100,000/yr.

Growth Projections – Although no economic data exists, the technology has been demonstrated to be viable, and potentially robust in future growth. Swarm engineering encompasses, among other things, robotics, which is projected to dominate several industries, including medicine and defense.

Quantum Computing

Economic – There are currently no economic numbers on quantum computers. However, the first quantum computer was sold to Lockheed-Martin by D-Wave in 2010, at a price-tag of ten million dollars.

Employment – There are currently no employment numbers for quantum computing.

Wages – There are currently no wage data for quantum computing

Growth Projections – While there are no official numbers, quantum computers are the wave of the future. There will come a time when most computers sold are quantum computers. As such, once the science and cost behind quantum computing is bridged, the growth will be equivalent to that of today's iPhone.

WORKFORCE REQUIREMENTS

“Aerogel has several unique properties that can provide many useful terrestrial applications.”
-- Dr. Peter Tsou, Scientist



Credit: NASA

Unmanned Vehicles

Most working in unmanned vehicles either have a Masters or PhD, but a growing number can now be employed by having a Bachelor's degree with on-the-job training in a related area. Students can now pursue a growing number of UAV Bachelor's degrees. Schools that offer UAV degrees include Embry-Riddle Aeronautical University and the University of North Dakota, with several more in the works from schools around the globe. Although there are no direct CTE programs at the community college level, manufacturing of UAV's is addressed through existing CTE programs in aerospace engineering or manufacturing technology.

Nanotechnology

As if the education has gotten ahead of the industry, there are a variety of nanotechnology-related degrees, offered at all levels of higher education. As for the CTE level, there are several Associate's degrees offered from North Seattle Community College, Dakota County Community College, Texas State Technical College, Butler County Community College, Normandale Community College, and Forsyth Technical Community College, among several others.

Aerogel Manufacturing

Most work in aerogel manufacturing requires a Bachelor's or Master's degree in chemical engineering, materials science, or a similar field. There were no aerogel degrees or certificates found.



Swarm Engineering

Engineers working in this area usually possess a Masters or PhD in Robotics, electrical engineering, computer programming, or a related field. To date, there are no identifiable degrees, at any level, in swarm engineering.

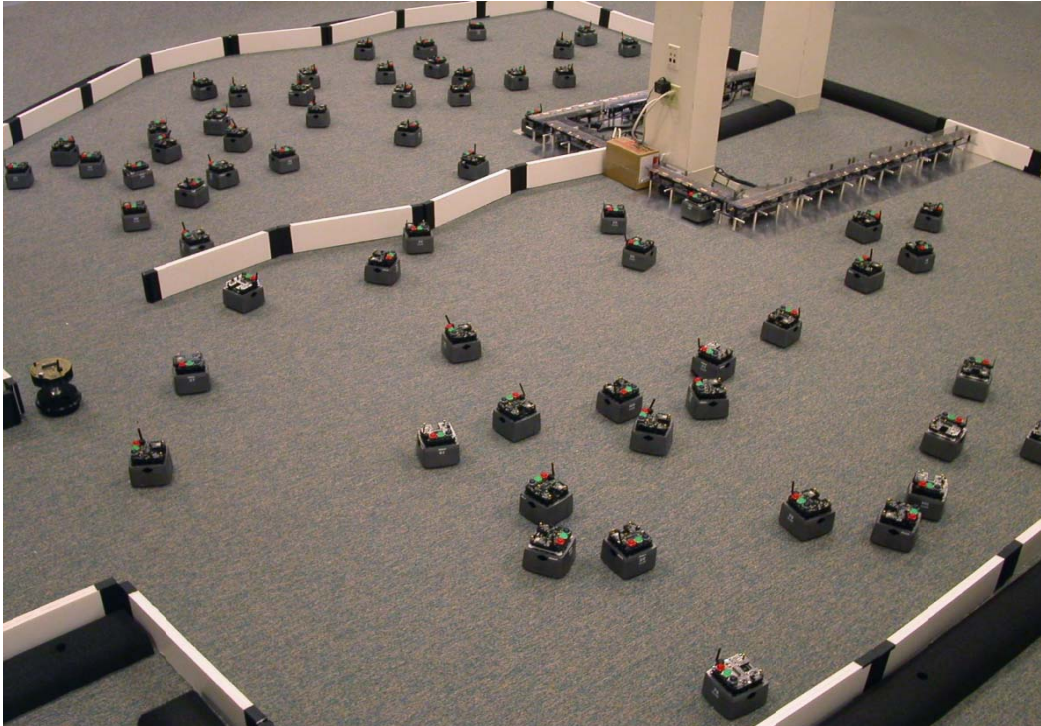
Quantum Computing

For what research is being conducted in quantum computing, it is safe to assume that most, if not all researchers, are at the Masters or PhD level.

RECOMMENDATIONS

“As robots become more and more useful, multiple robots working together on a single task will become commonplace. Many of the most useful applications of robots are particularly well-suited to this "swarm" approach. Groups of robots can perform these tasks more efficiently, and can perform them in fundamentally different ways than robots working individually.”

-- James McLurkin, Rice University



Credit: Rice University

Unmanned Vehicles

Given the unmanned vehicle demands (current and future), this skill-set cannot be ignored. However, putting together a tangible/relevant CTE program, for either the manufacturing or utilization of unmanned vehicles may prove quite difficult. Given the economic important of this area, it would be worthwhile to explore what California can do to ensure a robust unmanned vehicle future. If it appears that California will maintain a large enough manufacturing base of these vehicle types, then it would be worthwhile to analyze what industry skill-sets are needed, and see if a viable CTE program can be developed.

Nanotechnology

The promises of economic growth have not materialized into what experts would have hoped. Due to the fact that nanotechnology is more of a process that's utilized through a combination of learned fields, attempting to pinpoint specific skill-sets is quite difficult. As such, putting together a CTE program in nanotechnology, particularly when there are so few businesses who identify/classify themselves as nanotechnology companies, must be done with careful

consideration. One California community college, Foothill, has a nanotechnology program that should be looked at for emulation. However, there are several A.S. nanotechnology programs across the country that have no identifiable pathways from program to industry. Employment data should be carefully looked at to determine whether there is a demand in the Los Angeles area for such a program. It is possible to offer an introductory nanotechnology course that would complement existing science or engineering programs. It could also serve as fulfilling a general science education requirement, further ensuring student demand.

Aerogel Manufacturing

Although aerogel has been around for quite some time and the potential applications are off-the-chart, the manufacturing cost remains substantially high, with only a handful of companies able to turn profits. As such, the industry does not have any CTE demands at this time. As for the economic component, if there is a breakthrough in the manufacturing cost, then it would be worthwhile for California to look at how to capture the economics of this remarkable material.

Swarm Engineering

As is the case with nanotechnology, swarm engineering appears to be too broad in area skill-sets. However, due to its close relation with UAV's and robotics, it may be possible to have swarm engineering as a course that is part of full-fledged UAV or robotics CTE program. Course overlap would be advantageous to ensure that course offerings within these possible CTE programs would be well attended.

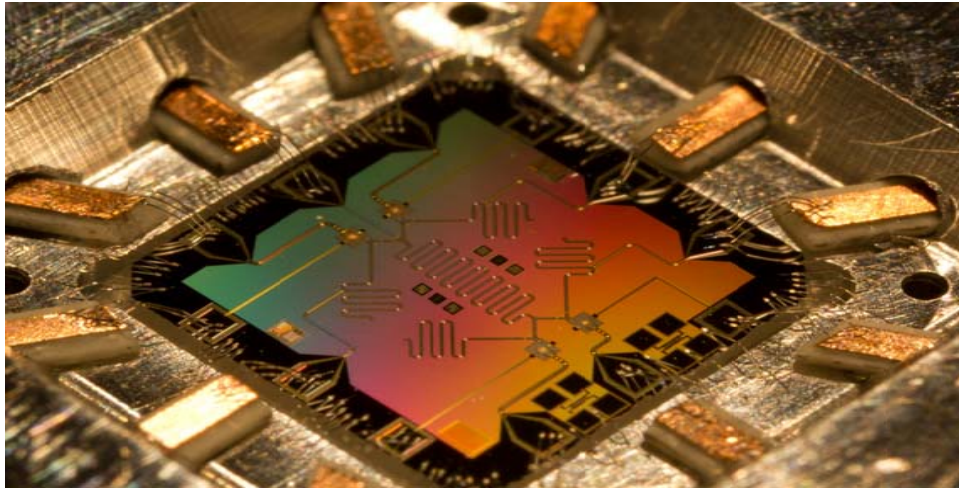
Quantum Computing

Quantum computers will revolutionize computer, but there are still a few more decades before the very first mass-produced quantum computers CTE programs would ever be viable, if ever. However, the manufacturing of quantum computers should be looked into, specifically how California can position itself to ensure that a California-based company is at the forefront of this eventual mass production.

RESOURCES & LINKS

“It’s not so straightforward to predict where computing goes. If you were to ask the folks that invented the transistor where it was going, they couldn’t have imagined what it would one day lead to. The same is true for quantum computing”

-- Matthias Steffen, IBM Research



Credit: Erick Lucero

BBC Research

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

Electronics.ca Publications

<http://www.electronics.ca/>

Lucintel

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

Lux Research

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

Market Media Research

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

National Science Foundation

<http://www.nsf.gov/>

Teal Group

<http://tealgroup.com/>