



**ECONOMIC &
WORKFORCE
DEVELOPMENT**
through the
CALIFORNIA
COMMUNITY
COLLEGES



EMERGING TECHNOLOGIES

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 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

“In California, geothermal is already providing over 40% of the renewable energy mix and we’re barely scratching the surface. The industry has the potential to be a jobs creator while lessening America’s dependence on fossil fuels.”

Karl Gawell, Geothermal Energy Association



California Geothermal Plant. Credit: Calpine

The following emerging technologies have been identified as potential areas for consideration in the development of future Career Technical Education (CTE) programs: geothermal energy, biotechnology manufacturing, additive manufacturing, geospatial technology, and composites.

Geothermal Energy

Geothermal energy is the process of harnessing thermal energy underneath the Earth’s surface for power consumption. While the industry is not a new one, technology maturity and improved efficiencies has allowed the geothermal sector to expand considerably and provide greater future viability. Due to the fact that California has the highest potential geothermal energy capacity, and the second most existing geothermal projects (with several more projects planned in the near future), this area is ripe for investigation.

Biotechnology Manufacturing

Biotechnology manufacturing encompasses a variety of applicable areas, including healthcare (pharmaceutical development, bio-engineered implants and other medical engineering devices), the environment (treatment of water and pollution prevention), and agriculture (for increased crop yields and less pesticide use). Although the area of biotechnology manufacturing has been around for some time, only recently have advances in biotechnology, along with financial investment, has brought this area to a point where manufacturing within the biotechnology sector has become viable for study.

IDENTIFIED INDUSTRIES **(Continued)**

Additive Manufacturing

Additive manufacturing is the reduction of material use in manufacturing products. While traditional manufacturing processes include the cutting and drilling of materials, 3D printers are now able to produce materials and variations of a given product, reducing the use of materials in the manufacturing process, turnover time and costs. More and more manufacturing companies are utilizing additive manufacturing for cost-saving purposes and other efficiencies, creating potential for community colleges to develop CTE programs specific to industry.

Geospatial Technology

Geospatial Technology includes global positioning systems (GPS), geographic information systems (GIS) and remote sensing. Geospatial-based devices are now common in everyday life and remains particularly critical for military operations. While the technology has fully matured in many facets, advances continue to be made, and an ever-expanding line of products infused with geospatial technology continues to be developed. Many community colleges across the country already offer CTE-related programs and certificates. As such, geospatial technology has the highest potential for immediate implementation.

Composites

Composites are engineered or natural materials with two or more chemically independent materials, a feature that lends itself to special properties that otherwise cannot be achieved. Composites are generally characterized by being stronger with lower densities. The downside is that these materials are significantly more expensive than using traditional materials. Composites applications span various industries, including aerospace, automotive and electronics.

INDUSTRY OVERVIEW

“Advances in biotechnology and its application to food production and agricultural practices can contribute to quality of life by improving food security, health care, and the environment.”

Board of Directors, Council for Agricultural Science and Technology



Students and scientist working on sample preparation for delivery to ISS. Credit: NASA

Geothermal Energy

Economic –According to the Geothermal Energy Association (GEA), the United States remains the leader in “installed geothermal energy capability” and accounts for 4% of total U.S. energy consumption (as of 2007). Naturally, the recent global economic downturn has slowed the development of geothermal capability. Despite this, as of 2011 more than 100 U.S. geothermal projects are currently in development, with Nevada leading the way (Source: GEA).

Employment – According to the GEA, a 2004 employment survey showed the total number of jobs supported by the geothermal sector to be 11,500 workers. They also estimated the direct employment of the geothermal industry in 2008 at roughly 25,000 people.

Wages – No estimates were found. However, given the wide range of skill-sets utilized in the geothermal industry, it is expected that the range to be anywhere from ~ \$30,000/yr to over \$100,000/yr.

Growth Projections – In 2006, the Western Governors Association put out a geothermal report, estimating that the addition of 5,600 MW of geothermal energy capacity to generate nearly 10,000 jobs.

INDUSTRY OVERVIEWS (Continued)

Biotechnology Manufacturing

Economic – According to a report by the Northern California Center for Excellence and the Center for Applied Competitive Technologies, in 2009 the biotechnology sector generated more than \$47 billion in California.

Employment – In 2007, it was estimated that the biotechnology sector employed more than 800,000 people. According to a 2010 estimate, California employed over 75,000 people in the biotechnology industry. And of the nearly 3400 biotech companies located in California, the largest company concentration was in Los Angeles County, followed by Silicon Valley.

Wages – Due to the variety of positions and accompanying education levels, wages can range from \$20/hr as a lab technician to \$43/hr as a biomedical engineer.

Growth Projections – It is projected that between 2009 and 2014, California will add more than 18,000 jobs, with greatest growth coming from San Diego & Imperial Counties, and Silicon Valley.

Additive Manufacturing

Economic – Due to the nature of additive manufacturing as being an application within the entire manufacturing industry, no assessment or breakdown is available. However, it has been estimated by industry experts that 20% or more of existing 3D printers now produce final products (as opposed to prototypes).

Employment – Due to the nature of additive manufacturing as being an application within the entire manufacturing industry, no assessment or breakdown is available.

Wages – Due to the nature of additive manufacturing as being an application within the entire manufacturing industry, no assessment or breakdown is available.

Growth Projections – Due to the nature of additive manufacturing as being an application within the entire manufacturing industry, no assessment or breakdown is available. However, some industry analysts claim that by 2020 that roughly half of all 3D printers will be utilized for a final product.

Geospatial Technology

Economic – According to the U.S. Department of Labor, in 2001 the geospatial market generated \$5 billion. Research done by Daratech noted that geospatial sales grew over 10% in 2010 to \$4.4 billion, indicating that the recent economic downturn had a profound impact on the geospatial sector.

INDUSTRY OVERVIEWS **(Continued)**

Employment – No estimates were found for the overall geospatial industry. However, when looking specifically at GIS, according to the California Employment Development Department, California projected employment at over 20,000 in 2008.

Wages – No estimates were found for the overall geospatial industry. However, when looking specifically at GIS, according to the California Employment Development Department, hourly wages for a GIS specialist was estimated at ~\$30 in 2001 (given the estimate year, it is expected that this number has increased since).

Growth Projections – According to the Geospatial Information & Technology Association, the geospatial market is growing at an annual rate of 35%. Daratech forecasts the geospatial sector to grow to nearly \$5 billion in 2011.

Composites

Economic – According to a Lucintel report, the composites industry generated nearly \$18 billion globally in 2010.

Employment – No information is currently available. This might be due to the fact that employment includes not just the manufacturing of composites, but also those that utilize composites for products that are not categorized within the composites industry.

Wages – No information is currently available. This might be due to the fact that wages includes not just the composites manufacturing, but also wages for employees making products that include composites technology.

Growth Projections – According to Lucintel, the composites industry is projected to reach over \$27 billion by 2016, which does not include a same-year estimate of \$78 billion for products that incorporate composite materials.

WORKFORCE REQUIREMENTS

“If one could calculate the monetary impact from the thousands of companies that benefit from additive manufacturing, it would be in the billions of dollars annually.”

Terry Wohlers, Industry Consultant



Credit: FKM Sintertechnik

Geothermal Energy

A variety of skill-sets are needed to work within the geothermal industry. One must first drill to reach the designated spot, followed by the construction of a pipeline. Then, an analysis of the potential resource acquisition from acquired drilling data will be conducted. Assuming that resource analysis confirms the company-defined criteria for viability in construction, a geothermal power plant will be constructed and technicians will be hired to maintain the plants. Several obvious skill-sets needed for these kinds of operations include, but are not limited to, the following: engineers (structural, mechanical, etc.), geologists, machinists, mechanics and others. Two schools have been identified as having CTE programs: Gateway Technical College of Wisconsin, and Truckee Meadows Community College. Additional schools have courses and certificates that are either in addition to another degree or for existing geothermal employees receiving additional specific training. Some of the schools are: Richard Stockton College of New Jersey, Siemens, and Southwest Mississippi Community College.

Biotechnology Manufacturing

Most positions in the biotechnology sector require (at a minimum) a Bachelor's degree in a science-related field. However, there are technical positions available (laboratory technicians) that have an Associate degree as the required educational level. The upper-level biotechnology positions (medical scientists, biochemists and biophysicists) require PhD's. Several community colleges have biotechnology CTE programs, certificates, and course offerings, including (but not limited to): Bakersfield, Coastline, Golden West, Solano, Ventura, and College of the Canyons. A biotechnology manufacturing certificate is available from UC San Diego; however, it is geared toward working professionals who most likely have already acquired at least a Bachelor's degree and/or are already working in the field.

WORKFORCE REQUIREMENTS (Continued)

Additive Manufacturing

Because additive manufacturing is an improvement technique to a very large, multi-dimensional industry, educational levels span from technical to advanced degree levels. However, no fully-fledged CTE programs have been identified. Rather, certificates and courses for additive manufacturing are available. Saddleback College offers several manufacturing courses that cover additive manufacturing. Another school is York Technical College, which offers three additive manufacturing courses. The Society for Manufacturing Engineers, a professional organization, also offers certificate programs in additive manufacturing.

Geospatial Technology

Geospatial technology incorporates a variety of technologies and skill-sets required to perform in the industry. As such, educational requirements range from technical to advanced degree levels. Basic programming, GIS computer programs (such as Arc-View), electronics knowledge (GPS), and the ability to read & analyze maps are just a few of many skill-sets needed to compete in this ever-growing field. Several community colleges have existing geospatial-related CTE programs, including (but not limited to): American River College, West Valley College, Central Piedmont Community College and Hudson County Community College. Many others community colleges offer individual geospatial courses, most predominately being an introductory GIS course.

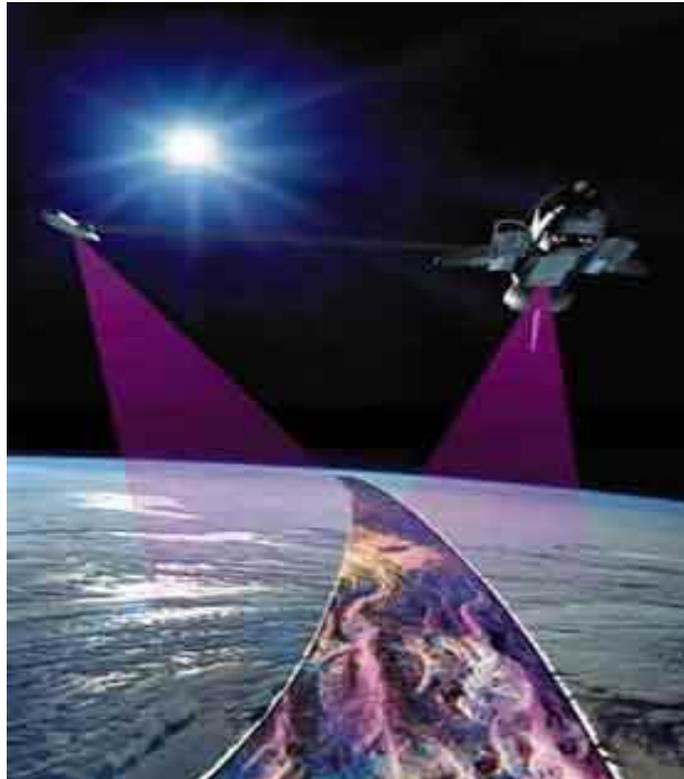
Composites

According to an editorial from Composites World, most work related to composites manufacturing is done in-house. That being said, Cerritos College has developed a hybrid plastics/composites manufacturing certificate program, and Antelope Valley College has a composites offering within their Aircraft Fabrication & Assembly program. There is a certificate program provided by the American Composites Manufacturers Association, designed to provide existing employees with industry standards and improve individual performance (among other things). One CTE program, housed at the *National Center for Aviation Training* and run by Wichita Area Technical College, includes composites training. Numerous universities conduct research into composites, including: Georgia Institute of Technology, Michigan State University and University of Maryland.

RECOMMENDATIONS

“As more and more websites, such as Google Earth, and consumer navigation systems, such as TomTom, bring awareness of the power of linking business and consumer information with their geography, geo-enabled apps will become the norm.”

Charles Foundyler, Daratech



Artists Impression of Remote Sensing. Credit: USGS

There's no question that more studies are needed to pinpoint particular skills-sets required for creating CTE programs. This is no easy task, as each particular CTE program must reflect the economic reality of each industry.

Geothermal Energy

Pinpointing the exact makeup of a CTE geothermal program will be difficult but worthwhile. Existing programs, certificates and courses would provide a foundation from which to formulate a California-based program. Given that California has the greatest geothermal energy potential, in conjunction with several more California geothermal power plants currently in production or planned, we can expect a growing need for well-trained geothermal technicians. Funding should be identified for studying best approaches towards statewide implementation of meeting the geothermal industry needs. If deemed appropriate to proceed, follow-up funding should be acquired to develop CTE programs/certificates in geothermal energy. Federal agencies would be a suitable place to acquire funding for exploring the possibility of implementing a CTE geothermal program.

RECOMMENDATIONS (Continued)

Biotechnology Manufacturing

While there are several community colleges offering CTE programs, certificates and courses in biotechnology, there remains an underlying question on whether the biotechnology manufacturing sector can maintain a stable California presence, and has future growth level projections that would allow for the development of additional biotechnology programs. An assessment on how relevant existing programs/certificates are to industry, determining which California locations might have enough industry for developing further CTE programs, and an in-depth analysis on future industry growth should proceed prior to establishing additional biotechnology programs.

Additive Manufacturing

There is no doubt that additive manufacturing will continue to play a significant role in the future of manufacturing. This, in conjunction with the ever-changing nature of manufacturing, warrants an assessment to determine whether or not a CTE program specific to additive manufacturing can be developed, as well as what existing manufacturing courses should integrate additive manufacturing. It would be advisable to look at existing CTE programs that involve additive manufacturing and assess their effectiveness as a workforce pipeline. In addition, it would be worthwhile to identify existing courses that might be able to incorporate additive manufacturing, as well as developing new manufacturing courses focused specifically on additive manufacturing.

Geospatial Technology

Of the five emerging technologies looked at in this report, geospatial technology has the largest infrastructure and redundancy to immediately implement a CTE program. In fact, many community colleges offer individual geospatial courses, particularly Introduction to GIS. Community colleges can work from this, incorporating other necessary courses to put together a full-fledged geospatial technology certificate. For each community college developing such a program, the regional industry needs would need to be matched to the particular program, ensuring a successful pipeline. Funding from the federal government, particularly the Department of Labor, can be utilized for developing geospatial-related courses and certificates. For all the aforementioned reasons, geospatial technology has the greatest potential for immediate development.

Composites

Composites are projected to have a profound impact on future products in a wide range of areas. However, the industry has yet to mature where CTE programs specific to composites can be developed to support large, technical workforce needs. Surveys should be administered to composite companies for determining what competencies are needed, which will allow a determination for pursuing a feasibility study on how, where and when to implement a CTE program.

RESOURCES & LINKS

“There is a little doubt that composite materials are rapidly becoming a mainstream technology and material of choice within many industries, from aerospace to wind energy.”

Lucintel Market Report, 2009



Artists Impression of Boeing 787. Credit: Boeing

American Composites Manufacturers Association

<http://www.acmanet.org/cct/>

American River College – GIS

<http://wserver.arc.losrios.edu/~earthscience/gis.htm>

Antelope Valley College – Aircraft Fabrication & Assembly

<http://www.avc.edu/academics/teched/afab.html>

Center for Applied Competitive Technologies

<http://makingitincalifornia.com/>

Centers of Excellence

<http://www.coecco.net/>

Cerritos College – Plastics/Composites Manufacturing Certificate

<http://cms.cerritos.edu/plastics/certificate-programs.htm>

Daratech

<http://daratech.com/>

RESOURCES & LINKS (Continued)

Freedonia Group

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

Geothermal Energy Association

<http://www.geo-energy.org/>

Lucintel

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

National Center for Rapid Technologies

<http://www.rapidtech.org/>

RapidTech - Saddleback College

<http://atecenters.org/rapidtech/>

Skinner Creative, Inc.

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

Society of Manufacturing Engineers

<http://www.sme.org>

UC San Diego – Biotechnology Manufacturing Certificate

<http://extension.ucsd.edu/Programs/index.cfm?vAction=certDetail&vCertificateID=9&vStudyAreaId=4>

U.S. Department of Energy – Geothermal Technologies Program

<http://www1.eere.energy.gov/geothermal/index.html>

U.S. Department of Labor – Biotechnology

http://www.doleta.gov/BRG/Indprof/Biotech_profile.cfm

York Technical College

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

Centers for Applied Competitive Technologies
www.makingitincalifornia.org