Producing New Technology and Products

For

New Markets in Real Time

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Time Structures

A Workforce Investment Board Toolkit Document

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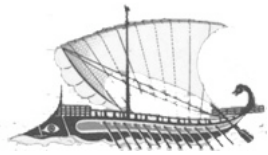
***Argonaut**: An adventurous Californian who uses science, innovation, and entrepreneurship in a global search to create wealth and to preserve the environment.*



Global Innovation and Trade Occurs in Real Time

Change! How much is happening *now* that will affect California's competitive advantage? How fast is it happening? What can we expect by 2010, 2015, and 2020?

These are not idle or trivial questions. For example:

- How long does it take to develop, test, tweak, and implement a workforce training program that meets the needs of rapidly and radically changing industries that are key to our state's economy, such as agriculture?
- What effect could climate change have on those industries? How might it affect a training program for a technologically driven construction industry that must adopt green and new energy technology as it builds new homes and offices?
- How long does it take to train an ethnically diverse workforce with new skills for new industries like nanotechnology or biotechnology? Or to train incumbent workers to use information and advanced manufacturing technologies in existing industries as they revolutionize what they do, how they do it, and where they do it?
- How many iterations must such training programs go through in five years to keep up with the rest of the world?

All of this is happening in a global economy that requires the capacity to anticipate and pace ourselves to these emerging developments as we work as a unit in *real time*—day by day—on a planetary scale.

Six pivotal developments are affecting the future prosperity of California's Innovation Corridor. **First** is the continuing improvement across the globe in manufacturing productivity. This involves extensive networks, information technology built around and supporting the revolution in global business and finance, the introduction of new materials, and relentless requirements for increased energy efficiency. **Second** is the emergence of new global companies and very large markets in Eastern Europe, China, India, and South America. **Third** are radical changes in the demographics and migrations of the world's workforce. **Fourth** is the strong competition to build and sustain a creative, scientifically literate and skilled workforce engaged in life-long learning. **Fifth** is migration away from petroleum-based energy to new forms of energy and of conservation. **Finally**, climate change will change agricultural and forestry practices, exacerbate already difficult food issues, and cause weather changes and rising sea levels that will affect major segments of the U.S. and world's urban production and population centers.

These developments are producing a complex and multifaceted future that will arrive on varying time scales with differing immediate or cumulative impacts. These developments will also vary in their regional impact. They will realign California's major indus-

tries, while at the same time supporting the emergence of new industries. They will change our state's very infrastructure.

California's Workforce Investment Boards (WIBs) will be heavily challenged to pace themselves to keep up with these pivotal developments now and in the coming years. For example:

- Global labor surpluses exist and will accelerate. They result from demographic changes, productivity improvements (job and wage losses), migration, and wage and skills competition;
- Global capital surpluses are producing favored and disfavored regional investments and will follow continuing changes in global markets and competitive advantage generated by skilled workforces and technologies;
- Basic and applied science and product and energy innovation is accelerating. Competition involves multiple states and nations, with first movers reaping the advantages in the next five to twenty years. This race includes redefining manufacturing, energy, logistics, agriculture, and other sectors leading to regional winners and losers in new technologies like nanotech, biotech, and IT;
- Large and small regional companies are part of global networks. They are speeding up innovation cycles, using advanced technology to produce products for an ethnically diverse global middle class;
- Climate-induced changes could gradually affect agriculture and urban services and manufacturing through rising seas, water shortages, and temperature changes;
- Trade networks and logistical systems are realigning from a limited number of partners to global networks and markets; and
- A global IT-network-driven revolution will induce innovation in science, technology, finance, manufacturing, and movement of goods and services, including software.

Innovation is part and parcel of the state's history.

Former California State Librarian, and current USC Professor of History, Kevin Starr recently pointed out, "Through engineering and technology, California invented itself as an American place." Such innovation is part and parcel of the state's history. The transcontinental railroad across the Sierra was an engineering feet of the first magnitude. Homegrown invention of the Pelton turbine brought hydroelectricity to California, making possible an industrial infrastructure. Aircraft were experimented with in the 1880s and perfected as military plane production in the 1950s. By the 1920s, California was a leader in vacuum tube technology, then replaced by the transistor in the 1950s and 1960s. And now we lead the world in biotechnology and

nanotechnology. Starr summarizes this scientific and entrepreneurial bedrock as follows:

> *In each instance, the specific scientific, engineering, or technological advance emerging from California was linked to the effort to discover a truth, solve a problem, make a profit, or make productive use of one's time, and in the process, to make the world a better and more interesting place. Open, flexible, entrepreneurial, unembarrassed by the profit motive, California emerged as a society friendly to the search for utopia through science and technology.*[1]

It deeply matters that California's Workforce Investment Boards and their partners align with our state's strong cultural history of science, innovation, and entrepreneurship. It matters that they develop and widely share a common understanding and response to these changes *now*. It matters that a deeply shared commitment to act is coupled to the right analysis that is used to organize a smart, networked workforce training and economic development system response. By doing so, California can gain competitive advantage over other states and nations that lack such a commitment.[2] The California Workforce Association, along with key government, community college, business, and union allies, strongly support an effort like this in the *California's EDGE Campaign*.[3]

California faced the challenge of Sputnik (1957), the "missile gap" (1960), and the Japanese manufacturing and IT challenge (1980s). The response involved mobilizing our universities, government, and the private sector. A similar effort can mobilize the state's workforce training capacity to meet the rapidly evolving global challenges and to take advantage of emerging opportunities.

This toolbox provides an overview of California's competitive position in the emerging global economy. It provides case studies of WIBs partnering with community colleges and high-tech industries that paid off. People from all walks of life and ethnicities are being trained by these projects today, for high paying jobs.

California's New Argonauts, Producing New Technology for New Markets

All of this is not new for California. Even the pace of change is not new:

> *Californians were at once conceptualizing and actualizing their society. It was all happening so quickly! Not for California would there ever be, as it turned out, a deliberate process of development. California would, rather, develop impetuously through booms of people and abrupt releases of energy.*[4]

Waves of Argonauts came in the past by sea and by "Prairie Schooners" in their quest for gold, then for agricultural products, then to build a railroad, then a defense industry, and most recently to build Silicon Valley, and now to lay the foundations for biotechnology, green construction and alternative energy production, nanotechnology and advanced manufacturing.

AnnaLee Saxenian, a Berkeley professor, makes the point that our new Indian, Vietnamese, Mexican, Cambodian, Chinese, Latino, Brazilian, and Eastern European Argonauts, along with native Californians, are building California's high tech start-up companies, establishing the state as the national leader in high technology development, product design, and production. Seeking new opportunities, today's California Argonauts are also building global networks that link their homelands back into California companies to produce new products for a globally emerging middle class.[5]

Who Are California's New Workforce Argonauts?

In a nutshell, California's new 21st Century Argonauts will be the predominantly Latino component of our multi-ethnic population competing for an ever-increasing number of jobs that require a high level of science, math, and English reading and writing skills. Older highly skilled workers will be retiring or looking for new part-time jobs. Job churn, time without work, and other factors will decrease job security. Businesses, in order to maintain innovation and skill-driven advantage to keep or to address new markets will seek to raise their productivity, export work to lower cost but equally skilled regions, import skilled workers, continuously amplify the skills of existing workers, expand the labor pool by reaching out to mature workers, retirees, reentrants, and career switchers, and improve their branding as a good employers. Generally, we are looking at producing a skills-driven, multi-ethnic, multi-generational industry-oriented workforce.

To understand why this is necessary, we will look at the emerging workforce and then at the global market and production challenges, including the effect of energy scarcity and global warming, finishing with an overview of needed skills.[6]

First, Second, and Third Generation Immigrants

California's workforce will change dramatically over the coming years. Almost 45 percent of California's workforce will be native born Latino/Hispanic in 2010. Whites will drop down to about 30 percent, with the remainder drawn from the African American, Asian, and other ethnic groups.

We now look more closely at Latinos, given their emerging and dominant role in the workforce. Elias Lopez, in a 2005 California Research Bureau study notes:

> *In the case of Latinos, the most demographically dynamic population, close to 40 percent of the population are children. In the next decade, for instance, there are going to be over 4 million Latino children moving through the K-12 system and into the labor force. With Latinos comprising the largest demographic group under age 18, there will be a significant change in the labor force over the next 10 to 20 years.*[7]

The settled immigrant Latino population and their children will contribute the most to this growth as the number of new immigrants decline. (Immigration leveled off in 2000.[8]) Still, about 41 percent of all Californians speak a language other than English in their homes, including, for example, Hindi, Spanish, various Slavic languages, and others indigenous to China, Vietnam, Taiwan, Korea, and Japan. Occupationally, over half those employed in science and engineering occupations in Santa Clara and San Mateo Counties in 2005 were foreign born.[9] These trends will likely continue.

Of all students taking and *passing* the high school math and English exit exam in 2005, over 50 percent (32,000) were Latino/Hispanic. They, in addition to all other students regardless of ethnicity passing the test, totaled about 62,000 in 2005 alone. In 2001-02, the total enrollment of adult students in adult education was 1,171,780. A quarter, or 292,795, of the students at adult schools reported having a high school diploma. Adult education statistics indicate that in 2001-02, 50 percent of students enrolled in adult schools were of Hispanic origin. In 2003-04 (the latest available figures), Latinos made up 53 percent of enrolled adult school students.[10] Of the 1 million minimum-wage workers in California, about 334,000 have a high school diploma. A very substantial number of laid-off manufacturing workers with at least a high school diploma need to be retrained for these new technologies as well.

By 2025, 41% of Californians will have a college degree; we need 55% to keep pace with other advanced countries.

Over generations, the profile of employed immigrants tends to move closer to the profile of native-born residents. This shows the desire of migrants and their families to improve their economic conditions.[11] Significant numbers of Hispanics and Asians are currently employed, for example as technicians (113,000 or 36 percent of all technicians), production workers (711,000 or 69 percent), and as scientists, engineers, or computer specialists (268.000, or 32 percent).[12] Over 73 percent of Califo rnia's families from whatever ethnic heritage would like to see their children receive a bachelor's degree.[13] Even so, California lags behind the best pe rforming state and the rest of the nation in the number of tenth graders actually graduating from high school, directly entering a two- or four-year college, and graduating in a timely manner.[14] In the last category we lag behind 21 other nations in actually completing a college degree.[15] It is projected that about 41 percent of Californians in 2025 will have a college degree; but a figure of 55 percent is needed if we are to keep up with most advanced countries.[16]

Two reading, mathematics, and science examinations—one state and one national—evaluate high school students' competencies in mathematics, science, and English competencies that are directly related to preparation for a technical skills training program. Typically, the results of both examinations are greeted with dismay. Without drawing anything away from this conclusion or the high priority that must be assigned to addressing this problem, the data can be used to estimate how many high school students from different ethnic backgrounds are prepared to enter an advanced manufac-

turing or NANO or MEMS training program.* (It should be kept in mind that at least 5 percent of this group will be qualified to go on to a four year college.[17])

For California students in grade 11 in 2005, 61,158 students passed the math test and 61,771 passed the English language arts test. Of the 60,347 who reported an ethnicity and passed the math test, the majority were Hispanic (52.3 percent). The distribution of the rest was: 11.1 percent Black; 0.9 percent American Indian or Alaska Native; 6.1 percent Asian; 2.4 percent Filipino; 0.8 percent Pacific Islander; and 26.3 percent White. About the same percentages passed the English proficiency test. Some 47 percent failed the test and will require remedial education.

The California High School Exit Exam also evaluated English Learner and Fluent-English Proficient Students. Many of these students are recent immigrants from Latin America, Asia, Russia and its neighbors, and other countries. Statewide, a combined total of 22,099 passed the math test, and 21,984 passed the English test.

The National Assessment of Educational Progress (NAEP) provides a window on the students currently moving through the educational system who will be entering high school soon and graduating in 2010. The data show that 74 percent of White students, 42 percent of Hispanic students, and 36 percent of Black students meet the basic level of mathematics preparation. Overall scores have improved in 2003 and 2005 for both the Basic and Proficient levels.[18]

Twelfth grade students did not do as well on the NAEP science test. Clearly this is the weakest area for ethnic minorities, with only 29 percent of Hispanics and 21 percent of Blacks achieving Basic or Proficient scores. Even so, math and English scores suggest that this can be remedied with appropriate science education. California's K-12 science education curriculum has been ranked as first in the nation: "California has produced an exemplary set of standards for school science; there was no question among readers about the 'A' grade."[19] Nearly half of the states studied received a "D" or "F" grade.

Displaced by Job Turnover, Laid Off and Long-Term Unemployed College Educated Workers

An analysis by the Economic Policy Institute of national long-term unemployment from 2000 to 2003, which included the short recession between March and November 2001, found that the number of people out of work for six months or more rose 198 percent. Job seekers with college degrees and those age 45 and older were particularly hard hit with long-term unemployment that rose by 299 percent and 218 percent, respectively, during this period.[20] This trend has improved considerably since 2004, with unemplo y-ment among that group tracking steadily downward in California. This is trend is reflected by a drop in the number of weeks people are on unemployment.[21] While data on education level achieved are not available for California, the length of time spent looking

* NANO = nanoscale, up to 100 nanometers in size; MEMS = Microelectromechanical systems.

for work has increased dramatically from 2000 to 2004, rising 78 percent, and is just now declining. Long-term unemployment growth in California has been particularly hard on youth (16-19), Blacks, and Hispanics. [22] Even as unemployment goes up and down, it appears that long-term unemployment and the time to find a new job is increasing.[23]

Many technical jobs can now be done at a distance, leading to increased outsourcing.

For reasons involving productivity that will be discussed below, large numbers of workers will likely not return to their previous jobs because the jobs have disappeared. The top three industries nationally experiencing these long-term losses were information technology, professional services, and manufacturing. This poses a substantial retraining challenge both to deal with displacements due to productivity improvements and to the emergence of new technologies.

Nationally, and probably for California as well, long term unemployment in manufacturing increased by 259 percent between 2000 and 2003.

> *Workers laid off from manufacturing jobs represented the largest share of the long-term unemployed (19.1 percent). In the information industry, there was a 354 percent increase in long-term unemployment. The second largest increase in long-term unemployment was for the professional and business industry (285 percent). The weak recovery has invaded every industrial sector, not only hurting the blue-collar industries that have traditionally suffered unemployment woes, but also leading to widespread joblessness among white-collar workers.*[24]

Service jobs that are highly compensated today could be lost to new information technologies. Fast computers, innovative software, and international communications networks have eroded the work of legal researchers, software developers, tax preparers, and accountants. The main reasons are that the procedures and data involved are highly standardized and that technical research can be done at a distance by well-educated workers.[25]

U.S. Census data shows that simultaneous with long-term lay-offs there is considerable turnover in manufacturing employment. Employee turnover ranges from about 15 percent to over 20 percent for younger workers, dropping quickly for older workers.

Aging Skilled Workers

California's professional, technical, scientific, and manufacturing workforces are aging.* Many will be retiring or working part time in the next 10 years, creating opportunities for

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* According to the Census Bureau, the Professional, Scientific, and Technical Services sector include establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. Activities performed include: legal advice

younger workers.[26] California is not nearly as threatened by the loss of skilled workers as many other states and nations are.[27] This suggests that the WIBs must retool the existing workforce and train migrants to meet new evolving skill requirements, leading to higher productivity for all workers—including aging workers. This will produce competitive advantage.

The gap in educational achievement between the young and older workers is increasing. In 2004, 86 percent of adults age 35 to 64 had an associate degree or higher, compared to 73 percent of younger adults between the ages of 25 and 34. The educational rank of older Californians places the state ahead of 29 nations and most U.S. states. The younger group moves the state down, below Canada, Japan, Korea, Finland, Norway, Sweden, and Belgium and just above Spain.[28]

Retirement of our currently skilled workforce compared with growth of new knowledge-based jobs in the U.S. will result in a gap that will require as many as 14 million *skilled* workers by 2020.[29] India is facing a similar problem with filling the demand for qualified engineers in Hyderabad. Demand has already outpaced in-nation supply and the imbalance will only get worse in the foreseeable future.[30] These shortages will occur in different industries at different times; the shortage will not be in the number of workers, but in workers with specific skills.[31] As the growth in the workforce drops, the competition for skilled workers will grow, generating a global market for skilled workers. California must be prepared to compete for and attract these workers as well as retain its own workforce. (These points are further developed in the discussion below on the number of workers needed to fill high technology jobs in the future.)

Veterans and Non-Traditional Workers

A significant number of veterans between the ages of 18 and 24 are or will be looking for work. “Nontraditional students” who are employed, have children and yet are seeking to up-grade existing skills or to move into a better paying job also need training. Many are women. These people are often interested in receiving part-time instruction with the goal of improving their income or moving into a new job.[32]

Occupational restructuring is changing how all workers, regardless of ethnicity, think about their jobs. According to a recent report by the National Governors Association,

> Every year, up to a third of all jobs are either additions to or are soon to be eliminated from the economy. This churning has contributed to the demise of the social contract between employees and employers and has reduced the incentive

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and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

for employers to invest in their workers. For many workers, the traditional concepts of job security, career ladders, and job progression are a thing of the past.[33]

For example, between 1983 and 2000, the percentage of workers that had been with their employer for 10 years or more dropped in every age group.[34] This could be a serious problem for retraining highly skilled science and technology workers if we think of it as a one-shot deal. Life-long training is necessary.

The Global Rise of a Permanent Underclass and Loss of Middle Class Security Could Push Wages Down for Untrained Workers

Two trends that cut across middle and lower wage jobs will affect employment and the need for training in the future. The first is the emergence of a new global underclass that will threaten California's low income workers. The second is increased economic risk for California's middle class. These factors are directly related to the need to continuously train California's entire workforce in order to move both groups up the income ladder to good jobs.

The population of sub-Saharan Africa will increase by 81 percent by 2031 and that of Middle Eastern countries by 132 percent. By 2010 more than 50 percent of the world's population will be living in urban rather than rural environments, leading to social deprivation and political instability. By 2035, those living in urban poverty could rise to 60 percent.[35] Competition for jobs will tend to drive wages down for urban unskilled workers there and in California.

California's middle-income workers saw the lowest increase in their wages in 2005 of any income group in the state.

These global developments parallel those here at home. About 265,000 immigrants, mostly Latino, ages 13 to 22 and living in urban centers are *not* enrolled in school today. Their fate, as for those in the developing world is to receive low wages as they compete with other low-wage workers around the world.[36]

Typically, the most repetitive and standardized jobs are the most susceptible to off-shore competition. While the impact of moving such jobs off-shore is relatively small now, it could grow in the future if California does not improve its competitive advantage. On the other hand, global manufacturing production networks can also lead to the generation of higher paying jobs that result from higher value added products for custom markets.[37] Both points apply to software-related jobs. [38] How this mix will work out for California cannot be easily predicted but is one of the key developments that must be closely tracked.

California's middle-income workers saw the lowest increase in their wages in 2005, even though their productivity increased,[39] and saw a lower wage than the highest income category in California[40] or U.S. workers generally. [41] Income in equality between

lower and middle wage earners and higher income workers is becoming more severe.[42] Californians, like the rest of the nation, are experiencing greater income insecurity even if they have a college education.[43]

For example, in 1970 the chance of experience an income drop of 50 percent was about 7 percent. Now its about 17 percent.[44] These factors, when combined with increased debt, health care costs, retirement needs, cost of shelter, and other factors, are closely related to a shift in risk onto the middle class as social supports are reduced.[45] This increasing vulnerability, when combined with longer lay-off periods for college-educated workers, provides an additional support for life-long training that is tightly tied to changes in productivity and new industries.

In summary, the picture that emerges from our analysis is very mixed and challenging. Unlike many states and nations, we are fortunate to have a young, work-oriented workforce, but it needs extensive training in English, science, and technology. Workers at the low and middle portions of the income scale are threatened with increased exposure to risk. This is exacerbated by greater difficulties in finding a good job, even for college-educated people. It will be necessary to train across generations to fully mobilize all of our resources.

How Many Highly Skilled Workers Will California Need by 2015?

A number of efforts seek to gauge California's future workforce needs. One estimate is that the overall demand for highly educated workers to fill new jobs combined with those necessary to replace the loss of the retiring highly educated worker is more than 3 million, which is equal to the populations of the cities of San Diego, San Jose, and San Francisco combined.[46]

The Center for the Continuing Study of the California Economy projects the following new and replacement jobs by sector for 2014:[47]

- Nursing: 55,000 new and 50,000 replacement;
- Production: 50,000 new and 250,000 replacement;
- Construction: 175,000 each for new and replacement; and
- Repair: about 80,000 new and 125,000 replacement.

New job growth by 2015 to 2025 will be slow in existing manufacturing sectors according the LMID; Only 28,800 new jobs are projected for that sector during that period, an increase of 1.6 percent. But, according to Time Structures, jobs in new manufacturing sectors or in firms that dramatically convert technologies to use new materials could produce a large number of new jobs:[48]

- Logistics and intelligent transportation systems (340,000, a 51 percent increase),
- Life-sciences (943,000 jobs in the entire sector by 2010 with an additional 38,700 by 2015),
- Micro-Electro-Mechanical Systems (12,000, a 67 percent increase), and
- Nanotechnology (226,800, a 95 percent increase).

Job growth will not occur only in the traditional growth centers. Due to the cost of living and related factors, it may continue a new growth trend occurring in both California's coastal and inland counties. Between 1990 and 2005 growth rates (not absolute numbers) in the inland counties exceeded that in coastal counties in professional and business services, educational and health services, natural resources, leisure and hospitality, trade, transportation and utilities (logistics), financial activities, government, and manufacturing.[49]

A technical workforce requires an advanced technical or college education. Over the last 35 years, California has depended on foreign-born college graduates to make its workforce competitive. Immigrants were 8 percent of California's total degree holders in 1960, but 31 percent of the total in 2005.[50] Domestic in-migration from other states has also accounted for a substantial number of workers with college degrees (out-migration has been increasing too, however).

Today, California needs an additional 650,000 associate and above degrees in the adult population age 25-44 to keep up with the world's top nations' performance (Canada for example). By 2025, California will need an additional 3,729,000 college-educated workers above current projections for 2025 to fill the jobs of the future: 278,000 adults with some college, 2,457,000 with a bachelor's degree, and 994,000 with a graduate degree.[51] This anticipated need calls for a marked i ncrease in California's attraction and production of degreed workers, as the gap then will be five times as large as it is today if things remain as they are.

Home-Grown and Trained Argonauts Will Be the Competitive Edge

The Public Policy Institute of California, in a 2007 study, addressed the question: *Can California Import Enough College Graduates to Meet Workforce Needs?* The answer is no:

> We conclude that it is extremely unlikely that the projected need for highly skilled workers will be met mainly through the increased migration of college-educated workers. However, increases in college participation and graduation among California's residents could help meet these future demands. Such increases will be at least partly induced by the wage growth that will occur as highly skilled labor becomes relatively scarce.[52]

It is important to realize that between 2000 and 2005, for the first time, immigrants to California with a college degree exceeded the number of immigrants who were not high school graduates. This is due to the large increases in the production of college graduates in other countries. This trend could continue to intensify, but the number of highly educated immigrants to California would still need to more than double to meet projected needs. This is impossible given increased competition for talent, and projected global shortages due aging populations and low reproduction rates in other industrialized countries like Japan and generally throughout the European Union and now Russia.[53] For example, Japan's engineers are being lured away by Asian rivals. [54] But California is advantaged by the high reproduction rate of its recent relatively young migrants.

What challenges will California's resident and immigrant Argonauts face while striving to achieve competitive advantage in emerging and evolving industries in a highly networked, global market place? What new skills will be required by to successfully generate new ideas and products and build new manufacturing, research, marketing, and financial networks which can distribute these services and products around this new world? According to California's Regional Economies Project, California Economic Strategies Panel, the "current workforce investment system is a hybrid based on both a cyclical model of unemployment, which assumes either explicitly or implicitly that jobs that have been lost within an industry are likely to come back, and categorical training programs aimed at helping disadvantaged groups find employment."[55] Are these a ssumptions the right ones for California's emerging, globally extended high technology economy? Will change follow business cycles? Will it be revolutionary, involving the in-

troduction of whole new technologies and production systems? Will workers have to continuously train themselves to keep up with either form of change?

Today's Global Production Technologies and Marketplace Are Not our Father's

Our ancestor's act of simultaneously conceptualizing and actualizing our society applies to us in spades today. The effects of World War II left a global economic playing field through the early 1970s dominated by the U.S. Today and into the foreseeable future that same field is populated by new surging nations and competitors in Europe, Asia, China, India, and Latin America all seeking to serve completely new and very large markets as well as the older ones. Global competition for these rapidly expanding market opportunities is not standing still. And neither is the U.S.: Standard & Poor's expects the 500 companies in its benchmark index to generate more than half of their 2007 sales in foreign countries. For example, over half of the 9.1 million vehicles General Motors produced in 2006 were sold in foreign countries.[56]

Not So Much Flat As Globally Networked

What we are looking at is not so much Friedman's flat world[57] as a highly ne tworked globe of varying competencies. At the core of California's turning point, where competitive advantage will be won or lost, is, are new fuels, new materials constructed at the molecular level, new bio-manufacturing processes, globally integrated logistical systems, and new global research, financial, and logistical networks. Every node on this global network uses information technology to invent, to produce, to move in real time.

This globe, with quickly evolving networks of hubs and nodes, is continuously linking researchers and innovators with distant manufacturers to meet the tastes of local markets wherever they are. Sitting in a satellite above a turning earth imagine that we could watch the flow of information and energy across this evolving net. We would see the intense lights of all of the world's major cities and transportation corridors, and the telecommunications networks dim and brighten to the degree that industries use energy sources, information, and innovation to secure competitive advantage. Some transportation nodes and networks flourish while others wither, dotting the globe with pockets of poverty or prosperity as new economic, research, financial, and manufacturing networks emerge following the flow of new ideas and resources to address new markets.[58]

The movement of today's goods from dominant cities in the Northern to the Southern hemisphere is being realigned by multiple medium sized cities in the Southern Hemisphere trading with the other cities in the same region or cities in Asia trading with cities in India and China—all meeting the needs of new markets so large that they will dwarf those of the U.S. and Europe combined.

New Global Markets And Production Relationships Will Change The Domestic Product Rankings of Nations

One estimate is that the combined Gross Domestic Product of China, India, Russia and Brazil, taken as a group, will overtake five of the world's most advanced countries (Germany, Japan, Italy, France, and the U.K.) by 2030, and will overtake those plus the U.S. by 2040.[59] A major driver will be the shift in the percent of the global market ($45 trillion) which is currently dominated by developed nations (80 percent) to a new division occurring around 2050, where 65 percent of the then-$220 trillion global market will be dominated by globally emerging economies and their companies. China's middle class is already about twice the size of Canada's entire population.[60] They will become global trendsetters and are expected to buy, for example, 4.5 million cars annually by 2010. India's and Latin America's middle classes are growing rapidly too. India's middle class is projected to represent 50 percent of its population by 2025.[61]

Older And Emerging Highly Networked Multinational Companies Will Play A Defining Role

Today's markets are being globally defined and supplied by multinational manufacturing companies that have at least 55 percent of their employees and 59 percent of their sales outside of their home countries. U.S. multinational companies employed 29.6 million workers worldwide in 2004, of which 21.3 million were employed in the United States by U.S. parent companies and 8.3 million were employed abroad by majority-owned foreign affiliates.[62] The 38 largest food processing firms combined (7 of the top 10 are American) own more than 682 food processing plants in foreign countries.[63]

Emerging developing world companies are not small. For example Samsung's earnings are close to those of Intel; likewise, Taiwan's TSMC's earnings are close to those of Nokia. China's Hon Hai is moving up quickly in appliance manufacturing. Emraer, Brazil, is the world's leading regional manufacturer of jet aircraft. Many companies that only serve a region like Southeast Asia occupy a leadership position in manufacturing products in that region.[64]

Today's markets are being globally defined by multinational companies with 55% of their employees outside of their home countries.

All of these global companies are competing and making headway on the basis of quality, design, technology, management, logistics, rapid response to emerging markets and customer needs, use of information technology, and innovative and unconventional thinking. They often take the role of both competitor and partner in global supply, innovation, and financing chains. For example any one of today's highly competitive IT-dominant regions may be part of one global research and production chain one day and then part of a different one another day. For example, a research or production network can quickly shift from one city to another, such as from Silicon Valley to Seattle or other

highly developed IT cities like Austin, Raleigh, Boston, Stockholm, Munich, Holland, Bangor, Beijing, Singapore, Seoul, Shanghai, Taiwan, or Tokyo.[65]

Nations, too, have varying concentrations of research in different sectors depending on government expenditures and expenditures of their most competitive companies. For example, Korea's R&D concentration is in electronics; Germany's is in automotive; Switzerland's is in pharmaceuticals; and the U.S.'s R&D is spread across multiple fields.[66]

Small and Medium Companies Will Play An Important Role In The New Global Service, Production and Research Networks

Globally, small and medium companies in the research and development sector grow fastest. U.S. small companies account for 9 of the 13 fastest growing global companies driven by research investments in 2006.[67] Small U.S. manufacturers in particular are showing strong competitive advantage.[68] Between 2000 and 2005 there was a 67 pe r-cent increase in U.S. manufacturing startups, according to a survey by the Kauffman Foundation.[69] Small manufactu rers can take some credit for the increase in overall manufacturing sales, which rose by 20 percent between 2002 and 2006.

Fortune credits smaller manufacturers with "applying creative tweaks to their manufacturing processes, improving efficiency and lowering production costs." Additionally, smaller manufacturers are "relying on theories and technologies that were once the exclusive province of multinationals: rapid prototyping, lean manufacturing, efficient supply chain management and better quality control." Finally, *Fortune* notes that with international shipping costs skyrocketing, small manufacturers have "[a]nother competitive weapon in the American arsenal: geography." For these reasons, *Fortune* says, "many manufacturers now realize that offshoring doesn't always make sense."[70] In California, as noted above, small high-tech start ups by immigrants contributed mightily to the generation of new jobs in California by being on the cutting edge of much new technology.

Four Keys To Competitive Advantage: Innovation, Intellectual Property, Productivity, and Information

Of those technologies that will define the future, California has major state, federal, and private sector research investments and industry clusters in biotechnology, nanotechnology, aerospace, information technology, health care, medical devices, agriculture, professional and business services, advanced manufacturing, and alternative fuels concentrated in regions within the Innovation Corridor.[71]

Innovation of intellectual property is one key to competitive advantage. Innovation includes basic research, applied research, product innovation, management techniques, IT applications of various kinds, such as those applied to advanced manufacturing and logistics, workforce training to make and use those applications, and shop floor innovation. [72] Economic studies conducted in the 1950s, before the information-technology

revolution, show that even then as much as 85 percent of measured growth in U.S. income per capita was due to technological change.[73]

California's universities and colleges, including community colleges, are key innovation generators. These activities receive federal and private industry funding. But, between 2000 and 2004, California saw industry-financed R&D expenditures at the state's colleges and universities drop by 11.5 percent. California was ranked 32nd against all other states in terms of this critical factor. Other states that did better include for example, Maryland, Hawaii, and New York. Overall, business investment in R&D in universities and colleges in the U.S. was off 2.2 percent, far less than in California. In 2004, 85 percent of all R&D spending by U.S. multinational companies was dedicated to domestic research. The "relative abundance of U.S. scientific and technical workers, including highly educated workers" made this possible.[74] Attracting future investments in California could be a problem if the educational level of its workforce declines through retirements and the failure to replace these workers with equally skilled ones.

The lion's share of California's R&D funds come from the Federal government (62 percent) followed by institutional funds (18 percent), other sources (10 percent), state and local government (5 percent), and industry (4 percent).[75] This level of investment places California in an enviable position. As a result of its long-term lead in overall research funding, California leads in biotechnology, nanotechnology, and in other advanced basic research.

In 2004 California managed to retain its first place overall investment position, attracting a total of $5.7 billion in university and college research funding from all government and private sources. New York was a distant second with $3.4 billion.

California has a major research resource that lies outside of its universities and colleges, though it is related to them. The state's federal labs provide critically important know-how and highly specialized facilities in science and engineering. This power is augmented when Technology transfer spurs innovation in California's high-tech industries. These labs also attract some of the best scientific minds in the nation.[76]

Successful translation of this research advantage to industry is critical. This suggests that workforce training must closely track the funding, development and commercialization of new technologies.

California's universities are key innovation generators.

Whereas investments in R&D as a share of gross domestic product actually decreased in the United States from 1992 to 2002, comparative investment levels increased in most other nations aggressively seeking to establish and maintain global advantage, including Japan (15 percent), Ireland (24 percent), Canada (33 percent), Korea (51 percent), Sweden (57 percent), China (66 percent), and Israel (101 percent).[77] The number of countries with U.S. R&D-based investments rose from 66 to 77. Daniel Yorgason notes,

> *The United Kingdom, Germany, Canada, France, Japan, and Sweden now host 65 percent of U.S. foreign-affiliate research, down from 72 percent in 1999. More than half of the growth in U.S. foreign R&D expenditures between 1999 and 2004 occurred in Europe. Overall, however, Europe's share of U.S. R&D declined slightly during that period.*[78]

Yorgason also points out that India and China are the fastest-growing sites for foreign-based research by U.S. multinationals.[79] Between 1999 and 2004, R&D expenditure in India jumped from $20 million to $163 million. Investments in China's R&D almost doubled, from $319 million to $622 million. Two-thirds of all new R&D centers are planned for China and India. A large portion of this research will be dedicated to producing customized products for their emerging markets. All of these research efforts are highly networked across the globe tending to rapidly spread an innovation to other research facilities, triggering additional research. Innovation leads to intellectual property rights that must be protected.[80] In terms of total number of patents, the U.S. leads the way as a nation, but large corporations in Japan, Korea, and China are filing more patent applications than many large U.S. firms.[81]

Innovation leads to improvements in productivity. Productivity and the relative cost of labor have reduced the number of manufacturing jobs worldwide: 10 to 20 percent of manufacturing jobs disappeared from 1995 to 2002. China lost between 17 percent and 34 percent; the U.S. lost 11.4 percent. Other countries did no better, with Japan losing about 25 percent, Germany 21 percent, the U.K. 18 percent, and France 11 percent during the same period.[82]

California lost manufacturing jobs too. Looking at 2000 to 2003, those losses were due to lower demand (about 65 percent), increased efficiency (about 25 percent), moving to other states (about 6 percent), off-shore competition or share gains in other states (about 3 percent).[83] In fact one million Califo rnia manufacturing jobs may be at risk to moving to other states and nations if we do not continue to improve our level of workforce skills, innovation, product development, and productivity.[84] Today, many of California's expanding industries, as elsewhere in the world, are no longer in manufacturing or professional and technical services. The jobs that are replacing them pay significantly lower wages.[85]

Information technology is the net that ties all of these developments together. The digital economy is more than an economy conducted on the Internet, even though the Internet is an important part of IT and has grown dramatically. Specifically, according to the Information Technology and Innovation Foundation:

> *[The digital economy] represents the pervasive use of IT (hardware, software, applications and telecommunications) in all aspects of the economy, including internal operations of organizations (business, government and non-profit); transactions between organizations; and transactions between individuals, acting both as consumers and citizens, and organizations. IT has enabled the creation*

of a host of tools to create, manipulate, organize, transmit, store and act on information in digital form in new ways and through new organizational forms.[86]

Companies use IT to achieve the following competitive advantages:

- Workers are able to do more things at the same time;
- Organizations are able to dramatically improve the efficiency of internal operations;
- Government regulatory processes can be streamlined;
- Supply chains can be structured and tied more efficiently to logistics;
- IT lets bits substitute for paper processing and filing, reducing the cost of information handling;
- Customers can self-service in searching for products;
- IT boosts product allocation efficiency by enabling the creation of new markets and market signals (energy metering and real-time costing) in areas where none existed;
- Quality of service can be monitored as well as product production quality monitoring;
- New small-scale sellers and producers are able to find markets and customize products;
- IT gives researchers powerful new research tools to visualize and manipulate atoms (nanotechnology) or genetic material;
- IT enables small firms to do more research individually or as part of a network; and
- Customers can participate in product design (for example, the Boeing 777).

Investment in IT has had a substantial impact on the productivity of firms in many other nations, including Australia, Canada, Finland, France, Germany, Korea, Japan, the Netherlands, and Switzerland. IT is also making a difference in developing nations where IT investment rose twice as fast from 1993 to 2001 as the Organization for Economic Cooperation and Development advanced country's average. For example, adoption of IT in China accounted for 38 percent of total factory productivity growth and 21 percent of GDP growth. (It probably also contributed to the loss of manufacturing jobs.[87])

How ready is California to participate in IT-driven global networks that will produce the advantages listed? One perspective would be to see how well the state is doing relative to other states in developing knowledge-based jobs, preparing a highly educated workforce, increasing the level of export orientation of manufacturers, increasing the number of fast-growing companies, encouraging business transformation to a digital

economy, and improving the rate of technology innovation in multiple sectors of the economy.

The Kaufman Foundation has applied such measures to U.S. states. Its research found that California moved backwards from 2nd to 5th place between 2002 and 2007. In terms of workforce related measures, California ranked 16th in IT professionals, 17th in managerial, professional, technical jobs, 12th in current workforce education, and 33rd in knowledge-worker education. In terms of overall preparation for globalization, California ranked 15th, after Georgia and Rhode Island, with Washington being first. [88] In terms of California's cities, none made the global intelligent communities list for 2006.[89]

California is not alone in moving backwards. In 2006 the United States lost its top position in adoption and use of communications and information technology, dropping to 7th place, overtaken not only by Denmark but also by Sweden. Singapore came in 3rd place, Finland 4th, Switzerland 5th, and the Netherlands 6th. Interestingly, Asian countries declined in their positions from 2005, with China coming in at 59th and India 44th. Latin American and Caribbean countries improved over the previous year with, for example, Jamaica, Mexico, Costa Rica, Uruguay, and Argentina improving their position.[90]

This general globalization and networking profile suggest that advanced nations and states continue to dominate. However, the data also suggest that a leveling is beginning to take place that could shift competitive advantage as a result of varying national and industry investments in workforce, IT networks, and research and productivity improvements.

Global Warming will Redefine California Cities and Infrastructures, while Creating New Global Markets

The global race to exploit new markets assumes that energy will be available to carry out this effort and that food, water, and other resources are, and will continue to be, available and sufficient. Even before global warming became a public issue, the world's soils, potable water, atmosphere, farmland, forests, and oceans were stressed by the pressure of economic development and population growth. Global warming has exacerbated, accelerated, and added new processes to this already difficult situation. The agricultural and related sectors of the global economy—and of California's economy—will undergo fundamental and complex changes in the coming years. These developments will offer diverse innovation, employment, training and retraining opportunities to California's new Argonauts as state and world markets shrink or reinvent themselves and as new and unexpected markets emerge. New technologies, skills, products, and distribution systems will be required.

Issues surrounding food production are a good example of how tightly existing resource degradation and global warming trends tie together. Good, productive soil is necessary for farmers to grow food and, in the future, energy-related crops, and even medically important ones (pharmbio) will compete for limited natural resources. Good soils are already being lost without the influence of global warming. Globally, an area about seven

times the size of Texas has been irreversibly destroyed by accelerated erosion. For example, in China, by 1978, erosion had forced the abandonment of 31 percent of arable land. African erosion rates are nine times that of Europe. The U.S. loses about 1.7 billion tons of soil to erosion a year. Globally, erosion may be destroying between 0.3 and 0.5 percent of the world's cropland yearly, pushing people to clear forested land to make up the difference.

California is already experiencing the result of human pressures on ecosystems.

Even so, world food production has increased spectacularly thanks to the Green Revolution, which included the greater use of fertilizers, new rice and other grain varieties, and the application of various scientific farming practices. Fertilizers, plant breeding, and biotechnology are viable alternatives that can produce competitive advantage. Unfortunately, they often require more inputs to create, may have unknown or unpredictable consequences, and can be more costly for small farmers who lack credit or irrigation.

Energy constraints, changes in climate, and competition for available fresh water will not only reorganize how farming is done and how food is processed and distributed by multinational companies, but also could increase agricultural costs, requiring a high level of continued innovation to keep costs under control.[91] Failure to control the quality of e xported food (GM foods for example), the introduction of bioengineered crops, biopharmaceuticals, and other issues will shape the international food market in unknown ways.

California, like the rest of the world, is already experiencing the result of human pressures on natural and agriculture and forestry ecosystems. Shrinking farm land, water problems, growth in the number of endangered species and other issues are already with us. A likely climate change scenario will bring further changes:

> *[M]ore rain and less snow, resulting in greater winter runoff and less flow in summer streams. Increasing evidence suggests more frequent and possibly more intense El Niños as the climate changes. . . . Simulations pinpoint the strongest warming in the Northern Sierra and Central Valley, with drying in the southeastern corner of the state. Such results confirm that climate change is likely to be highly variable across California, and that local impacts may be much greater than statewide averages would indicate.*[92]

If warming in California's agricultural and forest production areas is accompanied by increased drought there could be detrimental effects limiting which crops can be grown. Today California agriculture is a $68 billion industry. The state accounts for 13 percent of all U.S. agricultural sales, including half of the nation's fruits and vegetables.[93] Drought-driven shifts in what is grown could reduce the state's share of agricultural sales.

In California, 87 percent of crop areas are irrigated. Growers of perennial crops, including fruits, nuts, and grapes, cannot easily shift to new crops as heat and water conditions change. Crops most likely to be lost first to climate change would be those of lim-

ited economic value that use large amounts of water, such as alfalfa. Increasing irrigation poses a problem in a state where 100 percent of the surface water is already allocated and where water imports are unlikely to increase.[94] With too much irrigation, soils tend to accumulate salts that make them unproductive.

In some coastal areas increased ground-water pumping for irrigation, such as in the Salinas Valley, is already causing widespread saltwater intrusion into aquifers. The California Energy Commission estimates that Delta farmers could need an additional 700,000 acre-feet of fresh water from runoff to offset saltwater intrusion into areas protected by the levee system.[95] Changes in the demand for water by ci ties and other u sers could also place severe constraints on the cost and availability of supplies for irrigation.

The economics of producing, processing, and selling a particular crop or manufactured product will depend heavily on global and regional climate change and market development. We have seen that local agricultural problems like erosion could be exacerbated by global warming requiring new technologies with potentially increased costs to local farmers. Agricultural production in response to climate change, loss of soil, and global markets could simply respond by re-engineering a crop's physiological response. Increased drought could require intensified human water management, involving satellite soil monitoring and new innovative water systems. (California's Economic Strategy Panel has already identified irrigation technology as important emerging Central Valley technology.[96])

Demand for food regions could outpace increasing costs of production. Or costly specialized food-production technology for a new middle-class market could expand, with the result that profits from producing the specialized crop could outrun the value of alternative and potentially less water- and energy-intensive uses of the land.[97] Each of these alternatives suggests potential changes to California's agribusiness and its trained workforce. In the first case, more low-skilled workers might be required. In the latter, much-higher-skilled workers would be needed to operate high-technology processing operations, displacing lower-skilled workers.

Changing climate may also lead to new biotechnology solutions for producing needed products, requiring a wholly different workforce. Living organisms or their products, modified by biotechnology, will replace expensive older feedstocks and materials used to produce well-known non-biologically-based products. Such efforts might be more energy and water efficient. For example, a federal strategic plan uses biotechnology to develop biomass products. (Biodiesel and special soy-based plywood glues are examples.) In both cases, the introduction of a new biologically based product into existing fabrication process or equipment will change maintenance procedures. These developments suggest that it will be necessary to cross-train a diverse workforce to apply biotechnology production principles and product utilization in multiple areas. The use of biofuels in cars which is being addressed by ATTi is a good example. (Nanotechnology may have similar training requirements.)

Biotechnology-based renewable-resource products processed in fermentors and other related innovations could replace many petrochemically derived products. Examples of biotechnology-based products include fuels such as industrial ethanol, high-fructose syrups, citric acid, monosodium glutamate, lysine, enzymes (to replace catalysts in chemical reactions), solvents, and specialty chemicals. The gross annual sales of biochemicals in 1994 exceeded $13 billion. Analyses of historical and present market growth rates suggest that the worldwide market for specialty chemicals will grow 16 percent per year. Biologically derived products such as industrial starches, fatty acids, and vegetable oils are sources for bioplastics. Much of this work will involve the development of new fermentation processes over the next few decades. (Biotechnology-based manufacturing in the California's Central Valley is briefly discussed in the attachment.)

New Technologies for Water Conservation and Delivery

Globally, the withdrawal and use of potable water by whatever means, be it pumping or ox-driven water-raising systems, has increased from 2,590 cubic kilometers in 1970 to 5,190 cubic kilometers in 2000. Municipal uses, following population growth, almost doubled from 5 percent to 9 percent of the total; industrial use increased from 22 percent to 25 percent and irrigation dropped from 72 percent to 64 percent. Asia, due to its large population, used more water than all other continents combined. Global warming, much as is predicted for California, will threaten clean-water resources for coastal populations, including salt intrusion into rivers and aquifers.[98] Sewage treatment has become a problem as global cities sprawl. As late at 1980, half of the world's population had no wastewater treatment whatsoever. In China, the proportion was 90 percent.[99]

In the coming years, California will not be immune to changes in water availability. Even though the exact amount of change in rainfall is unknown, significant changes are predicted.[100] The Sierra Nevada snowpack provides natural water storage:

> By the 2035–2064 period, snowpack in the Sierra Nevada could decrease 10 to 40 percent depending on the amount of [global] warming and precipitation patterns. By the end of century, snowpack could decrease by as much as 90 percent if temperatures rise to the higher warming range . . ."[101]

Currently, the Sierra snowpack holds water equal to about half the storage capacity of California's major man-made reservoirs. But the run-off into the Sierra Nevada reservoirs will change and could decline between 25 to 30 percent (lower temperatures would produce a smaller effect). These changes have significant implications not only for agriculture but also for urban growth and for the construction of dams and other water storage and transport facilities that take years to build. Such shortages can also be drivers for new water production and recycling nanotechnology- and biotechnology-based industries.[102]

Competing with agriculture are global urbanization trends. These urbanization trends will challenge water allocations for agriculture. Consider the rate of increase portrayed by the following numbers for California. By 2020, California could be home to between 43 and 46 million residents, up from 37 million today, a 16 percent to 24 percent in-

crease. By 2100 California's population could grow to 80 million persons. Assuming that 10 percent of California's future population growth would occur through filling in existing urban land, California's expanding urban population could consume an additional 5.06 million acres of undeveloped land. Alternatively, allowing for greater urban density, this new population could consume an additional 2.6 million acres of land.[103] Tremendous water, sewage, and other infrastructure challenges could occur, particularly given the global-warming-related state water projections. Designing and building these new cites and infrastructures to meet water conservation, energy efficiency, and other standards will create many new high skill jobs.

Global Warming will Affect Global Industrial Competition

Large urban centers are the production and communication centers—global cities—that form the central hubs linking together small cities into global networks. They are at the core of a nation's or state's global competitive advantage but are at risk. Research on global warming shows that 634 million people—one tenth of the global population—live in coastal areas that are just ten meters above sea level. Of these, nearly two-thirds of urban centers with more than 5 million inhabitants are at least partially within the 0-10 meter zone that will experience gradual flooding over the next 50+ years. The ten countries with the largest number of people living within ten meters of the average sea level are: China (143,888,000); India (63,188,000); Bangladesh (62,524,000); Vietnam (43,051,000); Indonesia (41,610,000); Japan (30,477,000); Egypt (25,655,000); United States (22,859,000); Thailand (16,468,000); and the Philippines (13,329,000).[104]

China has begun to look at its coastal threat. The *People's Daily* noted,

> Large sections of Chinese coastal regions gradually disappear under rising sea levels because of global warming, severely impairing the country's social and economic progress. . . . China's long coastline is the base for about 70 percent of the large cities, over a half of the domestic population and nearly 60 percent of the national economy. . . . Du Bilan, a researcher with the National Bureau of Oceanography, said that the Yangtze River Delta, Pearl River Delta and Yellow River Delta — regions located along the coast with the country's most developed economies — may all in part be flooded if the sea level kept rising at the current speed.[105]

Clearly, loss of production capacity or logistics by flooding of coastal urban centers will affect the competitive advantage of any nation, including the U.S. Alaska is already experiencing the effects of global warming on its bridges, sewers, and other infrastructures.[106] These effects provide incentives to take action to limit the impact of climate change, such as helping people migrate away from risk, and modifying urban settlements to reduce their vulnerability. This will require enforceable regulations, economic incentives, commitment of a considerable amount of financial resources, and human capital to achieve the large-scale infrastructure, industrial, and housing construction required.

Global models project that the sea level in California will rise by 8 to 12 inches by 2100. That represents a doubling or tripling of the sea level rise seen in recent history. With a 12-inch rise in sea level, the current 100-year high in the storm surge felt on the levee system of inland San Francisco Bay and Delta would become a common event.[107]

Innovative Energy Alternatives will Fuel California's Competitive Advantage

Each day each American consumes 250 cubic feet of natural gas, 20 pounds of coal, 3 gallons of oil, 3.5 pounds of biomass, and one ounce of uranium.[108] The petr oleum-based infrastructure represents a 10 trillion dollar investment in oil rigs, tankers and pipelines, refineries, auto industry, 600 million cars running on gasoline, and electricity generation. Finally, to sustain the 8 billion people expected in 2025 at 5 kw/person we will need 40 Tw of power, over three times today's production.[109]

As we move to alternative energy economies, be they wind, alternative fuels, battery, or hydrogen, vast investments will be needed in research and innovation, machines and infrastructure to say nothing of workforce training. These issues are fully discussed in Time Structures' study, "California Community Colleges Sustainable Energy Initiative: Training for Competitive Advantage in The Hydrogen Economy."[110]

A Complex, Difficult To Predict Future Awaits

Professor Jim Dator, Hawaii Center for Futures Studies, put the challenge that California is facing this way:

> For the overwhelming preponderance of human history, humans have lived in societies that were characterized by 80 percent continuities, 15 percent cycles, and only 5 percent novelties at best. Now I believe the figures are reversed: 80 percent of our futures may be novel, 15 percent cyclical, and only 5 percent continuous with the past and present.[111]

Convergence of changes produced by scientific research in converging areas, technological applications like IT, emerging markets, new production methods, sources of energy, global warming are already producing a highly unpredictable world.

A committee representing the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine have described the immediate and continuing economic challenges faced by the United States and California in a joint 2005 study, *Rising Above the Gathering Storm*. Their statement deserves a lengthy quote:

> Having reviewed trends in the United States and abroad, the committee is deeply concerned that the scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength. We strongly believe that a worldwide strengthening will benefit the world's economy—particularly in the creation of jobs in countries that are far less well-off than

> the United States. But we are worried about the future prosperity of the United States. Although many people assume that the United States will always be a world leader in science and technology, this may not continue to be the case inasmuch as great minds and ideas exist throughout the world. We fear the abruptness with which a lead in science and technology can be lost—and the difficulty of recovering a lead once lost, if indeed it can be regained at all.
>
> This nation must prepare with great urgency to preserve its strategic and economic security. Because other nations have, and probably will continue to have, the competitive advantage of a low-wage structure, the United States must compete by optimizing its knowledge-based resources, particularly in science and technology, and by sustaining the most fertile environment for new and revitalized industries and the well-paying jobs they bring.[112]

Today's changing trends in California's competitive advantage reflect earlier predictions made in *Rising Above the Gathering Storm*. Table 1 summarizes how the storm is continuing to gather and will only strengthen as time goes on. One of the most important points of this analysis is that the economy of the 21st century will include many elements that either did not exist in the 20th century economy or have been substantially transformed.

Such changes include, as pointed out above, the emergence of a new breed of multinationals from non-Western nations, the development and application of new materials by highly networked laboratories around the world, the role that non-petroleum-based energy and conservation will play in competitive advantage, and the global competition to train and attract a highly skilled workforce. Probably the single most significant development, and one that was not fully analyzed in the *Gathering Storm*, is the growing and increasingly more disruptive effect that global warming will have on the pace and direction of globalization. Not only will new opportunities and markets emerge, but changes in water availability and food production will occur. Substantial redirections of public and private capital—potentially affecting R&D and productivity-related expenditures—will have to be made to directly address rising ocean levels and changes in local climate. These changes may seem far away, but planning for, modifying and moving infrastructure and research and production facilities take can take decades to accomplish.

Table 1: 20th Century Economy vs. 21st Century Economy

Issue	20th Century	21st Century
Markets	Stable, Predictable	Emerging, Dynamic
Scope of Competition	National	Regional on a Global Scale
Organizational Form	Hierarchical	Dynamically Networked
Production System	Mass Production	Innovative-Flexible-distributed/Logistical-IT-Customer Driven
Key Factor of Production	Capital/Labor	Innovation/Ideas/IT/Venture Capital

Production		
Key Technology Driver	Mechanization	New Materials-Digitization
Competitive Advantage	Economies of Scale	Energy/Innovation/Proprietary Methods/Quality
Company Market Dominance	U.S., European, Japanese	U.S., European, Chinese, Indian, Brazilian, Korean, other new firms
Relations Between Firms	Go It Alone	Global-Collaborative-Flexible
Worker Skills	Job-Specific	Changing, Scientific, IT Literacy/ Innovation/Collaboration
Nature of Employment	Secure	Risky at all Levels
Energy	Petroleum	Multiple Fuels/Conservation
Global Warming	Not An Issue	Disruptive and Drain on Public Resources

California's challenge is to respond to an eroding position and to the challenges of the 21st Century by cultivating its scientific, manufacturing and service sectors, by strengthening its current and future workforce, and by responding to energy and global warming issues in a measured, smart, and strategic way.*

Succinctly put, here is a "formula" summarizing what we have learned from our review:

> Competitive Advantage in Existing and Emerging Markets = *an Innovative, skilled Workforce + Advanced Manufacturing technology + Invention and Application of New Materials + Global Logistics + Energy Efficiency and emission reduction + links to Financial, Research, and Supply Networks +Ubiquitous Information Technology*.

The core of California's future services and manufacturing advantage is the development and use of new nanotechnology, MEMS, and other materials utilizing biotechnology. These techniques might be applied, for example, through globally networked, IT-driven, advanced service and manufacturing techniques in small and large companies to produce innovative products that are moved across the global using electronic and surface logistics—just-in-time—to customers anywhere in the world. Information technology penetrates and ties together every element of this process. (Global warming will intervene in unknown ways and must be strategically planned for.)

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* A key problem that is not addressed here is the challenges facing the state's math and science teacher workforce. A California Council on Science and Technology study**,** *Critical Path Analysis of California's Science and Mathematics Teacher Preparation System,* indicates that the growth in projected demand for science and math teachers could be over 33,000 during the next decade.

We are talking about first-mover advantage here. As these new technologies merge and mature they will revolutionize products and their production. An innovative, highly trained workforce working with these technologies will invent and apply proprietary knowledge that generates a firm's competitive and first mover advantage.*

Foresight, Innovation, Competence: Getting California's New Argonauts Ready to Compete

The California Council on Science and Technology has closely examined the whole issue of Science and Technology Innovation in California.

> *For the last decade, California's economic growth has been fueled by the rapid expansion of high-tech industries. Even in times of economic downturn, technology companies have been able to reinvent themselves and create new industries. This California Technology Miracle, with its promises of new products and more high paying, environmentally compatible jobs, is a critical part of both our present and future.*
>
> *Because fewer industries are doing basic research, a tight tie is required between university research and its transfer to private industry. New models, partnerships, venture capital involvement, and laws are emerging to create new businesses. Technical innovation requires people with technical excellence but California is competing with other states and nations to generate sufficient amount of this talent and to attract and retain it. . . . California cannot continue to produce innovation and crate new industries without improving the production of a skilled workforce.*[113]

What entry level literacy skills will California's workers need to compete in this new, rapidly changing economy? In 2005, Time Structures conducted telephone surveys of nanotechnology, biotechnology, advanced manufacturing, and intelligent-transportation-related companies to determine what skills will be needed through 2015. Table 2 summarizes how the economy of the 21st Century's entry level skill requirements are different from those of the 20th Century.

* Each element of this equation is developed in reports prepared for the California Community Colleges, Economic and Workforce Development Program. Copies can be downloaded at: http://www.cccewd.net/resource.cfm?c=11

Table 2: 20th vs. 21st Century Workforce Entry Level Literacy Requirements	
20th Century	**21st Century**
General literacy	Science literacy
Arithmetic literacy	Mathematics literacy
No computer literacy	Advanced computer literacy
Basic shop equipment	Scientific laboratory equipment
Conversational English	Specialized technical English
Follow instructions	Innovation and problem solving
No writing and analysis	Technical report preparation and interpretation
Individual job responsibility	Capacity to form and innovate in mixed groups
One-time Training	Life-long learning of different advanced competencies

This list is very consistent with that developed by the Labor Market Information Division of the Employment Development Department (Table 3).

Table 3: Top Skills in Rank Order Required in Key California Industries

Automotive	Biotech	Construction	Financial	Geospatial	Health
Active Listening	Active Learning	Complex Problem Solving	Active Listening	Active Learning	Active Learning
Admin./Management	Active listening	Critical Thinking	Critical Thinking	Active listening	Active listening
Critical Thinking	Complex Problem Solving	Equipment Selection	Decision Making	Complex Problem Solving	Complex Problem Solving
Customer & Personal Service	Critical Thinking	Installation	Judgment	Critical Thinking	Critical Thinking
English Language	Equipment Selection	Judgment and Decision Making	Mathematics	Mathematics	Mathematics
Equipment Selection	Mathematics	Mathematics	Reading Comprehension	Decision Making	Decision Making
Mathematics	Monitoring	Operation and Control	Speaking	Judgment	Judgment
Mechanical	Operation Analysis	Reading Comprehension	Writing	Reading Comprehension	Reading Comprehension
Reading Comprehension	Programming	Time Management		Speaking	Speaking
Speaking	Quality Control				
	Reading Comprehension				
	Science				
	Speaking				
	Troubleshooting				
	Writing				

ENDNOTES

[1] Kevin Starr (2007). California: A History. New York: Modern Library, p. 247.

[2] Robert Atkinson (2007). Deep Competitiveness, Issues in Science and Technology. http://www.issues.org/23.2/atkinson.html

[3] California's EDGE Campaign (2006). California's Edge: Keeping California Competitive, Creating Opportunity. See: http://www.californiaEDGEcampaign.org.

[4] Greg Critser, "Kevin Starr's California: The Golden Rush," LA Weekly, October 13, 2005.

[5] AnnLee Saxenian (2006). The New Argonauts. Cambridge, Mass.: Harvard.

[6] Ken Dychtwald, Tamara Erickson, and Robert Morison (2006). Workforce Crisis. Boston, Mass.: Harvard Business School Press.

[7] Elias Lopez (2002). The College Age Group and Scholastic Performance in California. Sacramento: California Research Bureau.

[8] Center for the Continuing Study of the California Economy, 2005 California Regional Economies Project, September 2005.; and Dowell Myers, John Pitkin, Julie Park (2005). California Demographic Futures Projections to 2030, by Immigrant Generations, Nativity, and Time of Arrival in U.S. Population Dynamics Research Group, School of Policy, Planning, and Development University of Southern California www.usc.edu/schools/sppd/research/popdynamics.

[9] Joint Venture Silicon Valley, 2007 Index of Silicon Valley.

[10] Patricia DeCos, "Educational Opportunities for Adults in California" (2004), California Research Bureau, CRB 04-004, p. 4, and the State Department of Education, Adult Education Division.

[11] Center for the Continuing Study of the California Economy, 2005 California Regional Economies Project, September 2005.

[12] Labor Market Information Division, EEO Occupational Groups by Race/Ethnicity and Sex, 2000 Census.

[13] U.S. Department of Education, 2004.

[14] NCES Common Core Data, IPEDS Residency and Migration Survey, IPEDS Enrollment Survey, 2006.

[15] The National Center for Public Policy and Higher Education, "Measuring-up 2006"; http://measuringup.highereducation.org/_docs/2006/statereports/CA06.pdf.

[16] NCHEMS, 2006.

[17] California Council on Science and Technology (2002). Critical Path Analysis of California's Science and Technology Education System. Sacramento: California Council on Science and Technology, April.

[18] Paul R. Gross (2005). The State of State Science Standards, Thomas B. Fordham Institute at: www.edexcellence.net/doc/Science percent20Standards.Final percent20(12-6).pdf.

[19] Thomas B. Fordham Foundation (2005). The State of State Science Standards. www.edexcellence.net/doc/Science percent20Standards.FinalFinal.pdf.

[20] Sylvia Allegretto and Andy Stettner (2004). Educated, Experienced, and out of Work: Long-term joblessness continues to plague the unemployed. EPI Issue Brief # 198, March 4, 2004, Economic Policy Institute.

[21] California Labor Market Review, March 2007. www.calmis.ca.gov/FILE/LFMONTH/CaLMR.pdf.

[22] Labor Market Information Division, Employment Development Department, "Share of Total Unemployment in California by Duration Not Seasonally Adjusted (in Percent)", at: www.calmis.ca.gov/file/lfmonth/CaLMR.pdf.

[23] Andrew Stettner and Sylvia Allegretto (2005). The Rising Stakes of Job Loss: Stubborn Long-Term Joblessness amid Falling Unemployment. Economic Policy Institute. www.epinet.org/content.cfm/bp162.

[24] Sylvia Allegretto and Andy Stettner (2004). Educated, Experienced, and out of Work: Long-term joblessness continues to plague the unemployed. EPI Issue Brief # 198, March 4, 2004, Economic Policy Institute.

[25] Thomas Friedman (2005). The World is Flat. New York: Farrar, Straus and Giroux.

[26] Robert Friedland and Laura Summer (2005). Demography is not Destiny, Revisited. Center on Aging and Society, Georgetown University.

[27] Mortensen Center for European Policy Studies.

[28] The National Center for Public Policy and Higher Education, "Measuring-up 2006." http://measuringup.highereducation.org/_docs/2006/statereports/CA06.pdf.

[29]David Elmwood, Aspen Institute, Domestic Strategy Group: Anthony P. Carneval and Donna M. Desroachers, Educational Testing Services, as cited by: Collaborative Economics, Center for the Continuing Study of the California Economy, and J.K., Inc. (2004). Creating a Workforce Transition System in California: A Monograph of the California Regional Economies Project, California Economic Strategies Panel. www.labor.ca.gov/panel/espcrepmonocwts.pdf.

[30] McKinsey and Company, CalEd Conference, 2006.

[31] Ken Dychtwald, Tamara Erickson, and Robert Morison (2006). Workforce Crisis. Boston, Mass.: Harvard Business School Press.

[32] Shirley Malcom (2005). "Bringing Women and Minorities into the IT Workforce: The Role of Nontraditional Pathways," American Association for the Advancement of Science.

[33] National Governors Association (2002). A Governor's Guide to Creating a 21st Century Workforce.

[34] Collaborative Economics, Center for the Continuing Study of the California Economy, and J.K., Inc. (2004). Creating a Workforce Transition System in California: A Monograph of the California Regional Economies Project, California Economic Strategies Panel. www.labor.ca.gov/panel/espcrepmonocwts.pdf.

[35] Richard Norton-Taylor (2007). Revolution, flashmobs, and brain chips. A grim vision of the future. The Guardian, Monday April 9, 2007.

[36] Laura Hill, and Joseph Hayes (2007). Out-of-School Immigrant Youth. San Francisco: Public Policy Institute of California.

[37] Jon Haveman and Howard Shatz (2005). Services Offshoring: Background and Implications for California.

[38] Association for Computing Machinery (2006). Globalization and Off-Shoring of Software.

[39] Lawrence Mishel, Jared Bernstein, and Sylvia Allegretto (2007). The State of Working America 2005/2007. New York: Economic Policy Institute.

[40] California Franchise Tax Board.

[41] California Budget Project analysis of Current Population Survey data.

[42] Cross-National Trends in Earnings Instability and Earnings Inequality, http://repec.org/sed2006/up.20150.1140040761.pdf.

[43] Source: Jacob Hacker, "Testimony Before the House Ways and Means Committee on the Economic Challenges Facing Middle Class Families," www.newamerica.net/publications/resources/2007/jacob_hackers_testimony_before_the_house_ways_and_means_committee_on_the_economic_challenges_facing_.

[44] Jacob Hacker, Testimony before House Ways and Means Committee.

[45] Jacob Hacker (2007). The Great Risk Shift. New York: Oxford University Press.

[46] California's Edge Campaign, California's Edge: Keeping California Competitive: Creating Opportunity, at www.californiaedgecampaign.org/download/CaliforniaEdgeCampaign_White_Paper.pdf.

[47] Center for the Continuing Study of the Economy, 2006 report.

[48] Time Structures estimates based on industry studies prepared for the California Community Colleges, Economic and Workforce Development Program. See: www.cccewd.net/resource.cfm?c=11.

[49] California Budget Project, California Jobs Have Shifted Inland, Policy Points, January 2007.

[50] Hans Johnson and Deborah Reed (2007). Can California Import Enough College Graduates to Meet Workforce Needs? Population Trends and Counts, Vol. 8, No. 4, May.

[51] Hans Johnson and Deborah Reed (2007). Can California Import Enough College Graduates to Meet Workforce Needs? Population Trends and Counts, Vol. 8, No. 4, May.

[52] Hans Johnson and Deborah Reed (2007). Can California Import Enough College Graduates to Meet Workforce Needs? Population Trends and Counts, Vol. 8, No. 4, May.

[53]Mortensen Center for European Policy Studies, 2006.

[54] "Rivals of Japan lure its engineers," New York Times, May 26, 2007.

[55] Regional Economies Project, California Economic Strategy Panel (2004). Creating a Workforce Transition System in California.

[56] "Rising Exports Putting Dent in Trade Gap," New York Times, Monday, May 14, 2007, p. 1.

[57] Thomas Friedman (2005), The World is Flat. New York: Farrar, Straus and Giroux.

[58] Gus Koehler (1999). "The Time Compact Globe and the Techno-Primitive at the Millennium," a chapter in Euel Elliot and L. Douglas Kiel (Eds.), (1999), Nonlinear Dynamics, Complexity and Public Policy. New York: Nova Science Publications, Inc.

[59] Goldman Sachs (2006). Dreaming With BRICs: The Path to 2050; http://www2.goldmansachs.com/insight/research/reports/report6.html.

[60] Lester Brown, (2003). Plan B. Rescuing a Planet under Stress and a Civilization in Trouble. New York: Norton; and Asian Pacific Foundation of Canada, Feb., 2004. www.asiapacificbusiness.ca/apbn/pdfs/bulletin144.pdf.

[61] Gurcharan Das (2004). India's rich are doing well, and good for them—but the growing middle class is the real story, Time Asia, December.

[62] Bureau of Economic Analysis (2006). Summary Estimates for Multinational Companies: Employment, Sales, and Capital Expenditures for 2004.

[63] Charles Handy (1990). The Globalization of Food Marketing. Washington, D.C.: U.S. Government Printing Office.

[64] Antoine Van Agtmael (2007). The Emerging Markets Century. New York: Free Press.

[65] Joint Venture Silicon Valley (2007). Index of Silicon Valley.

[66] DTI (Department of Trade and Industry, U.K.) (2006). The R&D Scoreboard. The Top 800 UK and 1250 Global Companies by R&D Investment.

[67] DTI (Department of Trade and Industry, U.K.) (2006). The R&D Scoreboard. The Top 800 UK and 1250 Global Companies by R&D Investment.

[68] Hise, Fortune Small Business, May, 16, 2007.

[69] Kaufman Foundation at: www.kauffman.org/entrepreneurship.cfm.

[70] Hise, Fortune Small Business, May, 16, 2007.

[71] The California Economic Strategy Panel produces regional economic reports for the state. See: http://158.96.229.228/labor/panel/.

[72] Industrial Performance Center, UK PLC: Just How Innovative are we? Findings from the Cambridge-MIT Institute International Innovation Benchmarking Project. MIT Working Papers, December, 2006.

[73] Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future, Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology (2005). Washington, D.C.: National Academy of Sciences, National Academy of Engineering, Institute of Medicine.

[74] Daniel Yorgason (2007). Research and Development Activities of U.S. Multinational Companies: Preliminary Results from the 2004 Benchmark Survey. At: www.bea.gov/scb/pdf/2007/03March/0307RDofMNCs.pdf.

[75] National Science Foundation, R&D expenditures at universities and colleges, by geographic division, state, and source of funds: FY 2004 at: www.nsf.gov/statistics/nsf06323/tables/tab17.xls.

[76] California Council on Science and Technology (2006). California's Federal Laboratories: A State Resources, at: http://www.ccst.us/publications/2006/LabExecSumm.pdf.

[77] Robert Atkinson (2007). Deep Competitiveness, Issues in Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and University of Texas at Dallas.

[78] Daniel Yorgason (2007). Research and Development Activities of U.S. Multinational Companies: Preliminary Results from the 2004 Benchmark Survey. At: www.bea.gov/scb/pdf/2007/03March/0307RDofMNCs.pdf.

[79] Daniel Yorgason (2007). Research and Development Activities of U.S. Multinational Companies: Preliminary Results from the 2004 Benchmark Survey. At: www.bea.gov/scb/pdf/2007/03March/0307RDofMNCs.pdf.

[80] California Council on Science and Technology (2006). Policy Framework for Intellectual Property Derived from State-Funded Research: Final Report to the California Legislature and the Governor of the State of California, and Policy Framework for Intellectual Property Derived from Stem Cell Research in California, at: www.ccst.us/publications/index.php.

[81] World Intellectual Property Organization, 2007.

[82] William A. Ward Clemson (2005). Manufacturing Productivity and the Shifting US, China, and Global Job Scenes—1990 to 2005, University Center for International Trade Working Paper 052507, (August 4, 2005).

[83] McKinsey and Company, presentation at CalEd Conference, 2006.

[84] Bay Area Economic Forum (2006). One Million Jobs at Risk: The Future of Manufacturing in California.

[85] California Employment Development Department.

[86] Robert Atkinson and Andrew McKay (2007). Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution. The Information Technology and Innovation Foundation, p. 1.

[87] Robert Atkinson and Andrew McKay (2007). Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution. The Information Technology and Innovation Foundation.

[88] Kaufman Foundation (2007). The 2007 State New Economy Index.

[89] "US Cities Don't Make the Intelligence Cut," NetworkWorld News, January 24, 2007.

[90] The Global Information Technology Report 2005–2006; www.weforum.org/en/initiatives/gcp/Global percent20Information percent20Technology percent20Report/index.htm

[91] J. R. McNeill (2000). Something New Under the Sun: An Environmental History of the Twentieth-Century World. New York: Norton.

[92] Christopher B. Field, and others (1999). Confronting Climate Change in California: Ecological Impacts on the Golden State, a report of the Union of Concerned Scientists and Ecological Society of America.

[93] California Environmental Protection Agency (2006). Climate Action Team Report to Governor Schwarzenegger and the Legislature.

[94] Christopher B. Field, and others (1999). Confronting Climate Change in California: Ecological Impacts on the Golden State, a report of the Union of Concerned Scientists and Ecological Society of America; and California Environmental Protection Agency (2006). Climate Action Team Report to Governor Schwarzenegger and the Legislature.

[95]Christopher B. Field, and others (1999). Confronting Climate Change in California: Ecological Impacts on the Golden State, a report of the Union of Concerned Scientists and Ecological Society of America.

[96] Regional Economies Project (2006). Economic Base Report: San Joaquin Valley Region. Economic Strategy Panel, http://158.96.229.228/labor/panel/Economic percent20Base percent20Report percent20for percent20San percent20Joaquin percent20Valley percent20Region.pdf.

[97] Christopher B. Field, and others (1999). Confronting Climate Change in California: Ecological Impacts on the Golden State, a report of the Union of Concerned Scientists and Ecological Society of America.

[98] Climate Change: Study Maps Those At Greatest Risk From Cyclones And Rising Seas, Science Daily, March 28, 2007.

[99] J. R. McNeill (2000). Something New Under the Sun: An Environmental History of the Twentieth-Century World. New York: Norton.

[100] Frank J. Wentz, Lucrezia Ricciardulli, Kyle Hilburn, Carl Mears (2007). How Much More Rain Will Global Warming Bring? Science at: www.sciencemag.org/cgi/content/abstract/1140746v1?etoc.

[101] California Environmental Protection Agency (2006). Climate Action Team Report to Governor Schwarzenegger and the Legislature.

[102] For examples of new water purification technologies see: Nanofrontiers, Woodrow Wilson International Center for Scholars, 2007.

[103] John Landis (2002). “50 Year Urban Growth Projections”, California Legacy Project Data Collection, California Environmental Education Catalogue, at: http://gis.ca.gov/catalog/BrowseRecord.epl?id=21105.

[104] Climate Change: Study Maps Those At Greatest Risk From Cyclones And Rising Seas, Science Daily, March 28, 2007.

[105] Global Warming Accelerates China's Sea Level Rise, People’s Daily, April 13, 2002.

[106] “Damage From Climate Change Could Cost Alaska 10 Billion,” Reuters, May 31, 2007.

[107] Union of Concerned Scientists, and Ecological Society of America (1999). Confronting Climatic Change in California.

[108] Gupta, Los Alamos National Lab;, 2006.

[109] http://t8web.lanl.gov/people/rajan/.

[110] California Community Colleges Sustainable Energy Initiative: Training for Competitive Advantage in The Hydrogen Economy. California Community Colleges, Economic and Workforce Development Program, 2005.

[111] Future Survey, World Future Society at: www.wfs.org/fstop10fal04.htm.

[112] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, Committee on Science, Engineering, and Public Policy, the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine (2005) Rising Above The

Gathering Storm: Energizing and Employing America for a Brighter Economic Future. National Academies Press; http://books.nap.edu/catalog/11463.html.

[113] California Council on Science and Technology (2002). Science and Technology Innovation in California. The Eighth and Ninth Hitachi California Public Affairs Forum Series, p. 1 and 19 at: www.ccst.us/publications/2002/2002Innovation.pdf.