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In April 2010, *The Economist* reported that China produces 75,000 people with higher degrees in engineering or computer science annually, and India 60,000. Additionally, the number of companies on the *Financial Times* 500 list from Brazil, India, China and Russia more than quadrupled from 15 in 2006 to 62 in 2008. This same list of 500 companies has 98 research and development (R&D) facilities in China and 63 in India. And the numbers are growing.

It is no secret that with innovation comes market power. With market power comes not only direct business and economic control, but political and cultural strength as well. The numbers above reflect the following reality: the global balance of power is shifting.

20/10 Vision focuses on industries that will help dictate where the balance of power lies in the years to come. Cutting-edge life-science technologies such as stem cells and wireless health represent huge growth opportunities with plenty of room for discovery. Advanced biofuels and solar power are also burgeoning onto the spectrum.

Our journal also inspects the wheels of this innovation. Where will the money come from? John Douglas, M.D. and Marc Hermsmeyer shed some light in their piece, “Venture Capital: Current Challenges and Future Directions.” Where will the R&D happen? Professor Vish Krishnan takes a peek behind university laboratories in our signature piece on innovation, “Innovating Our Way Out of a Crisis.”

Our goal with this publication is to inform our reader, you, with what you need to know to walk comfortably into the years ahead. Want to be an active participant in the global dance for impact? Learn about technologies that will save lives and make the Earth healthier? The pleasure is ours.

Royan Kamyar, M.D.
Editor-in-Chief

**Innovate** / inˌnovət/ v. [intrans.] make changes in something established, esp. by introducing new methods, ideas, or products.
■ [trans.] introduce something new, esp. a product.
- inˌnovəˈteɪər, -ˌvəˈtər/ n. inˌnovəˈteɪˈrə/ adj. [16th C.: from L. innovat- ‘renewed, altered,’ from the v. innovare, from in- ‘into’ + novare ‘make new’ (from novus ‘new’).]

India is rapidly becoming a consumer on a global scale. Can its national identity survive the transition?

U.S. EXPORT TO INDIA: CONSUMER CULTURE

by Richard Woodbridge

Last summer the world’s largest retailer, Walmart Stores Inc., made its grand entry into the Indian market. In a joint venture with Indian telecom giant Bharti Enterprises Ltd., Walmart opened the doors to its first Indian retail supply store in the northern state of Punjab. Although Walmart has been sourcing products from India for years, this launch reflected a growing paradigm shift within one of the world’s fastest growing economies. India is becoming a global consumer.
As the economic crisis tightened its grip on many Western economies, India’s $1.2 trillion gross domestic product was growing strong at 7.9 percent in the quarter ending December 2009, and averaging approximately a 9 percent annual growth rate over the prior year. Walmart’s entry into India’s $427 billion retail market has paved the way for other retail giants including the U.K.’s Tesco, and most recently, a proposed entry from France’s largest retailer, Carrefour. According to a recent Business Monitor International report, it is estimated that India’s retail sales will grow to $755 billion by 2014. Although the majority of products are currently sourced within the country, Walmart’s foreign private label suppliers are eager to gain entry into the burgeoning Indian market.

One of the most striking features of India’s incredible diversity is its stark economic disparity, which makes the country’s transition to a consumer culture extremely complex. In 2008, India was home to four of the world’s 10 richest people while over two-thirds of its population survived on less than $2 per day. As many sectors were showing signs of weakening, the fast moving consumer goods (FMCG) industry in India was experiencing nearly 15 percent growth in the financial year ending March 2009. Surprisingly, this was mostly driven by sustained economic activity in the country’s diverse, and typically poor, rural markets.

RURAL POWER
There are approximately 820 million people spread across 630,000 villages in rural India. This segment, which represents 71 percent of India’s population, is playing a key role in the country’s economic growth. Even though the majority of families in this segment live below the poverty line and more than 52 percent of their income is spent on food, demand is higher than ever for aspirational products. The rural market is not only demanding FMCGs, it is also a large consumer of durable goods such as TVs, mobile phones and two-wheelers. Today, companies all over the world are scrambling to find innovative ways to access the purchasing power of this enormous market.

It was Hindustan Unilever Limited (HUL), formerly Hindustan Lever Limited, that made the most famous foray into India’s rural market with an innovative sales technique back in the 1980s. It recognized that although poor families desired health and beauty products, they didn’t have the steady incomes required to afford large purchases. So instead of trying to sell bulk containers of shampoos to customers, HUL introduced the small one-rupee sachet, the equivalent of approximately 2 cents U.S. This technique was wildly successful, making small, low-priced, branded personal items the norm in just about every shop in India. More recently in 2007 Dove introduced a new three-rupee shampoo sachet in India that now makes up a major portion of their hair care sales.

As rural households increasingly enter the formal economy, many families are experiencing wealth for the first time. Public-private partnerships have pushed electrification and roads into much of the interior, increasing productivity and relieving supply chain woes to potential customers and suppliers. Financial inclusion through microloans and innovative mobile banking technologies has given this sector greater access to capital. Many farmers are switching to cash crops and modern, efficient irrigation techniques, resulting in increased yields, revenues and available jobs in rural communities. All of these changes bode well for retail.

A ROCKY ROAD
While India’s growing consumer market is enticing more foreign players, there are still harsh realities that need to be considered before multinationals take the plunge. Last fall, a government policy change left thousands of expats with business visas only two weeks to either attain a work visa or leave the country. This unexpected event caused severe disruptions to the management of many multinational corporations. Along with unforeseen policy shifts, other uncertainties such as corruption, regulatory issues and price sensitivity can be daunting for companies inexperienced with the nuances of the Indian market.

Walmart’s entry was stymied by the fact that India does not allow foreign direct investments for multi-branded retailers. The rule prohibited the retail giant from selling directly to retail customers. This was largely a move by the government to protect the millions of neighborhood and village mom-and-pop-style stores, commonly known as kirana shops. However, the regulation did allow for the creation of wholesale stores that cater to retail store owners and large institutions. There is now increasing pressure on lawmakers to ease restrictions for international retailers as was done in the telecommunications and other industries.

In response to increased demand for high-quality, low-cost items and growing competition, neighborhood kirana shops are changing the way they do business as well. In some areas, small stores are teaming up to make bulk purchases and passing the savings to their customers. Many stores go one step further, providing credit for purchases and even offering neighborhood delivery.

“Entrepreneurship is happening at the grassroots level in India with micro, small and medium enterprises,” said Dr. Jayshree Suresh.

THE ENTREPRENEUR
For all the challenges the Indian market presents, there also exist opportunities, and indeed entrepreneurship is gaining momentum across India. Visit any major Indian bookstore and you will see a large section devoted solely to business management and entrepreneurship. Even in the poor rural communities, microloans and self-help groups are opening the doors to fruitful new ventures.

“Entrepreneurship is happening at the grassroots level in India with micro, small and medium enterprises,” said Dr. Jayshree Suresh, dean of the Sri Ramaswamy Memorial (SRM) University School of Management, one of the largest private management schools in India, and author of the book “Entrepreneurial Development.” “Technology and venture capital are allowing for a whole new group of entrepreneurs.”

For a long time, there was a lack of entrepreneurial encouragement in India. Due to cultural, social and economic pressures, it was hard for many to justify giving up a stable salary and job to start a
new venture. Although societal pressures are relaxing, failure is still a major fear that is hindering India’s entrepreneurial potential. Once you have failed, you are branded as a failure. “It is very hard to get back into the corporate sector after a failure—that stigma is still there,” said Suresh. However, this too will likely change over time as more MBAs enter the market and the rewards associated with entrepreneurship are recognized. “For new Indian business students, entrepreneurship is becoming a career option.” And while there is no better business bureau, there are many support organizations, such as the Confederation of Indian Industry that offer resources for individuals interested in launching new enterprises.

LOOKING AHEAD
According to a report by the McKinsey Global Institute, Indian incomes are expected to triple by 2025, growing the country’s middle class population to 583 million people, nearly 10 times its current size. As the rural market opens up and government pressure is kept on the economy to maintain an 8 to 9 percent growth rate, needs for new products and services are surfacing almost daily. For example, India currently has a massive energy deficit of 13 percent (16 percent during peak hours). This will grow as demand on energy increases. Although new coal burning plants are being installed, cities and towns still suffer from inconsistent and dependable electricity supplies. New energy-efficient products and decentralized power generation projects can help rural and urban regions meet this demand and increase productivity.

Changes in lifestyles are fueling a growing need for new medicines and diagnostic technology. There are over 50 million people in India living with diabetes, making India home to the world’s largest diabetic population. Current estimates show nearly 11 percent of the urban population and 3 percent of the rural population have this disease. These rates are expected to grow rapidly as diagnosis improves, diets change and more people accept a sedentary lifestyle.

Even changes in India’s demographics present new opportunities. Currently, India’s rapid urbanization is creating a large demand for safe, reliable materials for new building construction. Just as India was able to make quantum leaps in its telecommunications industry, virtually bypassing the land line in exchange for the mobile phone, it is poised to cut to the forefront of the clean technology and green building consumer space.

The rural market presents several opportunities not only in energy generation, but also improved water management and irrigation technology, agricultural processing and cold storage warehousing, as well as fertilizers and farming equipment. As this population segment becomes both a strong consumer and producer, needs arise for improved supply chain logistics to get products and services to and from India’s interior. Innovative insurance, retail, medical and financial services that can cater to the rural sector have a chance of being lucrative.

With the allure of over a billion pocketbooks, many companies are ready to charge right in. However, in order to be successful in this market, multinationals must proceed with open eyes and a degree of flexibility, regardless of the product or service they plan to offer. “Foreign companies need to modify their business models to cater to the Indian conditions,” said Suresh. “There are slightly different ways of doing business here.” For example, Levi’s stores now offer installment payments for their clothing, allowing the customer to walk away with a new pair of jeans and pay for them in four parts over time. A trust of the consumer and a thorough understanding of India’s vibrant cultural, economic and political landscape are imperative before attempting to tap into this growing market.

As the economy grows and there is more disposable income, India is becoming a consumer on an international scale. Although this is a sign of progress for many, debates are currently raging about whether India’s approach to consumerism is good for the country in the long run. In a land where millions of families are caught up in a rapid transition between agrarian and post-industrial economies, there is a real fear that India is losing its identity. While this transition presents great opportunities for entrepreneurs and foreign multinationals, India will need to do some soul searching to decide whether it wants to become a consumer culture. Is India willing to follow the West, or will it create a new path that is uniquely its own? Only time will tell.

Richard Woodbridge (’09) is a product development professional with a background in anthropology and ten years of experience in market research and design consulting. He currently researches and designs rural energy solutions at the Centre for Development Finance affiliated with the Institute for Financial Management and Research in Chennai, India.
San Diego’s Stem Cell-Induced Business

State politics and a strong science sector in the region are poised to create a surge of novel stem cell therapies to previously uncontrollable diseases

by Joshua Rutenberg, Ph.D.

In 2004, the California electorate voted resoundingly in favor of Proposition 71, the California Stem Cell Research and Cures Act. Along with establishing a constitutional right to study stem cells in California, the act institutionalized the California Institute for Regenerative Medicine (CIRM) to distribute $3 billion to researchers and facilities throughout the state. The purpose was to advance embryonic and adult stem cell research, pursue therapies for unmet medical needs and create jobs.

Despite its majority following, the passing of Proposition 71 was controversial. It was enveloped in concerns about the embryonic sources of the cells as well as the necessity of allocating funds for such research while California was struggling with a $14 billion deficit. Notwithstanding the politics, California’s focus on stem cell research has become a driving force in establishing the Golden State and San Diego in particular, as a stronghold of public research and private companies. These entities are capitalizing on the welcoming environment generated by Proposition 71.

San Diego is home to world-class stem cell research expertise and technology. Four major institutions within walking distance of one another reap their share of money from CIRM: UC San Diego, the Salk Institute, Scripps Research Institute and the Sanford-Burnham Medical Research Institute. The local environment encourages collaboration among academics and commercial entities. It is no wonder San Diego’s “biotech beach” boasts one of the densest populations of stem cell businesses and startups in the world. In this article, we will explore how companies exploit the financial and intellectual resources in and around San Diego to develop the next phase of medical and biotechnology businesses based on stem cell technologies.

There is great enthusiasm with respect to stem cell research and business opportunities. In late 2009, companiesandmarkets.com reported global sales in the stem cell market reached $410 million, with conservative estimates predicting a rise to $5.1 billion in 2014. This estimate includes stem cell related therapies, but does not account for sales of the reagents and tools necessary to develop these therapies.

One of the greatest business challenges in biotechnology lies in deciding when the science justifies developing a company. As research drifts from academic pursuits to those more medically relevant or commercial, government funding tends to taper off. At this point, even a successful product or therapy may still be eight to ten years away from commercialization, too distant for venture capital interest. Companies must bridge this gap by using strategic collaborations and
A new company gaining prominence in San Diego is Fate Therapeutics. Fate specializes in reprogramming cells obtained from adult sources to acquire the characteristics of ES cells. Fate’s goal is to develop “stem cell modulators” that target and coax populations of naturally occurring adult stem cells to proliferate and differentiate to treat disease. Fate’s first stem cell modulator drug, FT1050, is designed to improve stem cell transplants for patients who have leukemia, lymphoma and other blood diseases.

The need for novel tools and reagents is greater than ever and demand could grow at double digit rates for the next five to ten years.

Conventional therapies, such as chemotherapy and radiation, destroy the cancer cells but frequently kill the patient’s own blood cells and immune system. Bone marrow and umbilical cord blood transplantation replenishes the patient’s dwindling or incapacitated blood supply. FT1050 is designed to be incubated with the donor cells before they are transplanted into the patient to improve restoration of the patient’s blood and immune system. Fate is currently testing whether umbilical cord blood can be safely treated with FT1050 in a clinical trial. The goal will be to test whether FT1050 treatment supports more efficient replenishment of the patient’s blood and immune system following transplantation.

STEM CELL BUSINESS MODELS — REAGENTS, TOOLS AND INFRASTRUCTURE

All stem cell research, from academic labs at UCSD, to large companies like Osiris and Geron, require specialized reagents, tools and infrastructure to perform their studies. Reflecting the significant growth in research and resources dedicated to stem cell research, a search on PubMed, a database that tracks biomedical publications, reveals that stem cell publications rose from 3,616 papers in 1999 to 10,789 in 2009. Following President Obama’s lift of the ban on stem cell research, doors opened for researchers to acquire federal funding. In fact, the National Institutes of Health (NIH) spent roughly $643 million on stem cell research in 2007 and $1.23 billion in 2009.

The need for novel tools and reagents is greater than ever and demand could grow at double digit rates for the next five to ten years. To serve these needs, an entire business sector materialized, with many companies located in California. The companies providing those reagents vary in size and specialty. Life Technologies in Carlsbad and BD Biosciences in San Jose distribute anything from plastic ware to biological molecules and live cells. Meanwhile, small, one-man startups are propagating to develop single items for stem cell identification. Although attracting less media attention than their business counterparts in regenerative medicine, the revenue possibilities for these companies are no less constrained.

WHAT IS A STEM CELL?

A stem cell is defined by two fundamental properties: the ability to reproduce and proliferate, and the ability to differentiate, which is the process of maturing to a distinct cell type. The capacity to replicate is an essential quality for the stem cell and allows it to divide indefinitely, thus maintaining sufficient numbers of identical, immature cells in the body. Importantly, this property may also allow scientists to grow large numbers of these cells for research or business endeavors.

It is the ability to differentiate that seizes the media spotlight for stem cells. This characteristic presents regenerative medicine as an opportunity to develop cell-based therapies to transplant new healthy cells, tissues or organs to patients who cannot otherwise repair damage from disease or trauma. Examples of potential applications include diabetes, Parkinson’s disease, heart disease and spinal cord injury.

STEM CELL BUSINESS MODELS — REGENERATIVE MEDICINE

Three overlapping business models are employed within the stem cell space. The most recognized, regenerative medicine, has benefited from attention by celebrities such as Michael J. Fox and Christopher Reeve, who promoted embryonic stem (ES) cell research as a means for developing therapies for Parkinson’s disease and spinal cord injury. The goal of regenerative medicine is to isolate and reproduce stem cells to develop new and healthy cells, which can then be transplanted into patients with damaged tissue, such as that arising from diabetes, muscular dystrophy, Lou Gehrig’s disease or heart disease.

Although the first stem cell therapy occurred in 1968 when Dr. Robert Good performed bone marrow transplants to treat patients suffering chemotherapy-induced blood disease, cell therapy still represents the most challenging and long-term application for the use of stem cells. Therapeutic research requires significant investments to bring potential therapies from the laboratory, through clinical trials, to the bedside. These businesses tend to be large, public companies like Geron, in California, or Osiris Therapeutics, in Maryland, that have the funds to pursue risky, yet lucrative markets.

Geron made headlines after obtaining FDA approval for the first human ES cell-based Phase 1 clinical trial. Using ES cells, Geron has produced mass quantities of a type of nervous system cell, called oligodendrocytes, that helps maintain the health of neurons. Geron demonstrated that these oligodendrocytes can restore nerve function in animals with damaged spinal cords. If similar results are reproduced in humans, a new age of regenerative medicine could be established. While Geron is breaking new ground, it is important to note they are doing a fantastic job of managing expectations and working closely with the FDA to set stringent clinical guidelines for ES-based therapies and FDA approval.

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An example of a startup company taking advantage of the growth in the stem cell reagent and tools space is MicroStem Inc., headquartered in San Diego. MicroStem’s mission is to develop and produce human adult cells in large enough quantities to sell to other research laboratories. The company targets cell types that have been difficult to obtain — such as heart muscle cells and neurons. Primary sources of such cells obtained from cadavers or biopsies have limited life spans and tend to be injured during isolation procedures.

MicroStem isolates stem cells by using proprietary reagents to cause them to stick on a glass slide. With the ability to query tens of thousands of combinations on just one slide, the company’s technology offers a significant advantage over traditional technologies to identify conditions that drive stem cells to develop into certain cell types. In addition to developing novel cells for commercial distribution, this technology yields valuable information about cellular physiology that can result in the discovery of therapeutic leads. Moreover, MicroStem is taking a similar approach to develop cancer stem cell lines, which can be used to discover agents that target and destroy malignant cells.

STEM CELL BUSINESS MODELS — SCREENS

As more previously unavailable adult cells are produced from stem cells, a third class of business is developing means to screen for new pharmaceutical agents to test against those cells. In such cases, stem cells are differentiated in the lab to create the mature adult cell or their immature precursors. The cells are then immersed in solutions containing assorted drug candidates and evaluated for various responses.

Dr. Mark Mercola, director of muscle development and regeneration at the Sanford-Burnham Medical Research Institute, directs research to recreate heart cell progenitors, the cells that develop into heart muscle, in Petri dishes in his lab. His company, Chemregen LLC, is manufacturing small molecules to be applied to these progenitors. Chemregen can test for drug candidates that induce formation of adult heart cells from precursors and may discover drugs that induce specific behaviors, such as heart contraction. Depending on the results, Chemregen could sell the progenitors to other laboratories studying heart development and heart therapy, sell the candidate drugs as reagents to induce heart formation in the lab or even develop the candidates as pharmaceutical agents.

Such pharmacological screening studies represent short-term, attainable goals in stem cell research. Pharmaceutical companies, which have the most experience in drug development are partnering with stem cell companies to tap this potential windfall. For example, GlaxoSmithKline recently funded partners at Harvard University to investigate stem cell technologies for drug screening, while Roche partnered with Cellular Dynamics International to identify similar opportunities. Johnson & Johnson has provided funding for San Diego’s Novocell, which specializes in developing insulin-producing cells for diabetics; and Pfizer recently opened up its own office of regenerative medicine in the U.K. These companies see the potential for stem cell research to generate big returns.

It is clear there is significant potential for the future of stem cell research, therapy and business. The field of stem cell biology is in its infancy and there remain numerous questions regarding utility and function. As evident from publication rates and NIH spending for stem cell research, the promise of novel therapies for previously uncontrollable diseases is generating scientific progress at an unprecedented rate. By exploiting the resources and talent local to life-science hubs such as San Diego, stem cell businesses are poised to make incredible discoveries and strong financial returns.

Joshua Rutenberg, Ph.D. (’11) holds a doctorate in cell and developmental biology. He has over 15 years experience in research focused on stem cell biology and embryonic development. He is currently leveraging his research expertise to perform market research and investigate consumer insight.
Imagine you want to book a vacation. After you indicate your desire via voice or text, your mobile Internet device (MID) goes to work. Without further effort, you receive flight and hotel recommendations based on your known preferences. Once you make a few core decisions, machines do the rest, making reservations, payment arrangements and coordinating with anyone joining you on the adventure.

This example represents the reduction of human participation in mundane tasks — the promise of the Semantic Web. It is the most widely discussed possibility for Web 3.0, a term used to describe the next major evolutionary shift on the Internet.

Tim Berners-Lee, inventor of the World Wide Web expressed his vision of the Semantic Web as follows: “I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web—the content, links and transactions between people and computers. A ‘Semantic Web’, which should make this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy and our daily lives will be handled by machines talking to machines. The ‘intelligent agents’ people have touted for ages will finally materialize.”

An alternative vision of Web 3.0 regards content control. Many people believe the Internet is overrun with useless content. Structuring useful content and creating new content would involve controlling clutter through a screening process — contributors would be credible experts. Others say Web 3.0 isn’t technologically possible or that humanity’s ability to manipulate machines will easily confuse computers.

**INFRASTRUCTURE**

A variety of factors may affect the feasibility of transitioning to Web 3.0. Today, broadband Internet connections, third generation cell phone networks (3G), and wireless Internet can accommodate social networking and searches that primarily involve text-based interactions. For Web 3.0, the ability to move larger data sets at higher speeds would have to be standard.

Many locations now have access to fiber optic connections and there is additional fiber infrastructure in place that is not yet in use. The wireless industry is also quickly moving toward fourth-generation cell phone networks (4G/WMX). The infrastructure will arrive. The main question is when? Will current visions of Web 3.0 still be relevant?
MOBILE
Web 3.0 would require people to carry 4G smart phones. The ability of computers to interact with other computers on behalf of humans will only work if people are available to make core decisions in a timely manner. Everyone would need a robust MID to facilitate these interactions. Another key factor is the usability of complex applications. Today, the technology lifecycle of mobile applications for smart phones is just beginning. Screen size and methods of interaction such as touch and voice currently limit application capabilities and usability. New mobile interaction technologies such as radio-frequency identification (RFID), which tracks objects with radio waves, and biometrics should be available in the next three years. Application designers will have to incorporate innovative ways for people to interact with their devices for Web 3.0 to reach its potential.

IMPACT ON OPERATIONS
As technology shifts toward MIDs replacing computers as the primary interaction device, computer processing and analysis will have to be done on remote servers. MIDs may become a communication device connecting people to their digital hub on a server they do not know the location of and have never seen, raising additional security concerns.

IMPACT ON MARKETING
In addition to accommodating greater technology demands, businesses would have to deliver timely personalized marketing messages on a greater scale than today to survive. Consumers already ignore most non-personalized marketing, and the trend will continue as people consume more personalized, on-demand media. Marketers will have to adapt to communicating with consumers on a timely, personal level.

In theory, if consumers have fewer, more critical interactions to get things done because machines are doing the work, marketers may have fewer direct interactions with consumers. The coveted opportunities to directly connect with consumers would drive a larger percentage of business and may determine the potential for a future relationship. Search marketing will change dramatically as search engines gain accuracy and move toward more complex queries in different formats. The idea of machines searching on behalf of humans managing potential revenue may be a scary prospect for marketers. However, machines wouldn’t mind considering constant advertising in their decision making while humans lose interest quickly. The only certainty regarding future marketing is that the pace of strategic innovation will continue to accelerate.

The business of marketing would also have to evolve to adapt to this potential new reality. Many small- and medium-sized companies cannot handle the volume of personalized marketing that Web 2.0 commands. The speed of delivering personalized marketing on Web 3.0 would create demand for powerful software that can analyze large volumes of data and make important decisions without human interaction. Ironically, personalized marketing may have limited involvement of people in marketing because humans may no longer be able to handle the volume of data and necessary speed of delivery.

No one knows exactly what Web 3.0 will look like or if it will materialize. Regardless of which vision of the Internet becomes reality, businesses will have to adjust and react faster to the shifting technological landscape. Companies that are on the forefront of innovation in operations and marketing will dominate if they add value to the lives of their customers. At the current pace of technology breakthroughs, we may be discussing Web 4.0 sooner than we think.

Jonathan Minder (’10) has been driving Internet marketing results at a wide range of companies for almost a decade. Minder is the founder of Maximus Internet LLC, a consultancy specializing in Web strategy for small- to medium-size businesses.
Concern over the rising cost of health care is an ongoing issue heightened by harsh economic times and record unemployment. Federal legislation passed to provide economic assistance to hospitals; however UC San Diego Health System is scrutinizing within to reduce operating costs. After implementing radio frequency identification (RFID) technology in 2006 to track certain mobile medical devices, the health system obtained a return on investment in just three months by reducing inventory leasing costs and search times. This is only the beginning for the health system. Six months ago it implemented its first trial to track patients through a hospital using RFID bracelets. Tracking and improving patient flow may provide exponentially greater savings as bottlenecks are exposed and process inefficiencies are identified and corrected.

BACKGROUND ON RFID
RFID identification tags are successors to bar codes. They are placed on objects that need to be identified for selling, shipping or tracking. RFID tags emit radio frequencies that can be picked up by an RFID reader to identify objects. An RFID reader does not need a line-of-sight scan to identify an object. It can read from many meters away, read multiple tags at once and monitor objects constantly with the continuous detection of radio signals.

RFID AT UC SAN DIEGO
Scott Sullivan, business manager of perioperative services and imaging at the UC San Diego Health System, knew of numerous successes of RFID technology in corporate America and became determined to apply it to the health system’s operations. He partnered with Thomas Hamelin, associate administrator of perioperative services to track 500 infusion pumps using RFID tags in 2006. Within three months the monthly rental costs for infusion pumps dropped from $8,000 to $2,000. Using utilization data, Sullivan identified excess inventory and rentals the staff lost. The reduction in leases and capital expenditure on new infusion pumps saved $450,000 for the health system in 2008.

With the initial success, more mobile assets were tagged. Tagging wheelchairs, for example, led to a decrease in theft rate. In the operating room, sterilized RFID tags placed on instrument trays led to a
Sullivan believes “patient tracking” is the next step for the health system to reach higher patient process improvements.

Misfortunes such as Herrera’s death create more support for change. But is the ED problem a lack of capacity, poor scheduling or both? The solution begins with using hundreds of hours to gather the information necessary to analyze patient flow. The data gathering is time consuming because of the variability in patient arrivals and steps involved. Data must be averaged to isolate demand spikes and shifting bottlenecks. Once a bottleneck is identified and addressed, the analysis is repeated to measure for improvement. It is here where RFID can curtail labor time required for data gathering.

If every patient wore an RFID bracelet, the health system would have complete transparency from the wait time before entering an operating room, to the visit time spent with a doctor in clinic. Once the technology is in place, the patient flow process could be continuously measured and information can be gathered without additional labor. With each process improvement, patient satisfaction will grow with decreased wait times and cost.

Sullivan believes “patient tracking” is the next step for the health system to reach higher patient process improvements. He recently completed a trial at UC San Diego Health System tracking 161 inpatient and same-day surgical patients through their entire visit. The trial revealed excessive wait times in the pre-operation area. Further exploration revealed the cause was a shortage of electrocardiogram machines. Another machine has been purchased and Sullivan’s team will soon reassess the process. He is searching for the next rate-limiting step. He believes it is staffing in the preoperative area. Here patients see a nurse, anesthesiologist and support staff with varying patient processing times. Sullivan thinks there are more areas of the health system that can benefit from RFID applications. He plans to meet with employees in other departments to identify these areas, and generate interest and enthusiasm for the new technology.

ENDNOTES

1 Scott Sullivan, MBA, department business officer for Perioperative Services and Imaging at UC San Diego Health System, Personal Interview, 5 March 2010

Peter Phung (’11) is a Rady School MBA student and medical student at St. George’s University. He obtained his bachelor’s degree in information and computer science at UC Irvine and is interested in integrating information technology into health care.
In recent years, it has become clear that the collapse of century old firms, including Lehman Brothers, was caused by a disregard for risk throughout the global financial system. As the dust settles, it is apparent that the events of 2008 to 2009 will likely become a chapter in the history books rather than just a few pages. Accordingly, we found it fitting to interview Harry Markowitz and Ross Valkanov, two Rady professors who have spent the majority of their careers studying market risk.

In 1990, Markowitz shared the Nobel Prize in economics for his work on modern portfolio theory. In it, he distilled over 50 years of financial market experience into a strategy for the average investor and provided key market insight. Valkanov’s work on risk management, coupled with his understanding of complex derivatives used in managing risk, has made him a rising star in academia. Both were kind enough to share some thoughts and insights, as well as a few predictions for the remainder of 2010 and beyond.

Can you talk about what has changed and what hasn’t changed since you discovered portfolio theory?

HM: The world is still uncertain and you have to diversify. Equity market probability distributions are still not normally distributed. Through the 1960s asset managers were very focused on a bottom up approach, which is all about picking stocks. Today it’s more of a top down approach, which is all about picking asset classes. Academic studies have demonstrated that much of investor returns can be explained by asset class selection and weighting. You have more data today, which allows you to make a more informed decision; however, you can’t just rely on historical data. Estimates should be forward looking.

How has risk management changed since the credit crisis began in 2007?

RV: Prior to 2007, risk management professionals were viewed as “alpha eaters” because they tried to limit traders from taking what the risk management professionals viewed as too much risk. Given the events that have unfolded over the past two years, the financial industry is now much more focused on risk and risk management is seen as more of a necessity again.

Is the recent shift in risk management temporary or more of a permanent change?

RV: It’s hard to say; in the last six months you have seen an appetite for risk and leverage come back into the global markets, which may indicate a reversion to pre-2007 practices. That said, I believe the longer term trend will be for people who invested through the recent downturn to take risk management much more seriously than before.

Are financial derivatives a good thing for risk management and what, if any, changes should be implemented to decrease the systematic risk derivatives pose to the broader economy?

RV: In general, derivatives are a powerful tool for risk management. However, in recent years some forms of derivatives, most notably credit default swaps, have been used for unregulated speculation. I believe that certain derivatives should have more transparency and be forced to...
post additional collateral. This would reduce the overall risk to the economy from counterparties not being able to cover their obligations in the event of a default.

Is the efficient market hypothesis still valid today? Are markets really efficient?
HM: Markets would be efficient if you could borrow and lend at the risk free rate and you knew all probability distributions with certainty. Practically speaking, markets are not efficient, but that doesn’t mean they are easily beat. Some active managers can beat the market, but most don’t when you adjust for their fees.

RV: Average investors should stay away from derivatives. It makes
HM: For equity positions, individual investors should buy no-load mutual funds or ETFs with low management expenses. It is still important to have the right mix of fixed income and equity to construct a portfolio that considers your time horizon, risk tolerance, liquidity situation, tax consequences and any other unusual circumstances.

How should the average retail investor do with their money?
HM: I go with the advice of David Swensen, Yale’s chief investment officer—if you don’t have the time, talent and training to evaluate alternatives wisely, stay away from the asset class. As to efficiency, Swensen’s track record shows that excess returns are available here, but only to the knowledgeable.

How do you define genius?
HM: Genius is somebody who, more than once, is able to gain insight into a problem that changes the world for the better.

RV: Two years from today the prices of Treasury securities will be roughly unchanged. Inflation will remain low for the next several years and Europe will struggle with lower growth than the U.S. as it works through its deleveraging process.

How efficient are markets and are less efficient markets more prone to asset bubbles?
RV: Public equity markets are very efficient, particularly in the large capitalization space. On the other hand, the real estate and private equity markets are much less efficient. Private equity is a market where some participants have an information advantage over others. In private equity, this leads to a sizable difference in returns of top quartile managers versus second quartile managers. I believe that excessive leverage creates asset bubbles. However, asset bubbles can occur in both public and private markets alike.

What should the largest shock (downside surprise) to the market over the next two years?
RV: Commercial real estate needs to refinance a sizable amount of short-term debt over the next three years, which will likely cause prices to trade down over the next year. Commercial real estate has too much leverage and there are not enough lenders to refinance the wall of maturities coming due. This process could have an adverse effect on the broader market.

How do you view market efficiency in the context of private equity investing?
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Is genius related to IQ?
HM: They are not the same. A reasonable IQ is necessary, but not sufficient to being a genius as I define it.

Does academic brilliance translate into real world outperformance?
RV: There are some examples where it has but, in general, I don’t believe it does. There are several reasons for this. First, academics are very risk averse, which can make it challenging for them to execute in a principal investment role. Second, in many cases, academics experience additional pressure from the market perception that they should get it right every time. Academics are like coaches, we have a vision and understand the game very well, but aren’t the best players of the game.

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How should the average individual investor think about risk management?
RV: Average investors should stay away from derivatives. It makes more sense for a retail investor to identify the optimal portfolio allocation and hold the market through low cost mutual funds or ETFs.

If this crisis has taught investors anything, it’s taught them not to try and time markets. Many investors tried to time the recovery and as a result of being early, experienced sizable losses.

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ENDNOTES
1 Alpha is the excess return that a portfolio makes over and above what the capital asset pricing model estimates.
2 A no-load mutual fund is a mutual fund that does not charge shareholders a sales charge or commission.
3 An Exchange Traded Fund (“ETF”) is a security that tracks an index, a commodity or a basket of assets like an index fund, but trades like a stock on an exchange.

Tony Cusano, ’07 is a member of Siguler Guff’s private equity research team where he focuses on distressed debt and special situations opportunities globally. He is based in New York. Cusano previously worked on the distressed research team at StepStone Group. He also holds a bachelor of science summa cum laude from California Polytechnic State University, San Luis Obispo.
Innovating Our Way Out of a Crisis

Can research on operations and innovation benefit (University of) California?

by Vish Krishnan, Sc.D.

How quickly time flies. It was two years ago that Maria Shriver, California’s first lady, headlined a rally for soon-to-be President Barack Obama at UCLA with the following words, “If Barack Obama were a state, he’d be California. I mean think about it. Diverse. Open. Smart. Independent. Bucks tradition. Innovative. Inspiring Dreamer. Leader.”

That was a powerful endorsement of Obama’s candidacy and a nice pitch for California. The description resonated around the world because it is not far from the image of the state both its residents and outsiders hold. The Golden State blazed the trail in health, automotive safety and energy efficiency and has been a land of innovation and entrepreneurship. Its prominent University of California system has also been a source of important discoveries and recipient of prestigious awards including 57 Nobel Prizes.

The state and University of California system are learning, much like innovative firms in corporate America including AT&T, General Motors and Xerox, that inventions and Nobel Prizes do not sustain good times and prosperity. While Ma Bell invented the transistor, other firms such as Texas Instruments and Intel reaped most of the rewards from the invention through operational excellence and market acumen. General Motors invented the first car safety air bags, automatic transmissions, high-compression V8 engines and catalytic converters, but lost sight of product development and operational execution resulting in less appealing cars, declining market share and eventual bankruptcy.

Similarly, the inventions from Xerox’s labs such as graphical user interface have gone on to create hugely valuable firms such as Apple and Microsoft while Xerox itself did not benefit. Industrial organizations learned that profiting from their inventive output requires organizational and operational infrastructure that helps translate these inventions into socially and economically beneficial offerings.

As California faces a whopping deficit in the general fund, is there a lesson to be learned from companies such as AT&T and GM for the state and the UC system, even if these institutions differ along many dimensions from commercial for-profit organizations?

In many ways, the golden state and the UC system today look like General Motors in the 1970s (still a formidable force, but seeing early signs of trouble in declining market leadership), and must mend their ways if they do not want to go down the same path. Tough times can provide the impetus and organizational buy-in for change, so it is imperative that the leadership of the University of California system seize this crisis to make much-needed changes that strengthen its fiscal and strategic position in the global higher-education market.

Researchers in the field of management of innovation and operations study how some organizations translate technical success into product leadership to create societal and economic value. While it is a relatively young and growing discipline, it is useful to review the lessons from this literature and discuss the relevance of these recommendations for the state and the UC system.
THE FIELD OF OPERATIONS MANAGEMENT OVERVIEW

Productivity advances of the Industrial Revolution, 20th century mass production and the logistical demands of the two world wars spurred the growth of operations management. Its goal is to help organizations create the most value in a resource-constrained environment — deliver maximally effective output in a consistent, predictable and timely manner with the least required amount of inputs. A core precept of the field is that a scrupulous systems, process and value-addition perspective helps organizations minimize waste, achieve consistent quality, lower cost and meet or exceed customer expectations in the most demanding of circumstances. Operations management considers all inputs into an organization including materials, labor, energy, space and customer time.

Throughout the 20th century, the field of operations management developed hand in hand with modern manufacturing, which experienced a steady increase in productivity and growth. In the 1980s it became clear manufacturing was maturing and the next frontier for the application of operations management techniques was in services and knowledge-intensive activities such as research and development. Researchers study how the systems, process and value-addition approach can be applied to settings that involve more human interaction and knowledge creation.

MANAGING ORGANIZATIONS FOCUSED ON INVENTION AND INNOVATION

In the popular lore, new breakthroughs emerge from the inspiration of a lone inventor tinkering in a garage. While this is true of a few high profile discoveries, most useful products and practices are the fruits of a team's perspiration and significant organizational investment in supporting design, development, procurement and testing that fit in the mold of classical manufacturing operations.

INVENTIONS REQUIRE INNOVATION TO REALIZE SOCIAL AND ECONOMIC VALUE

Too often the meanings of the terms invention and innovation are mixed up in popular usage. Invention refers to the birth of an idea or technology (such as nylon or the transistor) and is largely the outcome of research activities. Innovation is the commercialization or transfer to practice of the invented idea, including appropriate functionality, quality and safety at the right price. For transistors, innovation required the design, development, production and marketing of radios and computers that incorporated these transistors and offered useful applications to customers. Companies that benefited from the transistor such as Intel and Texas Instruments were particularly adept at these innovative activities.

Invention and innovation are mutually valuable. They are also different in their risk profile and complexity. The nature of risk in invention is more technical, such as making technology work and making it safe. Market and operational risks dominate the innovative activity such as making a product cheap. They must be managed differently, with more room for exploration and experimentation in the domain of invention and greater focus on time, cost and volume in the case of innovation. New product and service development is crucial to the commercialization of inventions, and literature has emerged to improve the effectiveness and efficiency of new product development. Companies such as AT&T are not emphasizing the innovative activities that reap the benefits of the invention and are losing product leadership to competitors.

MANY PRODUCTS ADAPT EXISTING INNOVATION

Studies show effective innovators and their organizations are not fixated on creating something from scratch and are good at repurposing old ideas, a phenomenon called recombinant innovation. Examples include Ford's adaptation of a meatpacking assembly line in automotive manufacturing and Reebok Pump shoes adapted from intravenous bag technology. A growing trend in pharmaceutical drug development is trying to understand which FDA approved drugs could tackle unsolved disease categories or emerging strains of bacteria and virus.

PRODUCT AND TECHNOLOGICAL INNOVATION IS NOT THE ONLY TYPE OF INNOVATION

While the term innovation evokes images of products that have changed the course of history, such as the first airplanes, telephones and medical devices, products are not the only route to creating enduring value. Dell Inc. carved out a strong niche through its direct marketing, ordering and distribution systems. Other examples of non-product innovation include the name-your-own-price model of Priceline, Internet distribution of entertainment with Netflix and the car-sharing concept of Zipcar. A term used to refer to this new category of innovation is business-model innovation, where an existing product is distributed and paid for through new means thereby increasing convenience and value.

INNOVATION IS NOT ALL INDIVIDUAL INSPIRATION

It is clear innovation entails a number of infrastructural and administrative activities that make it successfully adopted and useful — which differentiates it from inventions. These enabling activities include marketing, development, testing, production and distribution to help an organization scale up, expand market coverage and realize cost savings through greater volumes in procurement and manufacturing.

PROCESS AND ORGANIZATIONAL INNOVATION MAKE INNOVATION AFFORDABLE AND VALUABLE

While new products unleash new functionality and capabilities, they are typically too expensive at the beginning and are targeted primarily at the high end of the market. Organizations that make innovation affordable and appealing to the mainstream marketplace improve the robustness of new innovation and expand market coverage, thereby increasing profit.

Organizations must evolve to the challenges of their marketplace. Complex industrial technologies and the lack of satisfactory communication technologies in the mid-20th century resulted in the emergence of a hierarchical organization to coordinate the activities of an enterprise. However, advances in information and communication technology are lowering coordination costs and offering the possibility of lean and virtual organizations with dramatic reduction in the administrative hierarchy and reporting structures.

Private organizations reported significant savings in administrative and transactional activities through business process redesign/re-engineering (BPR). BPR represents a fundamental rethinking of an organization's structure, methods and systems to usher in completely new ways of doing business. Improvements in information technology allow for radical simplification of work flows, elimination of intermediate steps,
integration of components and leveraging of organizational templates thereby speeding up processes, improving quality and enhancing the overall customer experience. BPR has enabled innovative organizations across many industry sectors, including products and services such as education, to streamline their workflows, reduce administrative overhead and lower the prices of their products and services — making them more affordable to the larger marketplace and unleashing a virtuous cycle of growth and profitability.

**IMPLICATIONS FOR THE UNIVERSITY OF CALIFORNIA**

The state and the University of California are facing challenging times. Even if the larger economy turns around quickly, it is inconceivable the UC system would be able to continue to operate as freely as they did in the past. While the cost of educating a student is rising and is now estimated to be over $25,000 per student, the state’s contribution to the University of California student is declining, students are asked to pay more and the universities are facing a growing shortfall in their day-to-day operations. What gives? The modern research university is a classic organization focused on generating and disseminating inventions, so let us see how the findings from the previous section on managing such organizations can benefit the university.

Although a university is not a company in all dimensions, there are a number of parallels between a strong research university like those of the University of California system and research and development (R&D) intensive companies such as Apple, Intel or Qualcomm. These companies attract highly sought-after knowledge workers and leverage their heavy investments in R&D by expanding the market for their products and services and selling millions (if not billions) of their devices and chips. Key to their success is the ability to attain significant returns on their investments in R&D by successfully scaling up their development, production and distribution operations. As they grow, they realize economies of scale in procurement, production and distribution operations, lowering their costs and increasing their margins, setting them apart from their smaller competitors. When they grow they also risk becoming more bureaucratic, but competitive pressures and demands of investors force them to continually improve efficiency and effectiveness.

Universities are established institutions as old as other highly traditional institutions like the Catholic Church, with an equally noble mission of generating and disseminating knowledge. U.S. universities continue to be the world’s best, especially in generating new knowledge. As non-profit institutions they do not face the demands of investors and stockholders, which allow them to think long term and build functional excellence. However, the lack of market exposure results in less pressure and motivation to change.

Managing an enterprise involved in innovative and innovative activity requires sensitivity to the diversity of tasks these organizations pursue. Clearly researchers should be offered the resources and freedom to pursue exploration, experimentation and discussion. However, activities that enable inventive researchers, including teaching and administrative services, offer substantial opportunities for improvement.

One study at the University of North Carolina conducted by Bain & Company showed more than half the administrative managers had three or fewer people reporting directly to them. Changing this could save as much as $12 million. Similar targets for improvement have been observed at UC Berkeley (berkeley.edu/oec/) and Cornell University (cornell.edu/reimagining/initiatives.cfm). The 10-campus University of California system can do a lot more to realize economies of scale and scope by aggregating, leveraging and appropriately designing activities. Examples include money spent on travel, information technology and lab supplies. The Operational Excellence (OE) project at Berkeley provides evidence of such opportunities to achieve cost savings by leveraging the size and “taking advantage of system-wide contracts that could offer substantial discounts.” Administrative functions like procurement are highly fragmented at Berkeley and use too many vendors compared to peer institutions. Opportunities abound in applying BPR techniques to human resources (HR), finance, information technology support and other administrative areas. At Berkeley, the OE project found 75 percent of IT staff and more than 85 percent of HR and finance staff do not have a formal relationship with the central functional office resulting in replication and redundancy across the campus.

Educational delivery and student service areas must evolve in response to improvements in technology. Advanced classes should complement each other in different campuses and students should be allowed to participate in classes over the Internet. This will result in cost savings, provide more course choices and teach students remote collaboration and team work, skills increasingly valuable in the workplace.

A crisis helped some organizations re-examine their practices and emerge stronger. In the 1980s, faced with rising Asian competition, the semiconductor company Intel had to do such soul searching, resulting in its exit from the memory chip market and painful changes to its organization as it sharpened focus on the core microprocessor business. Similarly, faced with the recession of the 1990s, Stanford University consolidated departments to achieve operational savings. To borrow a phrase from the policy arena—a crisis shouldn’t be allowed to go to waste. The leadership of the University of California system would do well to tap into its intellectual reserves and usher in much needed change that will renew and strengthen the prestigious institution.

**ENDNOTES**


Vish Krishnan, Sc.D. is the Sheryl and Harvey White Endowed Chair in Management Leadership at the Rady School of Management. He received his doctor of science in mechanical engineering from Massachusetts Institute of Technology in 1993.
Venture capital is a type of financing for new companies with high growth potential that is considered the economic life-blood of technological development. This financing is one of the driving forces behind California’s economy. Companies supported by venture capital in California employ roughly 4 million people per year and produce revenues close to $1 trillion,1 accounting for more than half the state’s gross product.2 Venture capital firms generally receive returns on their investments when the companies they invest in go public or are acquired by larger companies. However, the recent financial crisis has limited these events, which is a major threat to the economy of California and our nation.

This article explores why venture-backed companies are struggling to go public or be acquired as explained by Niall O’Donnell, principal at RiverVest Venture Partners. It then discusses how some venture capital firms are realizing returns despite this struggle through secondary private equity investments. Finally, the article discusses a new more efficient model of venture investing described by Duane Roth, chief executive officer of CONNECT and one of San Diego’s leading experts on entrepreneurship.

CURRENT CHALLENGES REALIZING RETURNS

The money venture capital firms use to invest in new companies usually comes from large corporations, foundations, university endowments, state pension funds and high net worth individuals. Once these companies go public or are acquired, 80 percent of returns are generally distributed to the original investors while managers of the associated venture capital firms divide the remaining 20 percent. However, if these companies never go public or are acquired the money contributed by the original investors is typically lost and venture capital firms do not realize any gains.

The last two years have been the slowest consecutive years for U.S. venture-backed initial public offerings (IPO) since the 1970s.3 O’Donnell, who has worked in venture capital since obtaining his MBA in 2006 and holds a Ph.D. in biochemistry, helps explain why. According to O’Donnell, companies are struggling to go public because in the current economic crisis many of the traditional buyers of IPO
Such a model would drive economic growth and financial recovery. and financially incentivizes the development of early stage technologies. In the current economic environment, investors lack confidence these increases will occur as reflected in the recent disappointing IPO of Anthera Pharmaceuticals in March. Anthera targeted raising $69 million, but only raised $32.2 million.

The economy has also led larger companies to be reluctant to buy smaller venture-backed companies. Acquisitions in the U.S. of venture-backed companies declined 31 percent from 2007 to 2009. O’Donnell explained, “Larger companies are using their cash to acquire other large companies to increase stability.” Examples include Roche buying Genentech, Pfizer buying Wyeth and Merck buying Schering-Plough. Large mergers cause integration issues, management disruption and leave little cash to acquire smaller venture-backed companies.

SECONDARY PRIVATE EQUITY INVESTMENTS
With venture-backed companies extremely limited in their ability to go public or attract larger companies to acquire them, some venture capitalists are looking for alternatives to realize returns on their investments.

One of the main alternatives is for venture capital firms to sell equity in their portfolio companies to private investors. Such sales are called secondary private equity investments and are made by secondary investors. These investors are usually firms dedicated to buying secondary private equity, such as Opteris. Secondary investors usually receive equity in the entire portfolio of companies within a venture capital fund, but deals involving individual companies also occur.

Often the money venture capital firms obtain from secondary investments is distributed to their original investors. However, venture capital firms may also use this money to pursue new investment opportunities and correct over-allocations of capital to portfolio companies that have decreased in value.

Over the past few years, the values of portfolio companies across the venture industry have decreased dramatically, making secondary private equity investments much more attractive. Overall, the value of secondary investments rose by 83 percent from 2008 to 2009, setting a new record. Recognizing this increase in value has captured the attention of new investors, increasing the demand for secondary investments. As this demand increases, venture capitalists will receive greater value for selling equity in their portfolio companies to secondary investors, making secondary investments increasingly integral to the venture industry.

While secondary private equity investments provide liquidity for venture capitalists, they do not offer the financial gains necessary to incentivize venture investing in risky new technologies. The struggle in venture capital remains creating an investment model that supports and financially incentivizes the development of early stage technologies. Such a model would drive economic growth and financial recovery.

DISTRIBUTED PARTNERING MODEL
CONNECT is an internationally respected organization that fosters entrepreneurship in San Diego through providing guidance to startup companies. Since its inception in 1985, CONNECT has helped over 1,500 startup companies raise over $10 billion. As chief executive officer of CONNECT, Duane Roth has helped numerous startups obtain funding and become successful. He is one of San Diego’s leading experts on entrepreneurship and believes technology development is trending toward a more efficient model.

According to Roth, a major problem in the current model of venture investing is that “it focuses on the creation of companies rather than products.” Typically a new startup company will license and receive funding to develop a single lead product. This system is grossly inefficient when considering the money startup companies spend to establish their own research and development infrastructures.

Another major problem, according to Roth, is the expertise necessary to guide technology development is often concentrated in a few individuals. To recruit and attract these experts, startup companies must offer financial incentives, often beyond their means in early stages. Thus, many startups lack the management expertise necessary to succeed, resulting in the failure of promising technologies.

To overcome these problems, Roth sees technology development trending toward what he and his co-author Pedro Cuatrecasas call in their recent paper published by the Ewing Marion Kauffman Foundation, the “Distributed Partnering Model.” In this model, “the focus is on developing products, not companies.” Roth envisions wealthy individuals, such as angel investors, funding a team of experienced entrepreneurs to identify and license 10 to 15 technologies in a focused field from research institutions. Each member would have expertise related to the technologies licensed.

The team of entrepreneurs would identify crucial steps to reduce risk and guide the early stage development of new technologies. During these early stages, the high risk of new technologies often scares away investors and prevents their development. Through licensing multiple technologies, the team would lower the risk of developing any one technology because the successful development of only a few of the technologies is necessary to generate attractive financial returns for the original investors.

In the current model of technology development, individual companies establish their own research and development infrastructure. Under the Distributed Partnering Model the entrepreneur team would outsource research and development to contract service providers that have the facilities, staff and expertise necessary to develop new technologies.

In the high-technology industry, contract service providers such as D&K Engineering may be hired to develop and manufacture complex electromechanical products. For the biotech and pharmaceutical industries, contract service providers are called contract research organizations. These organizations, such as Clinometrics

Duane Roth, CONNECT CEO

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Research Associates, conduct all aspects of clinical trial work from conceptualizing how clinical trials should be structured to obtaining Food and Drug Administration approval. The advantage of using contract service providers is that their infrastructure is already in place and can be used to develop multiple technologies within an industry. Using established infrastructure rather than building it in house for each new product saves money and time.

Roth further explains that once early milestones in the development process are achieved, the entrepreneur team would sell the rights to their technologies directly to venture capitalists. In the life sciences industry these sales would occur when products are through preclinical or into early clinical trials. Structuring the transactions as direct asset sales gives the original investors a reasonable timeframe to realize significant returns on their initial investments. These returns are generated by venture capitalists buying the licensed technologies for approximately what they would invest under the current model into startup companies at similar stages of development.

After the asset sale, venture capitalists would continue using contract service providers to develop technologies. No new companies would be formed to develop these technologies, which would save resources. Experts hired by or within venture capital firms would coordinate with contract service providers similar to how venture capitalists presently manage their portfolio companies.

Under the Distributed Partnering Model, once technologies reach later stages of development, the rights to these technologies will be sold from venture capital firms to typical acquirers of their portfolio companies, such as large pharmaceutical and telecommunications companies. These sales would occur in similar time frames and for approximately the same large returns venture capitalists expect under the current model.

Some potential barriers exist to adopting the Distributed Partnering Model. Under the current model, venture capitalists invest in startup companies with products. Venture capitalists may resist changing to the Distributed Partnering Model where they buy products directly and manage their development with contract service providers. The main skills of venture capitalists often lie in identifying new technologies but not necessarily in developing them. The Distributed Partnering Model’s emphasis on managing the development of products will require venture capitalists to further develop these skills and change how they currently conduct business.

An additional barrier is that as this model develops, larger companies may become more comfortable buying very early stage technologies for cheaper prices directly from the original teams of entrepreneurs. Traditionally, larger companies are risk averse and look for well-established, later-stage technologies to acquire. However, if these companies determine acquiring technologies at earlier stages is beneficial, they can skip over deals with venture capitalists. Such transactions would limit the number of venture capital firms and increase resistance to adopting the Distributed Partnering Model.

CONCLUSION
According to the National Venture Capital Association, 90 percent of venture capitalists believe their industry will contract over the next five years. Evidence of this contraction is clear in the fundraising trend and number of new funds raised in 2009. This year saw a 47 percent decline in fundraising from the previous year and had the fewest new funds raised since 1993.

Contraction of the venture industry will pressure it to become more efficient. This pressure will likely encourage the growth of secondary private equity investments and changes mirroring those described in the Distributed Partnering Model. Regardless of these changes, venture capital is expected to remain the fuel that drives economic growth. By advancing new technologies that push forward the development of entire industries, it will continue to create jobs and ensure economic prosperity for California and the United States.

ENDNOTES

John Douglas, M.D. (’09) is a psychiatry resident at Emory University with experience working in venture capital for Burrill & Company. He earned his bachelor’s degree in microbiology and molecular genetics at UCLA, a master’s degree in physiology and biophysics at Georgetown University and a medical degree at Georgetown University.

Marc Hermmsmeyer (’09) is a co-founder and principal at Opteris, a private equity firm. He has over 10 years of consulting experience advising startups and entrepreneurs in the high-tech and information technology services industry on corporate strategic development and business growth initiatives.
Innovation in the financing of renewable energy installations for residential and commercial property has lowered the hurdles facing property owners considering adopting solar energy. Long-term financing choices involving fiscal incentives not only make it cheaper for property owners to access solar-generated electricity, but offer more than one way to "go solar." When presented with clear, customized, cost-benefit analyses of the tradeoffs of alternative energy installations, the rate of adoption of solar-energy systems by property owners will increase.

More rapid adoption of renewable energy will provide a number of economic, environmental and societal benefits, such as new job creation, steeper reductions in carbon dioxide emissions and reduced dependence on distant energy sources. In fact, installation of solar panels and improvements in energy efficiency within a structure can reduce electricity bills by 30 percent to 60 percent. Despite these benefits, most property owners in Southern California hesitate to adopt sun-generated electricity. Some barriers include a lack of clear information, the high up-front cost and the long payback period.

EXPLORING THE BENEFITS
Perhaps the most compelling long-term reason for going solar is to fight global warming. Unlike coal-fired plants that produce toxic emissions and hydro-electric plants that disrupt the natural flow of water in rivers, the conversion of sunlight to electricity involves no operating pollution. Unlike some forms of energy, solar power is available the world over. Most other sources of energy production such as oil, nuclear and crop-based ethanol can lead to disputes between countries. Widespread adoption of solar energy can reduce conflict between nations over natural resources.

The adoption of solar-generated electricity will spur creation of more new jobs than the number of jobs lost by workers displaced from existing coal, oil and natural gas industries. According to an article in the journal Energy Policy, job creation from renewable energy sectors will exceed job losses by over 4 million full-time-equivalent job-years by 2030.

BARRIERS TO ACTION
One barrier to solar energy adoption is a lack of knowledge about the resource. Education of adults, teens and kids through Web sites, the media and demonstrations can mitigate this barrier.
To make a decision to spend $20,000 to $30,000 on a residential solar power system, a property owner needs a customized property evaluation and reliable information on costs and benefits. Conversations with solar-empowered community members are also helpful. This service is provided by organizations such as One Block Off the Grid, which forms groups of buyers to achieve economies of scale before contracting with suppliers for solar system installation.

Lack of capital for up-front costs, the long payback period and uncertainty with respect to energy savings are additional barriers. Many property owners do not know how long they will stay in their property or are unclear how long it will take for their energy savings to pay for their upfront investment. Hence, they may prefer other investments that project a higher or more immediate return.

FROM OBSTACLES TO SOLUTIONS

Property owners can lower hurdles of investing in solar-generated electricity through innovative finance options. Residential or commercial property owners who do not have the money to invest in a solar energy system can lease it. Go Solar is one of the first companies in California to provide the option of leasing solar panels and using the electricity generated at no additional charge. Customers pay a monthly leasing bill and enjoy a reduced gas and electricity bill. SunRun offers a contract in which the customers agree to pay a fixed rate for electricity produced by company-owned solar panels installed on the customers’ property.

Another option is financing through a municipal bond. With the BerkeleyFIRST Program, a home owner borrows money from the city’s Sustainable Energy Financing District to procure and install a solar energy system. Property owners pay the total cost over 20 years through a lien on their tax bill. Program participants and solar installers share the rebates and incentives associated with the system’s cost. The program solves the problem of the high up-front cost and long payback period. Once the property is sold or acquired, the remaining tax obligation will transfer to the new owners. Additionally, a large portion of the repayments are tax deductible.

In another financing model, property owners lease roof space to an energy company that pays the upfront cost of installing solar panels. New digital residential electricity “smart meters” being installed by utilities, such as San Diego Gas & Electric, can track the surplus electricity generated by property owners. Surplus electricity could be sold back to the utilities or to the energy companies.

UTILITY-OWNED VS. CONSUMER-OWNED SYSTEMS

San Diego Gas & Electric is building the Sunrise Powerlink, a 120-mile high-voltage transmission line that will carry solar energy from the Imperial Valley to San Diego County. In this program, solar farms in deserts will capture the sun’s thermal energy. These large installations with rows of mirrors will use the heat captured to generate electricity. The electricity will then be transmitted to the consumer via the Sunrise Powerlink.

High-voltage transmission lines entail costs associated with towers and transformers. Storms and earthquakes can damage the lines and cause loss of service. In contrast, photo-voltaic systems on rooftops are quiet, durable and can withstand years of exposure to all types of weather.

For property owners in sunny locales, such as Southern California, the decision to tap the sun’s energy locally versus remotely is a complex and politicized issue, which deserves careful analysis involving short- and long-term costs and benefits.

THE GROWING COMPETITIVENESS OF SOLAR POWER

According to the International Energy Agency, in 2030 the world demand for energy will be 40 percent higher, and approximately 1.3 billion people will not have access to electricity. This challenge can be addressed through a renewable, local, abundant energy source such as solar power.

Case study: Property owner with average electricity bill of $200/month

<table>
<thead>
<tr>
<th>Benefits of a Solar Power System (25-year expected life)</th>
<th>Utility savings during first year</th>
<th>$1,200 – $2,778</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average monthly utility savings</td>
<td>$168 – $389</td>
<td></td>
</tr>
<tr>
<td>Utility savings over life of system</td>
<td>$50,354 – $116,560</td>
<td></td>
</tr>
<tr>
<td>System energy cost</td>
<td>14 cents per kW-h</td>
<td></td>
</tr>
<tr>
<td>Appreciation in property value</td>
<td>$24,000 – $55,556</td>
<td></td>
</tr>
<tr>
<td>Return on investment</td>
<td>22 percent</td>
<td></td>
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<tr>
<td>Internal rate of return</td>
<td>9.5 percent – 26.1 percent</td>
<td></td>
</tr>
<tr>
<td>Net present value</td>
<td>$14,187 – $68,165</td>
<td></td>
</tr>
<tr>
<td>Greenhouse gas emissions (CO₂) saved</td>
<td>138 tons</td>
<td></td>
</tr>
</tbody>
</table>

Case study: Property owner with average electricity bill of $200/month
Electricity costs from fossil fuels have risen 3 percent to 5 percent per year for the past decade. In contrast, the cost of solar panels has fallen 20 percent for every doubling of the installed base of solar panels. This cost reduction results from economies of scale and technology advancement in the production of solar panels. According to Harry Fleming, the CEO of Acro Energy Technologies, “A typical 5kW rooftop solar system has dropped from $22,000 after state incentives are applied ($40,000 without them) to $16,000 in the last 18 months. Prices are expected to fall to $13,000 by the end of the year ($25,000 without incentives).” If this trend continues, grid parity, the point when the cost of solar-generated electricity is on par with the cost of conventionally-generated electricity, will soon be reached. This is anticipated to be in the 2013 to 2015 timeframe for California, according to an article in *MIT Technology Review*.  

With a vast amount of money invested in seeking innovative technology to make solar more affordable, a significant proportion of solar panel production moved to countries with low labor costs. The installation cost of solar panels has been substantially reduced due to increased federal and state incentives.

According to Paul Linden, a professor of environmental science and engineering and chair of the Department of Mechanical and Aerospace Engineering at UC San Diego, in the near future, solar energy systems will pay for themselves. In fact, the increase in the conversion efficiency of rooftop panels will enable more solar panel owners to produce a surplus. Legislation is needed to enable home owners to sell electricity to the grid for a profit, like a utility. For instance, an enterprising home owner could sell surplus electricity to neighbors or to electric vehicle owners.

The sun’s light and warmth have been nature’s way of sustaining life for millions of years. We are hopeful solar energy will lead mankind toward sustainable, peaceful living for millions of years to come.  

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**ENDNOTES**


3 Max Wei, Shana Patadia, Daniel M. Kammen. “Putting renewable and energy efficiency to work: How many jobs can the clean energy industry generate in the US?” *Energy Policy* 38.2 (2010): 919-931. Print


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**Trang T. Nguyen** (’10) earned her bachelor of science in financial services and corporate finance from San Francisco State University, where she graduated with honors and received the Departmental Honoree Award in finance. Nguyen, who was born in Vietnam, serves as president of the Asian Business Association at Rady School of Management and is a teaching assistant for the FlexMBA corporate finance class and intermediate accounting.

**Michael D. Alston**, Ph.D. (’10) earned a doctorate in electrical engineering from UC San Diego. He has worked in San Diego since 1983 for several high-technology companies beginning with M/A-COM Linkabit and is now a microchip designer at Rapid Bridge LLC.
After a decade driven by the work of a small group of early-stage companies and visionaries within the health care and telecommunications worlds, wireless health exploded into mainstream consciousness in 2009. Despite the rapid increase in awareness of its value, proliferation of supporting technology and industry optimism about the potential market, significant challenges stand in the way of widespread adoption. Wireless technology can enable dramatic change in the way health care is delivered, but health care providers, hospitals, payers, regulatory agencies and most importantly, patients themselves must be willing to use the technology and pay for its implementation.

**WHAT IS WIRELESS HEALTH?**

Wireless health can be broadly defined as any health care application or service that uses wireless communication to gather and transmit health information. Wireless health is enabled by cellular and wireless Internet technologies and an increasing array of body-worn and implanted sensors that communicate with a “body area network” via low-power radios. Wireless health applications range from enterprise-level patient monitoring and asset tracking systems in hospitals, to remote patient monitoring and disease management solutions for the chronically ill, to consumer health and fitness products. The term can also refer to the infrastructure and devices that support these applications.

In their simplest form, wireless health companies offer services that leverage existing, commoditized technology to address serious health care problems. An estimated one-third to one-half of patients in the U.S. do not take their medication as prescribed, often leading to worsening health and hospitalization costing an estimated $290 billion a year. A number of clinical trials found simple, automated text messaging services such as CareSpeak’s MediM, which send messages to the user’s cell phone, can significantly improve adherence to medication regimens and dramatically improve health outcomes.

At the other end of the spectrum are new wireless technologies, such as Proteus Biomedical’s Raisin System. Currently in clinical development, the system uses pills embedded with tiny sensors which, as they pass through the digestive system, react with stomach acids and send a low-power radio signal to a body-worn device. Timing of the event and physiological changes, such as heart rate and respiratory rate, are
recorded. The technology allows physicians to monitor compliance, as well as examine the need for dose adjustments based on a patient's unique reaction to the medication.

THE PROMISE OF WIRELESS HEALTH

Wireless health solutions promise to improve the quality, efficiency and continuity of care while lowering costs and extending access to health care outside the clinical setting. In developed nations such as the U.S., a major driver of interest in wireless health is the push toward preventive care. Focus is turning to developing systems that target high-risk groups and the chronically ill through wellness programs and remote monitoring systems. With more than half of Americans suffering from one or more chronic diseases, making up an estimated 75 percent of annual health care spending, there is plenty of demand for new modes of care.

In developing nations, where access to medical care is often severely limited, the low cost and growing ubiquity of cellular networks allows health care practitioners to provide remote advice to patients who are unable to reach clinics. The mHealth foundation expects that by 2012, more than half the population of the developing world will have a mobile phone. Less than one percent will have access to a hospital. Basic care, such as medication reminders and information about managing disease, can be delivered by text message at very low cost. Nurses and public health workers in rural areas can collect information from patients using wireless devices such as GE's new low-cost, portable Vscan ultrasound, and then send that information to more experienced medical staff in other locations to get advice on how to treat patients. In fact, with fewer regulatory barriers and more incentive to expand their health care systems, the developing world is moving faster than the U.S. to implement wireless health solutions.

WHERE IS WIRELESS HEALTH TODAY?

While the proliferation of mobile connectivity and advances in sensor and low-power radio technology provide for the possibility of constant, real-time monitoring of health conditions and feedback about their management, it will be many years before the vision of wireless health can be reached. Several challenges stand in the way.

CHOOSING THE CORRECT TECHNOLOGY

Companies in the wireless health space face decisions surrounding the technologies they should incorporate into their systems. Although organizations such as the Continua Health Alliance have brought industry members across the world together to work on interoperability guidelines, the diverse and evolving technology has made consensus difficult, an issue that is often cited by investors as a reason to defer entry into the space.

Hospital-based systems and home health solutions typically use Wi-Fi, while solutions that are intended to be carried with users at all times use cellular. Companies that want to take advantage of cellular connectivity must decide whether to design an application that will work with the user's own cell phone or develop a proprietary mobile device. With four major carriers and nearly 900 handset models on the market in the U.S. alone, it is challenging to develop a one-size application. On the other hand, if a company decides to develop its own device, they not only face the challenges of designing and building it, but also resistance to adoption from users who are reluctant to carry an additional piece of equipment. Companies that use sensors to collect information must also decide which low-power radios, such as Bluetooth Low Energy or ANT, their sensors will use to transmit data.

REGULATORY AND PRIVACY ISSUES

Both the Food and Drug Administration (FDA) and the Federal Communications Commission (FCC) have jurisdiction over aspects of wireless health solutions, complicating the approval process. There are also many unresolved questions regarding which parts of a wireless health application or device will require FDA approval. If an application provides wellness advice based on information downloaded from a wireless blood-glucose meter to an iPhone, does the application need approval by the FDA? What about the iPhone itself? FDA officials hint they may seek authority to regulate smart phones used in wireless medical device solutions.

COST AND REIMBURSEMENT

The U.S. health care system is slow to adopt new technologies, and success for many health care products is predicated on the ability to gain reimbursement codes. CardioNet, the first public pure-play wireless health company, is a prime example of this pitfall. The company's Mobile Cardiac Outpatient Telemetry (MCOT) system is three times more effective in diagnosing arrhythmias than traditional Holter monitors, thus dramatically improving patient care and reducing the costs associated with incorrect diagnosis. Despite this, in September 2009, Highmark Medicare Services slashed reimbursement for CardioNet and other MCOT services by nearly 35 percent. The change in reimbursement sent the company's stock tumbling, and CEO Randy Thurman has since said CardioNet is "unable to sustain operations" as a standalone company.

Fortunately, the growing pressure to incentivize outcomes-based medicine is expected to work in favor of wireless health solutions. Although many of these products cost more to develop and implement than traditional alternatives, improvements in long-term outcomes are expected to provide dramatic savings in the future. Solutions such as WellDoc's Mobile Diabetes Management program are being implemented by insurance providers and employer health plans in hopes that improving monitoring and feedback early on will slow the progression of costly chronic diseases. Clinical results are promising. Other solutions in development will tackle problems such as high re-hospitalization rates—an issue which accounts for an estimated 17 percent of Medicare spending. Remote monitoring using "smart band-aids" that can recognize changes in fluid levels around the heart, or shoe sensors that recognize changes in gait and blood flow to feet, will help monitor known issues and identify new problems before acute events occur.

Hospitals and clinics are also recognizing the benefits of wireless health solutions. Radio-frequency identification (RFID) and wireless bar-coding solutions like PatientSafe Solutions' PatientTouch System enhance patient safety by ensuring health care workers have correct information about a patient at their fingertips and can provide appropriate medication, care and follow-up. Remote presence systems such as InTouch Health's iRobots allow doctors to "visit" patients in multiple hospitals without spending travel time. And remote mon-
Wireless health solutions don’t require smart phones—even the most basic cell phone can be a lifesaving device. The World Health Organization estimates that 15 to 30 percent of drugs on the market worldwide are counterfeit, with much higher rates of fakes in parts of the developing world where regulatory oversight is lacking. The quality of fakes is so high that even medical personnel are unable to tell whether they are providing their patients with real medication or a fake that will make them more ill.

PharmaSecure aims to solve this problem in the developing world by deploying a text-messaging based anti-counterfeit solution. The company is currently deploying their system in India, the fastest growing telecom market, where cell phones are beginning to reach even the most rural and poor areas of the country and where counterfeiting is rampant. Drug manufacturers partner with PharmaSecure to label their medicine packets with a unique code. Customers who purchase the drug can then text message that code to the PharmaSecure number and receive a response that authenticates the medication and provides expiration dates and other information. The system benefits both the pharmaceutical companies, who currently lose an estimated $75 billion a year in sales to counterfeits, and the customers, who know that the drugs they are taking are safe and effective.

Despite the challenges to implementation and adoption, the potential benefits of wireless health are overwhelming, and it is clear the market is responding. Reports of investments in the space climbed dramatically in 2009, a trend which is expected to continue this year. Industry analysts expect 2010 to see a doubling of the worldwide无线 health market, up to an estimated $50 billion. Meanwhile, governments and global health organizations are showing more interest in supporting growth in wireless health. The changes we will see in 2010 will pave the path toward a future in which wireless health is no longer a separate industry, but an integral part of the mainstream health care system.

**ENDNOTES**


**Andrea Jackson** (’08) is program manager at the Wireless-Life Sciences Alliance, a trade organization dedicated to accelerating the adoption of wireless health. Previously, she was marketing manager for the Lifecomm project in Qualcomm’s Health and Life Sciences group.
Last year was considered the breakout year for wireless and mobile health, also known as “mHealth.” On Feb. 17, 2009, the Obama administration announced plans to incentivize health care providers with nearly $23 billion in grants to implement health information technology (IT) systems.1 There are now over 10,000 medical applications for the iPhone, BlackBerry, Palm, Android and Nokia devices. According to McKinsey & Company, global mHealth market opportunities are estimated to be $50 billion in 2010. The CTIA, a wireless trade organization, expects the industry to grow at nearly 100 percent per year over the next three years. Michael O’Hara, CEO of GSMA, estimates managing chronic diseases with mHealth would save $175 billion to $200 billion globally and $21 billion in the U.S. alone. Sprint CEO Dan Hesse stated, “If I had to pick the one industry facing the biggest gap between need for change and use of wireless to facilitate that change, it would be health care.”

The following interview highlights the “20/10 Vision” insights of three San Diego mobile health leaders: the iconic Dr. Eric J. Topol, startup guru Darrel Drinan and industry catalyst Paul Sonnier.

What is wireless health?
ET: Wireless health encompasses a broad range of sensors and gadgets designed to prevent, diagnose and monitor health conditions, manage treatment and enable timely communication and intervention. A new era of consumer-driven health care — from my perspective, we’re entering the most exciting phase of innovation in medicine to date.

What area of health care will mobile health benefit the most?
ET: The entire continuum of care, across the ages, from preemies to seniors, across the world. Every segment will reap benefits. We’ll see a tremendous impact on chronic care and disease management through remote monitoring, imaging and compliance. Not too far in the future, we will be able to look at a person’s genetic susceptibility for cancer or obesity, make early use of wireless sensors to monitor them in an appropriate, non-invasive way and be out in front of the development of such conditions.

DD: Two market channels could benefit: quality of life, or health maintenance applications and chronic disease applications. Today the largest opportunity in terms of health care expenditures is in the chronic disease market. Most chronic disease expenditures today are on the acute manifestations from underlying disease and most industry experts feel this market channel will achieve the highest growth in the near term. This is said with one caveat; if someone effectively creates a killer application for quality of life that achieves widespread Facebook-like adoption, it may tip the opportunity scales away from chronic disease care to managing and maintaining a person’s health.

Is the iPad, Apple’s new mobile tablet device, a step in the right direction?
PS: The iPad, in its current iteration, doesn’t seem to be a game-changer. It’s not really suited for the hospital environment and doesn’t offer any significant advantages to existing tablets currently being used in hospitals. However, if some key features are added and it becomes ubiquitous, like the iPhone, this outlook could change. Some of the shortfalls include: size (it doesn’t fit into a pocket like an iPhone does), not ruggedized, an inability to run multiple apps concurrently, no camera, no barcode reader, not sanitizable, no radio frequency tag sensor and a non-swappable battery.
Is the current data transfer speed a limiting factor to wireless health?
DD: For the acute care setting, such as transferring electrocardiograms, electroencephalographs or imaging, spectrum and transfer capacity and speed will be challenging, but not for the majority of care for stable chronic disease or healthy patients. However, the wireless spectrum will be challenged when a large number of users send small amounts of data, while the spectrum is shared with other non-health data applications on smart phones, in densely populated urban areas. I recently made a presentation to the chairman of the Federal Communications Commission and suggested they allow joint use of the D Block spectrum\(^2\) for health care and first responder applications. It would be a tragedy if a patient’s critical health data were delayed because someone was watching a YouTube video on their iPhone.

What major hurdles exist for wireless health?
ET: Changing medical practice is one of the most difficult things to do. We will need to prove that wireless health will not only save lives, but cost less. In addition to that overarching challenge, we will need to work together as an industry to overcome regulatory, reimbursement and legislative barriers. Enlightened policies are desperately needed to change outdated, inefficient models of health care delivery.

How can wireless health reduce health care expenditures?
ET: One example: remote monitoring. Between 2003 and 2007, the Veteran’s Affairs conducted the largest study ever in this area, tracking 17,000 veterans with chronic conditions who used technology solutions to manage their health at home. The study demonstrated dramatic results, including a 19 percent reduction in hospital admissions. Additional findings in 2008 showed remote monitoring decreased hospital visits even more dramatically: 20 percent for diabetes patients and 56 percent for patients with depression.\(^3\) Health care costs associated with one or more chronic diseases amounted to about $1.7 trillion or 75 percent of total health spending in the U.S. in 2009, so you can see we have a remarkable opportunity to help redress this crisis.\(^4\) One of the main functions of the West Wireless Health Institute\(^5\) will be to validate wireless health technologies and help show the potential for cutting costs and eliminating the excessive waste in health care.

Are you currently using a mobile health device to improve your personal health?
ET: Zeo’s Sleep Coach, which captures brain wave data via a headband. Wireless sensors inside the headband relay the data to what looks like an alarm clock, but instead shows a real-time minute-by-minute display of the various stages of sleep. When I wake up in the morning, I know how much time I spent in deep, rapid eye movement sleep, light sleep, when I’m waking up and other events. During a keynote address at the Consumer Electronics Show in January, I also conducted the first live demonstration of GE’s Vscan, an ultra-portable handheld ultrasound. When I was up on stage, I used the device to show a picture of my heart beating in real time. As a cardiologist, this was fascinating and I believe people are going to be doing their own echocardiograms and sending them to their doctors in the not-too-distant future.

What will be the biggest wireless health breakthrough in 2010?
DD: I currently use a Garmin 305 heart monitor when I run, and it wirelessly transmits heart rate and calorie consumption data to the watch which then can be downloaded via USB to my computer where I keep track of my runs.

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What we’re seeing is an evolution in the consumer-driven use of wireless sensors in preventative health and wellness. Consider the 1.2 million runners who use the Nike+ sensor in their shoe to track how many miles they’ve run and calories they’ve burned. Or the 10,000-plus health-related software applications for the iPhone. These products are the forerunners of breakthrough technologies coming this year and over the next decade.

DD: Remote care, the opportunity of practicing medicine from afar, is probably one of the emerging transitions this year. Major companies such as GE and Intel have finally acknowledged this is a growth market, and are shifting large amounts of R&D dollars into low-cost, mobile remote health care development programs.

PS: The home health monitoring segment as a whole seems to have garnered the most attention. Parks Associates forecast that the U.S. market and sales of wireless home-health technology (home-based health care applications and services) will grow from $304 million in 2009 to $4.4 billion in 2013; a five-year cumulative annual growth rate of over 180 percent.

Is there a specific topic or question commonly left out of the wireless health discussions in media that you would like to address?

PS: I think the topic of wireless health itself is conspicuously absent from the popular media. This is changing, but there is a lot more visibility that needs to be achieved so that the general public, policymakers, and the fragmented system of health care payers are all more aware of the unique benefits of wireless-enabled health devices, which can help our nation achieve the seemingly paradoxical goal of reducing costs while enhancing patient care and improving our general health.

Eric J. Topol, M.D. is vice chairman of the board of directors and chief innovation officer of the West Wireless Health Institute, director and professor at the Scripps Translational Science Institute, chief academic officer and holder of the Gary and Mary West Chair of Innovative Medicine at Scripps Health, a senior consultant cardiologist at Scripps Clinic, and a member of the board of directors of Sotera Wireless. His work in the genomics of heart attack led to the discovery of key genes, which were recognized as American Heart Association Top 10 research advances in 2002 and 2004.

Darrel Drinan is the co-founder and CEO of PhiloMetron, a medical technology accelerator in San Diego that is developing novel therapeutic solutions for chronic disease and quality-of-life conditions. Prior to co-founding PhiloMetron, Drinan was the director of new program management for Braun ThermoScan, a $2 billion subsidiary of the Gillette Company. He led the new consumer medical products development activities for Braun, including research in wireless, non-invasive, medical sensing applications markets.

Paul Sonnier, MBA is the founder of the Wireless Health group on LinkedIn. The group advances knowledge and relationships between professionals interested in the convergence of wireless technology with the continuum of consumer-health applications and clinical health care. Sonnier is also co-chair of a health care communications group at CommNexus San Diego and managing director at Wireless Health Strategies, an executive management consultancy.

Brad M. Pruitt, M.D. (’11) is involved with the Executive Mentor and Vistage programs and serves as vice president of the Life Science & Health Care Club. Pruitt received his medical degree at Michigan State University – College of Human Medicine in 2007.

ENDNOTES
2 In 2008, more than a thousand regional licenses in the 700 MHz spectrum were won at government-held auction. Nobody bid the $1.3 billion minimum for the D blocks (788MHz, UHF 67)
4 Almanac of Chronic Disease. Partnership to Fight Chronic Disease, 2009. Web. 10 May 2010
5 Founded in March 2009 by the Gary and Mary West Foundation, the independent nonprofit West Wireless Health Institute is dedicated to innovating, validating, advocating for and investing in the use of wireless technologies to transform medicine. The Institute’s primary mission is to cut health care costs by accelerating the availability of wireless medical technology
Among the high-profile approaches addressing the need for large-scale renewable energy resources, biofuels have attracted significant attention. The enthusiasm of policymakers and investors for first-generation biofuels from crops such as ethanol from corn and biodiesel from soybeans waned after peaking in 2006 and 2007. However, increased media and investor attention is now being paid to technologies and companies involved in the development of advanced biofuels. Those technologies include cellulosic ethanol, as well as biofuels based on renewable, non-cellulosic feedstocks such as algae.

Many advanced biofuel production processes are out of the discovery research stage. They are now evolving to optimize the economic metrics of small-scale or unit-level production and expansion to large-scale production. Both of these are risk reduction prerequisites to render any advanced biofuels process suitable to traditional project finance and widespread deployment. However, several strategies may accelerate the successful deployment of advanced biofuels.

This article addresses strategies for optimal product mix and the two main business models of advanced biofuel developers.
PRODUCT MIX CONSIDERATIONS

Cellulosic ethanol and algae companies should recognize the strategic value in developing biorefineries. Rather than make a single product, biorefineries would produce a flexible mix of complementary products. They would optimize cash flows by balancing the revenues from different products against the associated feedstock and processing costs.

For example, cellulosic ethanol companies could convert cheap, mixed sugars into ethanol when ethanol maximized cash flows. In response to changing commodity cycle dynamics, they would be able to shift to bio-based plastics or other bio-based products. This flexibility allows the companies to exploit long-term fluctuations in supply and demand. Building in these strategic options would entail additional up-front and periodic costs. It might mean additional expense in the design and construction of pre-treatment tanks for cellulosic ethanol processes or in developing additional production strains. Companies that fail to recognize this opportunity and weigh the costs and benefits appropriately cede a significant competitive advantage.

The majority of algae-based biofuel companies face a more interesting product mix optimization situation. Typically, only 20 to 40 percent of the total biomass from photosynthetic algae is comprised of lipids, or oils, that can be converted into biofuels such as biodiesel. The rest is mostly proteins and carbohydrates. Algae companies face two key product mix strategy decisions: finding the optimal product mix given a specific commercial production strain and selecting optimal commercial production strains from competing candidates.

Conceivably, the value of the whole algae biomass for a non-biofuel application may be worth more than the sum of the parts, depending on existing market prices and marginal operating expenses associated with extracting and purifying one or more component. In this event, production would simply skip the downstream process. Conversely, a high price for one or more of the extracted components could make the parts worth more than the whole. A flexibly designed and staffed facility could switch and run the more complete process with the appropriate strain.

In addition, product mix considerations are relevant even when an algae company is committed to extracting lipids. Here, the algae company is focused on the quantity and qualities of the lipids produced. However, the large percentage and volumes of residual proteins and carbohydrates render these components neither waste products nor by-products. Instead, they are co-products that can have equal or greater value than the lipids themselves. Production strain selection criteria even prior to commercialization need to take into account the required co-product specifications. They are a function of the requirements a customer or collaborator will specify in the offtake agreement.

The licensing business model involves the license of rights to use technology from a biofuel technology developer to one or more commercial facility developers. Key issues involved here include licensee selection, exclusive versus non-exclusive rights, territorial restrictions, product or field restrictions, diligence obligations, and economic terms. However, there is an even more fundamental question advanced biofuel developers must ask themselves. What is the earliest stage of development at which a licensing program is optimal? And what does this imply in terms of obtaining value from licensees in the form of favorable economic terms, as well as the quantum of materials, information, intellectual property, and standard operating procedures that would be necessary for a licensee to successfully deploy the technologies? There already exists a classic positive correlation between the level of investment and risk taken on by the technology developer and the value attained in a licensing package. An additional consideration is that the technology may be viewed as unfinished until it clears the demonstration-scale phase. One would expect to see relatively few willing licensees prior to this. Moreover, hearkening to Groucho Marx’s line about not wanting to be a member of any country club
that would have him, biofuel developers should be wary of taking on licensees prior to success at demonstration-scale.

If they do so, there should be well-defined diligence obligations to ensure adequate investment by the licensee and coordination with the developer. Should a licensee fail for reasons having something or even nothing to do with the technology, it may cast a pall over the developer's technology or other licensees. This could impede other project development initiatives.

There are examples of licenses being made at early stages of development such as the laboratory or pilot plant stage. For instance, Celunol, now Verenium, granted a geographically limited license to Marubeni prior to construction of a cellulose ethanol demonstration facility. However, it seems likely most licensing business models will instead follow the example set by DuPont Danisco Cellulosic Ethanol (DDCE). DDCE's strategy is to develop and license a robust, "turnkey package for an advanced biorefinery." The centerpiece of their approach is first to demonstrate the technical and economic metrics of large-scale cellulose ethanol production in a $50 million, 250,000-gallon-per-year demonstration facility in Tennessee.

OWN-AND-OPERATE BUSINESS MODEL

The own-and-operate business model involves the technology developer attracting the human and financial capital to build and operate one or more commercial biofuel facilities in which the technology will be deployed. One would expect the corporate structure to follow traditional project finance norms. Accordingly, each facility would be developed by a special-purpose entity (SPE). The SPE would own and operate the facility as its sole function. The technology developer would own equity in each SPE based on financing arrangements.

The financing constraint has outsized importance in the current economic environment. To attract private equity to fund a first commercial facility, advanced biofuel owners and operators must consider the valuation of the associated SPE, the amount of equity they can retain, and the rights given to financiers for participation in subsequent rounds of financing.

A developer should be able to receive a share of the cash flows of the SPE commensurate with the equity the developer owns. In addition, the developer has the option to structure the SPE to provide for up-front or periodic cash flows for license fees, management fees, and royalties on product sales. These latter types of arrangements look like the cash flows of a licensing business model. They would not make sense for 100 percent owned SPEs, but would make sense for partially-owned SPEs. However, there is a consequence of a greater number and amount of licensing-like cash flows coming from the SPE to the developer. The private equity financier may commensurately reduce the valuation of the SPE for purposes of the negotiated equity the developer will be allowed to retain. This wouldn't be the end of the world for the developer. Arguably, the minimum amount of equity the advanced biofuel developer should own in the first commercial facility is zero — meaning the most important aspect of the first commercial facility is not its cash flows or economic value per se. The greater benefit is the strategic value of removing the risk at commercial scale that a successful commercial facility provides.

Regarding who should own how much equity in a given SPE, non-dilutive financing of a first commercial facility with government grants can present several complications. This type of financing can provide a downside protection or magnified returns to equity investors. However, the question is whether the biofuel developer gets ownership of the equity in the grant versus the investors, or whether ownership is shared. Within the advanced biofuel industry, this remains to be seen, as the initial set of private equity commercial project financing has not yet occurred.

Licensing and own-and-operate business models are not mutually exclusive. An owner-operator can decide to limit its model geographically. It could then pursue a licensing model elsewhere. Similarly, a company pursuing a licensing model can decide to shift to an own-and-operate model.

The commercialization of advanced biofuels has reached the crucial point of late-stage, pre-commercial development. Going forward, the foundation laid by key strategies will define the success or failure of the initial commercializations. All developers will need to build optimal product mix strategies to be successful. And with both business models, a focus on the optimal strategy to facilitate the first commercialization is essential. If advanced biofuel developers do both, they can accelerate the successful development of their first commercial facilities. At that point, advanced biofuels will have justified the current high levels of enthusiasm.

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