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Quarterly Publication of the Engineers' Society of Western Pennsylvania

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Guest Editor Column

Smart Technologies in Future Lifestyles:

Pittsburgh is Playing a Central Role

By: Audrey Russo

When I think about the rapid change that has occurred in the last 10 years in how we live, work, and access and consume information, it is impossible to predict the next 10. However, I am certain that technology will continue to impact how we live, work and use information. We exist in a time of major disruption and transformation — a time of great excitement and, for many, a very disturbing time. The way we learn, absorb information, communicate and experience life no longer follows the road map defined by the industrial age that we have leveraged for the past 100 years. As the CEO of the Pittsburgh Technology Council, it's not hard to guess why I was ecstatic for the opportunity to serve as the guest editor for this edition of *Pittsburgh ENGINEER* Magazine, focused on the impact smart technologies will have on our current and emerging lifestyles.

My role at the Council affords me the privilege of working with many of the technology companies and entrepreneurs that are creating technologies with the potential to revolutionize (and in some cases, explode) whole industries in the future. As a region, southwestern Pennsylvania has an incredibly rich array of technology-based competencies that will play a large role for generations to come. Data from the Council's most recent State of the Industry report accurately reflects the major role technology companies play in the overall economic vitality of our region.

"The 8,438 technology firms tallied in the year 2007 represent more than 11.2 percent of all companies in the region. These firms employ more than 248,000 individuals and account for 19.4 percent of the area's overall workforce. The \$14.5 billion total annual payroll of technology and related companies represents more than 27.5 percent of the region's wages."

If you would like to learn more about the specific technology sectors in Pittsburgh that are contributing to the overall industry, please visit <http://www.pghtech.org/news-and-publications/state-of-industry-report.aspx>

I can't think of a better place to be in 2010 than in Pittsburgh. Everyday, innovative technology companies in our region make breakthroughs that are effectively changing our lives for the better either through efficiency, breakthrough solutions or elimination of debilitating lifestyles that impede independence. At the Pittsburgh Technology Council, we work very closely with many of the companies that are commercializing technologies capable of redefining industries. Our member companies rely on us to provide the resources and the connections that they need to grow.

We provide value across four distinct service platforms:

- Business Development

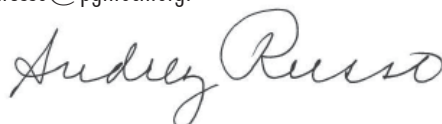
- Government Relations
- Talent Attraction
- Visibility

In fulfilling our mission — to help regional technology companies succeed — I am confident that we too, are helping to mold future lifestyles.

I am thrilled to connect the readers of *Pittsburgh ENGINEER* Magazine to companies we have lined up for this issue.

- The Quality of Life Technology Center illustrates how Carnegie Mellon University and the University of Pittsburgh are collaborating to create technologies that assist people with a range of disabilities to live more independent, richer lives.
- Dr. Alan Brown from the Pennsylvania NanoMaterials Center focuses on how local companies are integrating next-generation nanotechnology into everyday products.
- Mickey McManus of the design consultancy and technology research lab, MAYA Design, explains the value of truly being interdisciplinary.
- Carnegie Mellon's Robotics Institute is a world-leader in developing unprecedented robotics breakthroughs. The head of the NanoRobotics Department, Metin Sitti, describes one way nanorobotics will affect our future lives.
- Mickey Miller updates the usefulness of cell phones in today's world.

After you read these articles, it will be clear that the future is very bright as technology and engineering are spearheading the next generation of life-altering innovation. Pittsburgh-based companies are playing major roles in developing technology that will define our daily lives for years to come. If you are interested in learning more about any of the companies mentioned above or Pittsburgh's technology community in general, feel free to email me at arusso@pghtech.org.



Audrey Russo is President and CEO, Pittsburgh Technology Council. Learn more about the Council at www.pghtech.org.

1. From the Pittsburgh Technology Council's State of the Industry Report, published September 2009



Audrey Russo

Pennsylvania NanoMaterials Commercialization Center Portfolio Companies

Assembled by Jonathan Kersting

Since 2007, the Pennsylvania NanoMaterials Commercialization Center has supported 21 projects to develop early stage prototype products using nanotechnology. The following summarizes the most active projects and provides an overview of each company and technology along with contact information.

Pennsylvania NanoMaterials Commercialization Center Portfolio Companies

Since 2007, the Pennsylvania NanoMaterials Commercialization Center has supported 21 projects to develop early stage prototype products using nanotechnology. The following summarizes the most active projects and provides an overview of each company and technology along with contact information.

Integran Technologies USA

In partnership with Integran Technologies USA, the Center funded the commercialization of a new nanomaterials coaxial wire technology. This novel wire technology will increase the durability of lightweight electrical wiring systems and will benefit weight reduction and energy efficiency initiatives in the transportation sector. www.integran.com

Crystalplex Corporation

The Center is supporting the commercialization of an innovative new quantum dot technology with Crystalplex Corp. This company uses these nano-sized devices to improve the efficiency, while reducing the costs of light-emitting diodes (LEDs) used in energy-saving lighting and electronic displays. www.crystalplex.com

Illuminex Corporation

Center is funding Illuminex to commercialize a novel Copper-Silicon Nanostructured Anode for the next generation of Lithium-ion Batteries, LIB. This technology will lead to higher energy density LIB's used extensively in portable electronics and will significantly benefit the development of Electric Vehicles. www.illuminex.biz

Industrial Learning Systems, Inc.

The Center is supporting Industrial Learning Systems (iLS) Inc., to develop a novel silicon wafering technology for the continuous production of nano structured solar cells. The project is based on the patented technology filed through Carnegie Mellon University (CMU) and licensed to iLS. www.ilsystems.net

NanoLambda, Inc.

The Center is funding a project with NanoLambda Inc. to develop a very low-cost fabrication process using nanoimprint lithography for an ultra-compact, low-cost spectrometer-on-a-chip sensor. The sensor will monitor the color quality of LEDs for the color consistency over time and temperature, which is one of the biggest challenges in the soon-to-explode LED markets. NanoLambda was founded in 2005 as a spin-off company of the University of Pittsburgh.

PlextronicsSM, Inc.

The PA Nano Center has supported a project with Plextronics, Inc. to develop a semi-continuous processing technique for flexible organic photovoltaic (OPV) devices which could lead to new solar cell technologies. The process uses the company's proven expertise in materials synthesis, ink formulation and OPV device fabrication, which has resulted in world record device efficiency. www.plextronics.com

Y-Carbon, Inc.

The Center is supporting the commercialization of Y-Carbon's innovative nanoporous carbon technology for supercapacitors. Y-Carbon's ground-breaking technology is based on the platform of making tunable nanoporous carbon. www.y-carbon.us

Strategic Polymer Solutions, Inc.

The Center funded SPS to develop and commercialize an advanced nano-structured polymer hybrid capacitor for implantable cardioverter defibrillators (ICD's). The novel capacitor has higher energy density, higher reliability, while reducing the cost of current ICD's, enabling a wide accessibility to millions of Americans threatened by sudden cardiac arrest. The company is a spin-off from The Pennsylvania State University with an exclusive license of the electroactive polymer technologies invented by Dr. Qiming Zhang. www.strategicpolymers.com

Arkema, Inc.

The Center is supporting Arkema Inc, in partnership with Lehigh University to develop and commercialize the company's Nanostrength® block copolymer technology for toughening epoxies in wind energy and electronic materials applications. This technology will be extremely valuable in wind energy applications where there is a demand for increased reliability of the wind blades without sacrificing strength. www.arkema-inc.com

nanoGriptech, LLC

The Center is supporting the commercialization of novel gecko foot-hairs inspired polymer fibrillar adhesives technology with nanoGriptech, LLC, a spin-off company from Carnegie Mellon University. www.nanogriptech.com

Kurt J. Lesker Company

The Center is supporting Kurt J. Lesker Company (KJLC), in partnership with Integran Technologies USA for the commercial development of nCu (high purity Copper) sputtering targets used in the fabrication of the latest generation semiconductor devices. This next generation product will be manufactured using Nanovate™ technology, a novel process technique, developed by project partner, Integran Technologies USA. www.lesker.com

ICx Technologies, Inc.

In collaboration with The Pennsylvania NanoMaterials Commercialization Center, ICx Technologies is developing a process for production of molecules that are identical to diesel fuel. This "next generation biofuel" can represent an improvement over current biofuels such as ethanol and biodiesel. ICx Technologies is a leader in the development and integration of advanced biotechnologies for commercial and government applications. www.icxt.com

The Pennsylvania State University

The Center is supporting a pre-commercialization project at Penn State University to develop and commercialize an advanced graphene-based nanocomposite for electrochemical energy storage applications such as Li-ion battery and supercapacitors. The novel graphene-based nanocomposite will have high energy density and/or high power in the energy storage devices, and it can also significantly improve electrode kinetic and cycling stability for energy storage techniques. www.psu.edu

Jonathan Kersting is Director, Visibility Initiatives at the Pittsburgh Technology Council. He may be reached at jkersting@pghtech.org.

ROBOTS FOR LIFE

Pittsburgh's Quality Of Life Technology Center Is Solving The Human-Machine Equation And Spawning A New Industry In The Process

By: Tom Imerito

"Quality of life." It's one of those stubbornly vague terms that are hard to define. For some people, having a good "quality of life" might mean getting a job that allows them to spend lots of time with family. For others, good "quality of life" might mean a certain possession, like a luxurious home.

But for someone with limited mobility—a veteran with a missing limb, a car-crash survivor, an older person with severe arthritis—having a high "quality of life" is a lot simpler. It's about getting dressed in the morning, navigating the kitchen and going to work or school.

"...hundreds of thousands of Americans every day face the prospect of becoming dependent on people or machines due to age-related illnesses or conditions"

Yet hundreds of thousands of Americans every day face the prospect of becoming dependent on people or machines due to age-related illnesses or conditions. According to the U.S. Centers for Disease Control and Prevention, about 1.5 million people reside in skilled nursing facilities, and about 88 percent of them are age 65 or older. Another 76 million Americans born during the so-called "Baby Boom" of 1946 to 1964 are starting to reach retirement age.

Conditions related to aging aren't the only thing that can make simple, everyday tasks more difficult or force someone into an assisted-living facility. About 250,000 Americans are living with spinal cord injuries, according to the National Institutes of Health, while 2.2 million veterans have a service-related injury, reports the U.S. Bureau of Labor Statistics.

It's a strange dichotomy that technologists like Jim "Oz" Osborn (E'81,'86), longtime researcher and scientist in the Robotics Institute, have watched with frustration. At the same time that computers were making the world smaller and robots were exploring other planets, millions of other people were watching their lives shrink to just one small room.

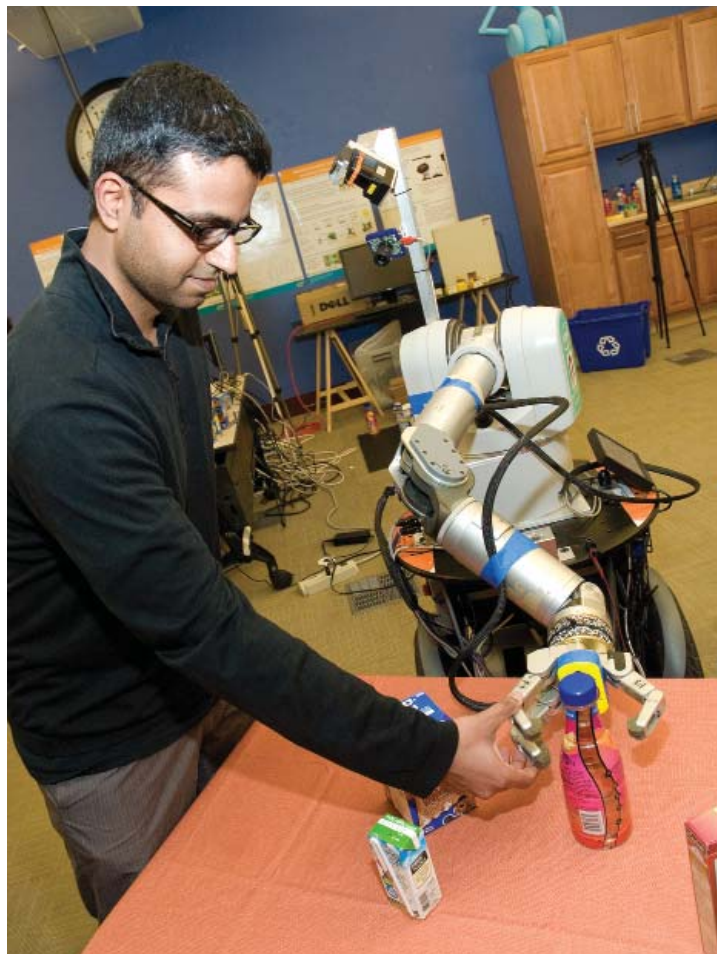
If computers can run the anti-lock braking systems on our cars and put streaming video on our cell phones, why can't they make sure that an elderly person is receiving his medication?

If robots can navigate Three Mile Island or the surface of Mars, why can't they find their way around a suburban bedroom? Shouldn't technology be able to address "quality of life"?

The Quality of Life Technology Center aims to answer those questions. Founded in 2006 as a joint project of Carnegie Mellon and the University of Pittsburgh,

it's merged CMU's leadership in developing and deploying robotics and sensor technology with Pitt's excellence in health care and rehabilitation sciences. The QoLT is one of five Engineering Research Centers in biotechnology and health care that's recognized and funded by the National Science Foundation. The center receives \$4 million annually from the NSF and was recently awarded a three-year, \$1.5 million NSF Innovation Award to get "quality of life technology" into the hands of people who need it as quickly as possible.

Highly interdisciplinary, the QoLT draws on the talents of roboticists, computer scientists, engineers, industrial designers, psychologists, social scientists and other researchers at both universities. Its commercialization counterpart, the Quality of Life Technology Foundry, has already spun off three companies based on ideas created at CMU and Pitt, says Rick McCullough, Carnegie Mellon vice president for research and former dean of the Mellon College of



Siddhartha Srinivasa and the Home Exploring Robotic Butler (HERB)



Inside Out Vision — Michael S. Devyer, research staff member at the Robotics Institute, wears a prototype of Inside Out Vision, a device that can tell what the wearer is looking at.

Science. With the new funding, he says, “we envision even greater success.”

“Everybody wants to live independently, enjoy their life, feel secure,” says Osborn, who serves as executive director of the Quality of Life Technology

Center. “Robots have taken us into outer space, under the sea and into places too dangerous to go. QoLT gives us the opportunity to merge these technologies into rehabilitation and geriatrics—and at the same time spawn a new industry.”

In various stages of development at QoLT are more than 20 assistive devices and systems ranging from things as simple as a computer application called “Lean and Zoom” that automatically zooms a computer screen in response to its viewer’s body movements; to a full-scale assistive home that allows persons of limited abilities to live independently.

And thanks to its new funding, the QoLT Foundry is expanding its efforts to accelerate the new-product commercialization process by looking for broader consumer possibilities for assistive technology. “In the past, the typical assistive device has been produced in very limited quantities and paid for by the government,” says Curt Stone, director of the QoLT Foundry. “We’re trying to develop a business model where large consumer demand results in higher production and lower pricing, so consumers can pay for these products on their own.”

For instance, a vest designed to allow people with hearing impairments to enjoy music by means of vibration has morphed into a consumer product called “VibeAttire.” It allows the wearer to “feel” the music from an iPod, MP3 player or any other handheld audio device.

Integrating “man” and “machine” requires finesse, says Takeo Kanade, director of the QoLT Center and Carnegie Mellon’s U.A. and Helen Whitaker

“In my mind, human ‘quality of life’ is the (ability) to live as independently as possible—to do what we can do for ourselves, rather than having it done by other people or machines”

University Professor of Computer Science and Robotics. “Until now, the key goal of robots has been to reduce human involvement,” he says. “However, I don’t think people want to live with robots that do everything for them.”

For Kanade, the “magic equation” of a quality of life technology system is solved by taking what a person wants to do, and subtracting what he or she can do. “The difference between desire and ability is what the machine should provide,” he says. “In my mind, human ‘quality of life’ is the (ability) to live as independently as possible—to do what we can do for ourselves, rather than having it done by other people or machines.”

The practical and technical challenges associated with solving that equation are daunting, Kanade says. “One of the key components of quality of life technology is to understand what the user wants,” he says. “Because unless a machine understands what its user wants, it cannot help. The machine system and the human being must work together to make a better system. We call that a human-system symbiosis.”

QoLT has reduced the problem of symbiosis between people and machines to four research thrusts:

- Living a Life: The Person and Society
- Knowing the Person: Perception and Awareness
- Using the Machine: The Human-System Interface
- Interacting With the World: Mobility and Manipulation

Rory Cooper, co-director of the QoLT and also director of the Human Engineering Research Laboratories (a joint project of the University of Pittsburgh and U.S. Department of Veterans Affairs), says the technologies under development at the center must be able to address and mesh aspects of all four thrusts. For instance, the first area—“Living a Life”—requires researchers to assess the practical implications of machine assistance on a person’s needs. The second addresses how machines can best sense a user’s intentions and interpret them. The third and fourth areas focus on the ways that people can share information about their environments with an assistive technology, and then use that technology to interact with their environments and one another.

Some of the interfaces that users might deploy are as familiar as keypads, joysticks and touch-screen monitors. Others are more unusual. Take the visual recognition system called “First-Person Vision” being developed by a team led by Kanade and Robotics Institute professor Martial Hebert.

“First-Person Vision” uses a pair of tiny, eyeglass-mounted cameras to allow a computer to “see” whatever the person wearing the glasses is looking at. The first camera uses a wide-angle lens to look at the full field of human vision, while the second uses a close-up lens to examine the user’s eye and pinpoint the exact area he or she is looking at. From that composite result, the computer can determine what the user’s intentions are.

When a user is looking at a can of soup on a kitchen counter, for instance, the computer can guess that the user needs it. If the computer is controlling a robotic arm, it can reach out for that can and bring it back for the user.

“If a computer has access to a user’s field of view and area of interest, it will have a much easier time knowing what he or she is doing and thinking,” says Kanade, acknowledged as one of the world’s leading experts in computer vision—the science of enabling computers to see and interact with their environments. “First-Person



Benjamin Salatin works with the Personal Mobility & Manipulation Appliance (PerMMA)



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Vision" is one of the biggest steps toward solving the quality of life equation, he says: "If the computer knows you want to reach something, and—if you reach it—knows that it doesn't need to help you, that's an effective quality of life system."

Manipulating a physical object—that hypothetical can of soup, for instance—is part of the fourth research thrust. One of the technologies being developed at QoLT that Cooper points to with pride is the Personal Mobility and Manipulation Appliance Robot, or PerMMA, a two-armed intelligent wheelchair that can automatically transport a user around the house, open the refrigerator door, remove a snack from a shelf, and put it to its user's lips to eat.

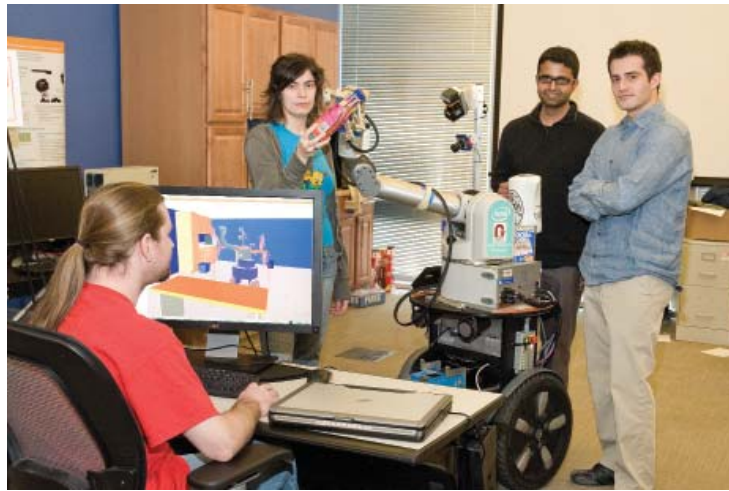
It can map and retain local environments, memorize user activity and predict future behavior. It can even reach nine feet into the air to change a light bulb in a ceiling fixture, without using a ladder or breaking the bulb. Depending on a user's individual requirements, PerMMA can be fitted with all manner of sensors, cameras, monitors, interfaces and tools. In order to facilitate squeezing through a narrow halls and doorways, PerMMA's robotic arms swing out of the way to the back of the device.

Currently being tested in a laboratory at the VA Pittsburgh Healthcare System's hospital campus in the Highland Park section of the city, PerMMA isn't quite ready for deployment to users. But it's getting closer. And Cooper says the goal of QoLT is always to deliver its technology "into the hands of health care and rehab professionals and patients."

One place where QoLT systems and sensors are already being used is in nearby McKeesport. The former mill town just south of Pittsburgh is home to the first of a series of "research cottages" built by a non-profit partner of the QoLT, Blueroo Technologies.

Blueroo's research cottages are designed to be fully equipped and comfortable homes where senior citizens or others with limited mobility can live independent lives. They're also test beds for what QoLT calls "active home" technologies. Equipped with more than 100 sensors, cameras and automation components, the research cottages allow a computer to log human activity inside.

"The sensors can detect how many people are in a room by the level of carbon dioxide," says John Bertoty, chief executive officer of Blueroo. "They tell the system when the cabinet and refrigerator doors have been opened, so it knows if the occupants are eating. And if they're not, it will send out a caregiver alert." The computer can also alert the residents to pending events like visitors, doctor's appointments or emergencies, and remind them to take



Ross Knepper, Anca Dragan, Siddhartha Srinivasa and Alvaro Collet work with HERB - the Home Exploring Robotic Butler

"Baby boomers represent unprecedented numbers, unprecedented wealth and unprecedented expectations for maintaining a high quality of life as they age"

their medication, close doors or windows, or shut off water accidentally left running.

Other active research areas include a "safe driving" effort, Cooper says, focused on applications that help older adults and people with disabilities operate vehicles with confidence with the help of global-positioning systems and automated, driver-specific advice.

Another effort—Virtual Coaching—addresses not physical disabilities, but memory and cognitive disorders. MemExerciser, an

assistive device for people with impaired memories, uses a wearable camera to automatically record and log pictures and sounds from a person's daily life for future viewing and memory improvement exercises.

Besides their obvious benefit to mankind, these quality of life technologies also represent a chance for Carnegie Mellon and Pitt to aid the region's economic development. Blueroo, for instance, is located in an economically depressed area where up to a quarter of the population lives below the poverty line. Bertoty says the non-profit is already putting local people to work building homes with assistive technologies and hopes to eventually create an assembly plant where it can manufacture complete pre-fabricated structures.

Stone, the director of the QoLT Foundry, predicts that projects spawned at the Quality of Life Technology Center will be responsible for more than

100 jobs in the Pittsburgh area over the next five years. "With the greater resources made possible by the NSF, we think we can spin out even more companies," he says. QoLT is also preparing undergraduates and graduate students to develop new assistive technologies through education and research programs.

Older Americans in 10 or 20 years won't accept the sedentary lifestyle their grandparents' generation might have tolerated, Osborn says. "The baby boomers represent unprecedented numbers, unprecedented wealth and unprecedented expectations" for maintaining a high quality of life as they age, he says. "That's a whole different society than the world has ever known before. Quality of life technology represents a great commercial opportunity for companies that can provide those services."

Tom Imerito is president of Pittsburgh-based Science Communications. A writer and technology consultant, his articles have appeared in Pittsburgh Quarterly, Research Penn State, the Journal of the Minerals, Metals and Materials Society, and TEQ, the magazine of the Pittsburgh Technology Council. Email him at thomas@science-communications.com. Link Managing Editor Jason Togyer contributed to this story.



Innovation and Nanotechnology

By: Alan G. Brown

It is a generally accepted truth that customers don't buy technology. Instead, they buy products and services which add value or fulfill a need. A variation on this adage is that investors don't invest in start-up companies with great technology, but invest in innovators with unique market solutions. Angels and Venture Capital investors are particularly attracted to people with ideas that are "game-changers" in the market, i.e. disruptive.

Many examples exist of disruptive products, enabled by new technology; Sony's Walkman, video recording, DVD's, and of course Apple's I-Pod and I-Phone. However, the overwhelming success of these innovative products was not necessarily because of the technology. It was how the technology was used to create new features, ease of use, or solve an existing problem. As Christensen and Raynar point out in their breakthrough book, *The Innovators Solution*, "having an advanced technology is not enough for a market disruption; the innovator needs to choose the right application for the right customer to be successful"

Recently the field of nanotechnology has received widespread attention in the press. This is because of several factors. First, the U.S., along with other industrialized nations, is investing large amounts of R&D dollars on nanotechnology. Since 2001, the federal government has invested a total of \$ 11.9 billion in nanotechnology R&D across 13 federal agencies. The current year amount is \$ 1.76 billion. The second reason for national interest is the attention from the press and popular culture describing futuristic stories based on the uses of nanotechnology, both for good and potential harm.

Despite all this hype about something new (and possibly dangerous), nanotechnology is in reality the culmination of the steady scientific advancement into the atomic world. Today, scientists are creating, manipulating and


measuring matter at the molecular and atomic scales. Currently, scientists are lining up atoms to spell out their corporate logos or university names. However, what the general public doesn't understand, due to the complexities of the physics and chemistry at these scales, is the so-called "quantum effect". These effects create the tremendous potential to develop materials with major enhancements in conventional properties, such as increased strength, electrical and thermal conductivity, or reduced friction. But the most exciting development is the realization that some new materials and structures at the nano-scale demonstrate entirely new properties.

As the advances in semiconductor and information technologies of the past three decades have enabled breakthrough products such as; laptops, PDA's, smart phones, and the worldwide web, so too does nanotechnology offer major opportunities for entrepreneurs to create a wide range of new products. The breadth of these opportunities across all sectors of our economy will be revolutionary. Nano-particles containing chemotherapy drugs targeted to individual cancer cells are currently being tested. Carbon nanotubes are routinely being incorporated into new stronger but lighter weight aircraft, such as the Boeing 787. Lithium Ion batteries are employing materials at the nano-scale to steadily improve energy density while lowering charge times and reducing weight, to completely change the automotive industry.

But one key challenge facing the commercialization of nanotechnology research is the complexity and technical jargon associated with the field. It is rare that a scientist who understands the quantum world will also have the skills and experience to be a successful entrepreneur. To bridge this gap, many business schools address this problem by adding courses in entrepreneurship along with technical and business courses. Alternatively, many engineering


"The United States has a history of combining the elements of innovation, individualism and capitalism in various ways to power our economy and grow our standard of living"

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Apart from these solutions to educate the next generation of “technology entrepreneurs”, the single biggest obstacle to commercializing the potential of nanotechnology is our nation’s system of risk and reward for starting new businesses. Much has been written about the successes of our nation’s venture capital investment model. We pride ourselves on how the “market” rewards risk takers with the passion and energy to bring their ideas to the marketplace. Success stories such as Google, Face Book, and E-bay are great examples. However, even before the current grim economic climate, many observers of the VC market have noted the growing imbalance between the availability of risk capital and the number of innovative ideas. This imbalance has resulted from the desire of private investors to reduce their risk and maximize their payout, in both shorter timeframes for return on investment and requiring higher initial valuations. This is exactly the wrong trend for encouraging innovative new ideas in nanotechnology.

The federal government has noted this challenge and has issued open invitations from corporations, the private investment community, universities and non-government organizations to provide innovative ideas and solutions to solve this problem. Although we realize that government policy is a blunt instrument compared to market efficiencies in solving these problems, publicly funded organizations like the Pennsylvania NanoMaterials Commercialization Center can, and indeed do, play a key early stage “accelerator” role in evaluating and supporting the development of new ideas using nanotechnology,

while reducing later stage investment risk.

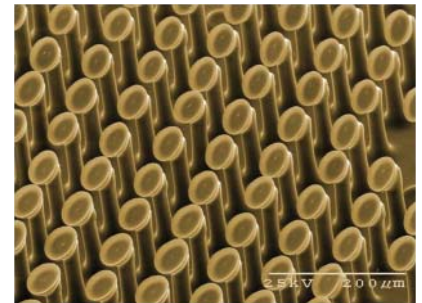
We at the Center, along with our partners, constantly discuss ways to encourage researchers and entrepreneurs to consider and follow-through on their plans to commercialize nanotechnology.

Fundamentally, we realize that a single entity does not have either the skills or the resources to be successful on their own. University researchers understand the intricacies of their specific technology, but usually don’t understand market needs and how to run a company. Large companies have tremendous resources in marketing, manufacturing, logistics, and financial depth, but tend to be slow and bureaucratic. Entrepreneurs have the energy, flexibility and experience to develop a start-up, but may not have the skills and resources for a sustainable company.

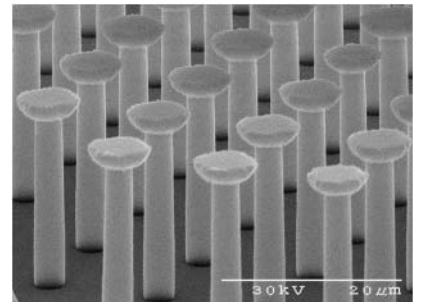
By creating partnerships between all these groups, the risk can be significantly reduced in commercializing a particular area of nanotechnology, matched to a great product idea. That is why the Center through its network of researchers, large and small companies, stresses the importance of forming and strengthening key partnerships for common benefits. The Center plays a key role in encouraging and supporting partnerships to transition an idea and technology from research to a commercial application. First, we facilitate open sharing of information on technologies and product concepts. Second, we offer “matchmaking” between technology solution providers and product developers. Third, we review and qualify new product ideas matched to innovative applications of nanotechnology and support the early stage prototype development of the product concepts.

One example of such a partnership and successful first step in commercializing a unique nanotechnology effect with a great product idea is the Center’s recent investment in nanoGripteck LLC. NanoGripteck is a new start-up company formed by Professor Metin Sitti of Carnegie Mellon University. Dr. Sitti has spent many years researching the so-call “gecko foot” effect. This effect is familiar to many of us who have observed these little lizards easily clinging to walls and windows while they busily devour insects. Most of us assume that the Gecko’s foot is “sticky, like a Post-It note. However, nature has developed a unique solution. Under a high powered microscope, the gecko’s foot is covered by millions of tiny hairs at the nano-scale. Due to a tiny electrostatic effect magnified many times, the gecko’s feet can easily support its weight, but easily disengage itself to be mobile and avoid predators.

Professor Sitti’s research has developed a means to develop structures which mimic the hairs on the gecko’s foot. The challenge is in how to make these



Nano Gripteck Gecko Adhesive



Nano Gripteck Gecko Adhesive, Part 2

structures repeatable, in large areas and at reasonable costs. The most obvious application is as a replacement for Velcro™. Professor Sitti engaged with the Center and proposed a commercialization project which would meet the Center's criteria for establishing partnerships to successfully commercialize his idea. With the assistance of the Office of Technology Transfer at Carnegie Mellon University, nanoGripteck was formed, licensed the technology and won a support grant from the Center.

However, the key to the early success of the company came from employing the Center's partnership model to their commercialization strategy. In the early stages of the project, nanoGripteck established two key partnerships with larger companies. The first was with a company which would act as the "test customer" of prototype samples of the product. The second was with a large chemical and polymer company to develop unique polymer materials needed to make the idea work and be cost-effectively manufactured at large scales. This multi-partner approach, in the early product development stage, coupled with advice and financial support from the Center (provided by funding from Air Force Research Labs in Dayton, Ohio), has accelerated the commercialization pathway. In addition, the approach has allowed the company to quickly develop working prototypes, attract other investors and partners, and grow to five employees in just over one year.

The example of nanoGripteck demonstrates the successful innovation using nanotechnology by a start-up company. However, the Center also works with established companies creating new ideas using nanotechnology. One example is another Pittsburgh based company, Crystalplex Corp., which has perfected the manufacture of quantum dots. Quantum dots are very small

particles of various semiconducting compounds. These particles are so small that one could theoretically count the number of atoms in the particle. At this scale, the "quantum effect" becomes dominant, so that the particle acts like a single atom in its interaction with light at various wavelengths. Crystalplex uses this unique property to make more energy efficient lighting and displays. Prototypes currently being developed by this company, in partnership with the Center, will soon make their way into the marketplace for new lighting and display applications. These products will significantly reduce the demand on the energy grid, and reduce our dependence on foreign or polluting energy sources.

The United States has a history of combining the elements of innovation, individualism and capitalism in various ways to power our economy and grow our standard of living. But we should not rely on our current approaches to continue our technological and economic leadership into the future. As a nation, we need to also apply our innovative talents to overcoming obstacles to commercializing emerging research and new inventions. Nanotechnology offers a tremendous opportunity to ride the next wave of innovation for the nation and the world. I believe that a key element in these new approaches will rely on win-win partnerships which support and nurture new ideas which leverage nanotechnology's potential.

If you wish to suggest an innovative idea based on nanotechnology or otherwise join the Center's network, please contact me at abrown@pananocenter.org

Alan Brown, Ph.D., MBA, is the Director of PA NanoMaterials Commercialization Center

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ESWP Member News

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PAPER, Scissors, and a Little Bit of Glue

By: Mickey McManus

At this moment in the history of the world the most interesting (read valuable) challenges can only be solved at the intersection of various disciplines, rather than at their core. We have reached a point where connected products, services, and environments are blending atoms and bits like never before. Yet the steps you should take to become more interdisciplinary in your efforts are far from obvious.

We've been practicing interdisciplinary design for twenty years now. There is a painfully incessant amount of give-and-take, it is troublesome and time consuming and it frankly never gets easier. Further it is seldom seen as the most efficient approach (at least not in the short term). More often than not businesses hear that they should be interdisciplinary, blur their eyes, see a few meetings where marketing, engineering, and design are all present, and check it off their list as "mission accomplished." The value of "being interdisciplinary" has received decades of lip service in education and business, but the real thing remains a rare occurrence.

Paper

We would suggest that sharing a piece of paper between two or more disciplines is a first step towards bridging the divide. If you ask an engineer to draw, rather than tell you, what is in his head, you can decode his jargon almost instantly as the sketch comes to life. It turns out that drawing is the lingua franca of thinking. You can immediately translate what the engineer has drawn into your own worldview, see how he pictures the problem or solution, treat the drawing as a medium by adding your own parts to the picture, and most importantly, see critical gaps in his thinking that you may be able to fill in.

A simple metric based on the number of square feet of drawing surface (in the form of papers pinned to walls, whiteboards, etc.) in use *between* disciplines within an organization would be a reliable indicator of true interdisciplinary teaming, collaboration, and innovation.

Effective teams share paper. Not a day goes by in our labs where you don't

hear "draw what you mean" at least a half a dozen times. We find ourselves encouraging everyone (not just designers and engineers but business leaders and even customers) to draw, to share ideas over paper.



MAYA Design teams at work

Scissors

Herb Simon, one of the most profound thinkers of the twentieth century, suggested that we should think about our minds as being like a pair of scissors. Scissors require two blades to do their work, one blade pushing against the other. Similarly minds are made up of two "blades" as well, one of them is our brain and the other is the environment that we find ourselves interacting within. A common saying like "if you can't change the person, change the environment," hints at this concept. An example from nature might help clarify this idea. When we see a colony of insects performing seemingly sophisticated behaviors like building hives, coordinating attacks on predators and leading their compatriots to food, we marvel at the ability of so much complexity with so few neurons. When we hear about a bird that can speak and respond to complex sentences and commands, famously popularized by a grey parrot named Alex, we are astounded again by the complexity that comes from such

a small brain. In fact we are misapprehending the situation. In every case the brain is “pushing against” an extremely complex environment with relatively simple rules and actions.

What does all this have to do with interdisciplinary problem solving, innovation and design? Put simply we ignore our environment, as a crucial component of creative interdisciplinary thinking, at our peril. Businesses looking for ways to save money usually order modular cubicle farms divided by discipline to house their workers, encourage conference calls and web connect meetings over face-to-face interactions, and celebrate chat systems and emails over serendipitous interactions made by wandering around the office. Worse they spend all that saved money on extravagant conference rooms with gleaming walls, rich paneled details, generic corporate art, and immovable hard wood tables that are sized like continental tectonic plates. High-end lighting and projection systems often top off the power conference room effect. Usually over in the corner, will be a small whiteboard or flipchart. PowerPoint reigns as king.

Sadly human minds don’t work well within these constraints. When a program director steps into a meeting and begins to talk about slide number four bullet point number seven of a soon to be mind numbing fifty or sixty slide deck, the chances of winning the game are reduced dramatically. Our brains can only remember seven plus-or-minus two things in short-term memory (though this is “pop” psychology the fact is we can only keep a few things in working memory at any one time), that’s why telephone numbers were originally seven digits long. However, most experts will tell you that new ideas often come from the creative recombination of different concepts in new ways. Unfortunately, when presented with fifty or sixty slides full of bullet points that flash by and disappear as quickly as they arrive, our memory limitations reduce the pool of raw materials for creative thinking drastically.



Daily Whiteboard Help Team Members Make Connections Faster

Enter Environment—the Other Blade that our Brain Pushes Against

Although we can only remember a handful or two of items in the abstract, we can remember tens, hundreds, and sometimes thousands of items if they are located in physical space. The space helps us not only remember but actually index our thoughts. Imagine that conference room again, but this time get rid of all the fancy stuff on the walls, remove the marooned sea-going vessel of a table from the center of the space, and cover all the walls with continuous whiteboard (think of this as our paper). Now start a new meeting. Every time someone shows a PowerPoint slide, draw the most important elements on the whiteboard. Start at the far left (at least in most of the western world) and as the day progresses slowly fill the walls with comments, thoughts, ideas, assertions and other raw materials. What you’ll discover is that the team members will now start making more connections, faster. They’ll say things like “what if we took that idea from this morning . . . the one over there, and combine it with this one over here,” while pointing at the different locations on the wall like a human clock.

This phenomenon, something we call “Where It Is, Is What It Is,” turns out to be how we organize the world. You see it all the time when people pile things on their desk and yet somehow can always find that particular report, halfway down the pile. It is a feature of our mind that is found at the intersection of brain and environment. It is hard wired into the way we work. Effectively we “push” our brains against the world like that blade on a pair of scissors.

Glue

Now get rid of all those cubicle farms organized by department and build neighborhoods of practitioners from various disciplines. Encourage them to draw what they mean, and give them plenty of wall space to have conversations. You’ll be two steps closer to the painful, woefully unsatisfying, brutally hard, but brilliant potential of true interdisciplinary collaboration.

PS We never said it would be easy.

Mickey McManus, is President and Chief Executive Officer, MAYA Design, Inc.



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micro-nanorobotics

By: Metin Sitti



Once every millennium, an invention comes along that speeds the pace of the whole human race. At the NanoRobotics Lab at Carnegie Mellon University, our major micro-nanorobotics research thrust is the miniaturization of mobile robots with a variety of locomotion and manipulation capabilities at a very small scale.

One of my ultimate goals is to scale down some of these robots to sub-millimeter overall sizes. Like any new innovation, my challenge is to develop new micro-nanoscale manipulation, manufacturing and control methods for powering these miniature mobile robots.

Making these tiny robots a reality involves biological inspiration where animals have found good-enough locomotion solutions at the small scale by evolution. For example, being inspired by foot-hairs of climbing animals such as geckos, we can build new miniature climbing robots. Only recently did researchers figure out what makes the gecko's microscopic foot hairs so sticky that the little tropical lizard can run upside down across ceilings. Made of silicone rubber, polyurethane or other polymers, the man-made strands appear to adhere to surfaces just as strongly as the real thing.

To adhere to a surface, the hair-covered pads are pressed against the surface and then dragged along it. This helps the tips of the hairs conform closely as possible to the shape of the surface. The hairs are oriented in one direction, so they can be detached by pushing in the other direction or twisting them. Attachment takes about 6 thousandths of a second, detachment takes 16 thousandths of a second — fast enough to allow a gecko to run.

"We envision a day when miniature mobile robots will navigate through human fluids, looking for signs of disease"

To make synthetic versions of the gecko's sticky feet, we used micro-nanofabrication methods to create flexible negative molds of mushroom shaped fiber adhesives. Once these channels are molded, the dried polymers are peeled off from the mold.

Properly designed, the synthetic gecko hairs act much like a piece of Velcro, albeit one-sided Velcro. Though Velcro requires two complementary patches to adhere to each other, the gecko glue could work when pressed against almost anything. Teflon is about the only thing to which geckos won't stick.

While many applications are possible, I am particularly interested in making use of the new adhesive technology in our NanoRobotics Lab. For instance, gastroenterologists now use a capsule-size camera that can be swallowed to view some parts of the patient's intestine. By adding gecko adhesion to the exterior of the capsule, it may be possible to control the camera's movement and position by attaching to the intestinal lining with no damage.

We've also developed a "Waalbot" concept — a legged climbing robot using our fiber adhesives to attach to surfaces that might be used for space and

extraterrestrial applications. In low or no gravity, the van der Waals force might be sufficient to support even a heavy robot, allowing a Waalbot to scurry over the skin or a space ship for in-flight inspections and

repair, or to scale rock walls during extraterrestrial exploration.

Another project studied in our lab was looking at methods beetles used to defend themselves from predators. The palmetto beetle, for instance, is a small



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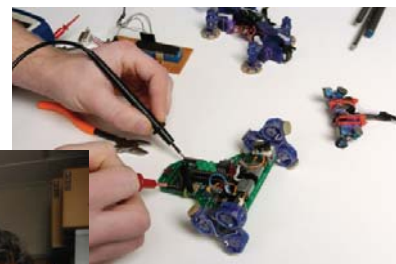


blue beetle found in southwestern United States that can cling tenaciously to palmetto leaves when under attack. It's secret is on the bottom of its footpads — a total of 60,000 bristles. When the beetle presses the bristles against the surface and secretes an oily substance, it can strongly adhere to surfaces.

We have been working to mimic the beetle's adhesive foot pads as we continue to design robots that maneuver inside the human bowel. The bristles would be fashioned out of polyurethane, silicon rubber or various biocompatible polymers; silicon oil might substitute for the beetle's secretions.

And the research continues as we improve our research with miniature robots. The goal is to develop a miniature insect robot that can stay and maneuver on

water with power, efficiency, and agility for taking advantage of the water's surface tension. In addition to the water-strider robot, Carnegie Mellon's NanoRobotics Lab is also investigating robots that can swim and fly. We envision a day when miniature mobile robots will navigate through human fluids, looking for signs of disease.



Dr. Metin Sitti (pictured right) is the Head of the NanoRobotics Lab and Associate Professor in the Department of Mechanical Engineering, Electrical and Computer Engineering, and the Robotics Institute.

Spotlight on ESWP Outreach Programs

The inaugural year of the Pittsburgh regional *Design Squad* competition wrapped up in May, with more than 70 students and 15 professional engineers in the broadcast studios of WQED-Multimedia. They were gathered to participate in the year-ending challenge of the *Design Squad*. Students represented public and parochial schools, as well as in-school and after-school groups, and ranged from Grades 5 through 11. The event was a huge success, and proved to be the perfect send-off at the conclusion of year one. *Design Squad* is produced locally through a partnership between ESWP and WQED-Multimedia.

Throughout the year, almost 40 school districts expressed interest in *Design Squad*, and 23 groups, representing 575 students, actually enrolled to conduct student activities based upon the award-winning PBS television show—aired locally on WQED—of the same name. The *Design Squad* model offers a powerful way to open kids' eyes to the exciting world of engineering.

Design Squad challenges use simple, readily available materials and are open-ended with multiple solutions that engage a wide variety of ages and

ability levels. The challenges offer kids fun ways to apply the design process and core science concepts. They are excellent ways for kids to exercise their creativity and practice important skills, such as problem solving, teamwork, and critical thinking.

One of the many benefits of the partnership with WQED is the video production of the entire challenge event, plus interviews with students and mentors. The video can be viewed online at the WQED website, and will be used to help further promote *Design Squad* around our region by recruiting students, educators, mentors and sponsors.. You can view photos of the event here: <http://share.shutterstock.com/action/welcome?sid=ORbNXllyZuKA>

If you would like more information about bringing the *Design Squad* to your school or after-school group, or how you can participate as an engineer mentor, please contact David Teorsky at the ESWP.



as built on TV





Mickey A. Miller

Cell Phones and Steamrollers

By: Mickey A. Miller

Stewart Brand, creator and publisher of The Whole Earth Catalog, has said, "Once a new technology rolls over you, if you're not part of the steamroller, you're part of the road."

I awoke this morning to my cell phone's alarm clock then I checked any emails that came in from the night before. Mostly junk mail, but I received an interesting email from a prospect I had been working with. This excited me so I replied to set up a meeting for the following day. I then checked the weather so I would know how to dress and finally perused my bank account to see my finances. I looked over at my wife who was emailing her boss about a client and paying our weekly sum to our day care. All of these tasks were handled within fifteen minutes of waking up from a singular device, our cell phones.

I work in Business Development for Merging Media, a Digital Marketing Communications firm in the South Side. A portion of what we do is to learn about new technology and demystify their uses for our clients' marketing efforts. I came into this career as a casual technologist which means I liked gadgets but never thought too hard beyond the obvious use of the device. I have since released the grip of reluctance and welcomed new technology into my everyday workflow. I urge you to do the same because learning how to operate in a technologically driven economy is no longer a luxury but a way of life. I got to see firsthand how a company ill-prepared for the future struggled to adapt.

For years I worked in traditional media creating ad campaigns and sell-

ing advertising, but one day I noticed a change in the way businesses were interacting with their prospects. Interactive websites, email blasts, web banners, and text messages were taking large chunks out of the market share. The TV station I worked for made the leap to provide a slew of digital assets to our advertisers hoping to make up for the losses, but there was something missing in our method. Advertisers didn't want a list of web banners they could purchase, they wanted to create smarter ways to reach their consumers; they wanted the magic of technology to be put in place in their company's infrastructure.

I felt like I was getting old in my late-twenties so I made the conscious decision to leave traditional media and look at how I could be a part of the shift. I started by taking a look at where we were headed as a population and how we were interacting with media.

Around this time in 2007, a new device had emerged from Apple called the iPhone. It brought the iPod together with a cell phone and had these little things called apps. The explosion of the iPhone was the largest indication of a serious change in culture. What the iPhone and other smart phones brought to us was a device that could streamline our everyday tasks. They have a customizable interface that allows you to purchase the applications that you need for work and life. On my phone, which is a Blackberry, I have a direct link to my bank, news, the Texas Longhorns football schedule and play by play, my date



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more from mobile devices. I like to use the analogy of cable TV. It was clear that TV was big business, so people bought the signals and started forming Networks that showed programming to specific demographics. What they learned from this, was that people will pay for programming tailored to them and even more advertisers will pay for programming tailored to their demographic.

What we see in the mobile devices is similar. Developers are making apps that fit specific groups of people and advertisers are supporting their efforts. As the iPad and other similar devices emerge as mainstays, you will see another evolution. These new devices will have a larger memory and greater graphics cards thus enhancing the quality of the content. The newspapers of old will now incorporate videos, games, and limitless content to engage consumers. A small business can have a TV series explaining their service in an entertaining way. Instruction manuals will be video downloads to your mobile device. It really is limitless at this point. With all that is available, there is a great opportunity for people to find gaps in efficiency and compensate with technology. But I give this warning, technology can be destructive. Although I have created a virtual office and automated menial tasks I have also created a twenty-four hour a day, seven-day a week distraction located within five feet of me at all times. I have to remind myself to not hide behind the technology or use it as a way to remove myself from colleagues, prospects or even family. A Facebook status update is no substitute for a good old-fashioned phone call or letter when it comes to keeping in contact with family. I had to learn that the hard way. Meeting with clients face-to-face is still the best way to do business and earn trust. It is the human element that often gets left out of technology so it is incumbent for non-technologists to take part in the progression of these devices. Without human interaction these mobile devices are just a motionless piece of wires, plastic, and metal. So if you are a casual technologist like I was, I welcome you aboard the steamroller because we need you more than you need us.

For more information about Merging Media go to www.mergingmedia.com.

Mickey A. Miller is Director of Business Development, Merging Media Inc.

book, email, contacts, Facebook, the web, a camera, GPS, a dictionary and more. This phone didn't replace any other devices for me but rather became the virtual key to my collection of technology at home. I often wonder what Alexander Graham Bell would think of the evolution of the phone.

A few years ago I read a story that showed a wonderful example of the modern age of communication. The story was about a small independent bookstore called Broadway Books in Portland, Oregon. The store had been open for 18 years and in December '08 it looked like the long time owner, Roberta Dyer, was going to have to shut the doors. The holiday season was usually the time of year she would make enough to keep the store open but due to the economy and a snow storm, the regular holiday influx was dead. When her son heard the news that the bookstore he grew up in was threatening to close he sent an email that would change everything. Roberta's son, Aaron, sent a message to his friends in Oregon that said if they would buy \$50 worth of books from his mom he would buy them a burrito the next time he was in town. The email described what was going on with Broadway Books and it struck a nerve. Via mobile devices, his friends started circulating the email to their friends who rallied behind the little store. By the end of the Christmas season Roberta had a record month, the burrito restaurant gave the burritos away and local TV crews reported on the story.

The speed in which the information traveled had never existed prior to the smart phone. This kind of news traveling would have saved Paul Revere a severe saddle sore. The expedient way information travels is just one way the smart phone increases efficiency in life. As the application developers become smarter so do the phones. PBS kids launched an iPhone app loaded with educational games for children. There are graphing calculators, light meters, and even an app to help you locate the nearest bathroom; I would gamble to say that there is an app for just about anything.

The Nielson Company recently released a report that said 1 in 2 Americans will own a smart phone by 2011. That signifies a cultural change. It shows that this technology is a mainstay and that smart phones have become engrained in our culture like TV sets in the living room or microwaves in the kitchen. As for the future of handheld devices, I believe it is now in the hands of the developers. With the recent launch of the iPad, it is clear that people want



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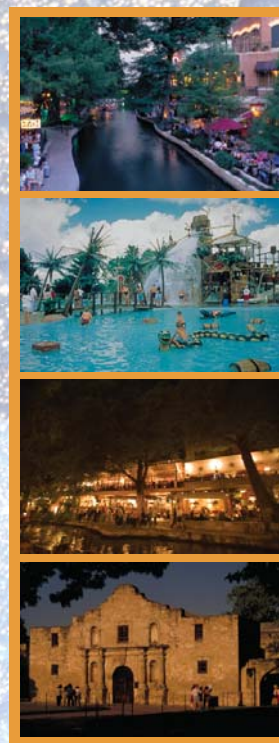
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