THE PENNSYLVANIA TRIANGLE

A PUBLICATION OF THE SCHOOL OF ENGINEERING AND APPLIED SCIENCE AT THE UNIVERSITY OF PENNSYLVANIA - ESTABLISHED 1899

Fall 2006

Volume 92, Issue 1

India China Brazil Argentina Egypt Nigeria Thailand

Computational Power Reliability Manufacturing Problems Education Socio-economic Upliftment Low Cost

The Green Machine

Can the $100 laptop really rid the digital-divide and better education worldwide?

By Ju Tan p11

Entrepreneurship & Tech Transfer for the Engineers
By Karishma Mehta p8

Quantum Entanglement
By Rishabh Jain p26

Evaluating Google's Success
By Easwaran Subbaraman p16

Cover Story
As engineers, we are trained to be versatile problem solvers even when confronted by the most daunting of challenges. Our education, however, sometimes fails to make us aware of the more urgent problems facing people outside the walls of academia.

When we take a look at the social fabric of our civilization, no problem is more real or more alarming than the problem of world poverty. In a recent movement engineers have started to tackle those issues with improvements in computing, telecommunications, information technology, education, and civil infrastructure, illustrating how technical skills can be extended even to ameliorate social problems. We at the Triangle believe that bridging the “digital divide” is no longer just a fashionable cause, and that is why we feature this issue on the impact of emerging technologies on developing economies.

When MIT pioneered the open courseware initiative and released its university lectures and notes to be freely accessible online, we witnessed how innovative approaches to education could promote a more open attitude to advance knowledge around the world. The idea of “intellectual philanthropy” made waves, challenging traditional thought of the well-established for-profit industry, which concentrated on the publishing sector and benefited from the sales of the intellectual product of universities and their faculties. To try to gauge the effect of the open courseware initiative, MIT last fall surveyed about 5,000 users of the site. It found that nearly half of users are what it calls “self learners” — individuals seeking to educate themselves by tapping into course materials from one of the world’s most prestigious universities. MIT received “tear jerking, heartfelt” e-mail messages from some of these people — those who are physically disabled, or in countries with intense political strife that limits other kinds of learning — who say they “never thought they’d have access to such high-quality materials.” Since we are products of one of the world’s finest educational institutions, it seems only fair to share a bit of our own privileged education with those not as fortunate. Let us share our wealth of knowledge.

Several of the best and brightest technically-minded people have risen up to play a role in helping world poverty. That movement, led by Nicolas Negroponte of the MIT Media Lab, has already spurred countless others to follow in the footsteps of the $100 laptop project. What’s more, skeptics of that project have turned away to launch their own projects. Intel’s Discover the PC initiative plans to distribute PCs powered by hand-cranked targeted for use in developing countries. In response, AMD, Intel’s chief rival, launched its Personal Internet Communicator, an internet-enabled device priced at $250. Wired Magazine reported that Philips Electronics is developing a $20 mobile phone, which the company believes is a technology that the poor need more over personal computing. Another race to the bottom of the price scale was initiated by the Emerging Market Handset Programme, which outlined a viable business strategy serving people who may only pay $5 a month for cellular service. Texas Instruments, Nokia, Motorola, and Microsoft are among other companies involved in the race to the bottom of the price ladder, as well as the social pyramid.

Since the start of the information age, the possibilities for the improvement and expansion of teaching and learning via the web continue to capture the imagination of educators. Web technology seems to promise a real transformation in education, not only in its ability to improve access to higher education and reach new audiences, but also to make the act of learning more efficient and effective. The rise of open-source, wikis, blogs, and Web 2.0 applications shows that it is possible for people connected over the web to contribute to knowledge. These exciting new technologies will naturally promote people working together in network-based environments, using computers to dream up innovations in a way they never did before. Sources of creative content will spring from people in developing countries with low-cost, hi-tech computers thanks to these emerging technologies. As Thomas Friedman’s groundbreaking book The World is Flat attests, the world is flattening because of the lowering of barriers and costs by things such as the internet.

In this new issue of the Triangle, we take a moment to reflect upon the importance of technology in society. The $100 laptop project marks an ambitious, but much needed, project in India that will help to alleviate social deprivation through investment in one of the most our most cherished assets — education. If the project turns successful in India, onlookers from China, Brazil, Argentina, Egypt, Nigeria, Thailand will be next in line for the OLPC and other international education initiatives.

There has never been a more promising opportunity for engineers to make a difference in social and humanitarian issues. As Jeffrey Sachs puts it in his book The End of Poverty, “It is no good to lecture the dying that they should have done better with their lot in life. Rather it is our task to help them onto the ladder of development, to give them at least a foothold on the bottom rung, from which they can then proceed to climb on their own... Since September 11, the U.S. has launched a war on terrorism, but it has neglected the deeper causes of global instability.” The story of world poverty is deeply rooted in inadequacies in education. Technology in our lifetimes may play a crucial role in that story.
ABOUT THE PENNSYLVANIA TRIANGLE

Editor-in-Chief: Michael Young
President: Steve Hershman
Executive Editor: Tushar Khanna
Faculty Advisor: Dr. Noam Lior
Editing Manager: Rachel Omansky
Copy Editors: Shawn Dimantha, Janice Gunther, Steven Hershman, Annabelle Lyons, Hunter Schloss, Easwaran Subbaraman, Sriraman Subbaraman
Production & Graphics: Tushar Khanna, Michael Young, Karishma Mehta, Rachel Omansky, Neeti Bagadiya
Cover Design: Rashmi Pujari
Webmaster: Steve Hershman
Business Manager: Shawn Dimantha
Public Relations: Sundar Balu

All material within this publication is copyright 2006 the Pennsylvania Triangle, unless otherwise stated. The Triangle is published twice annually by students at the University of Pennsylvania, and is funded in part by the Student Activities Council.

The opinions expressed within this publication do not necessarily reflect those of the administration, faculty, or the student body of the University of Pennsylvania.

Contact Information:
322 Towne Bldg, 220 South 33rd St
Philadelphia, PA 19104
E-mail: PENN.TRIANGLE@GMAIL.COM

INTERESTED IN CONTRIBUTING?
The Triangle encourages submissions of articles or photos from students and faculty alike. Just visit us on the web at www.penntriangle.com.

APEX: FROM THE DESK OF THE EDITOR
The ambitious one-laptop per child initiative has become the standard for a number of other nonprofit and profit programs. Michael Young

NEWS: TECHFLASH
A summary of the most interesting discoveries by Penn professors in the last six months. Steven Hershman

ENTREPRENEURSHIP: GET IT OUT THERE!
The basics of starting your own business. Karishma Mehta

COVER STORY: COMPUTING THE LEARNING MACHINE
Can this $100 gadget revolutionize education in the third world? Ju Tan

COMPETING: GOOGLE
A close look at Google. Easwaran Subbaraman

ENGINEERING: PLASMA ENGINES
Plasma Engines: The vision of Dr. Franklin Chang-Díaz. Valeria Montero

ENGINEERING: FRACTALS
A look at how Fractal Geometry is used in engineering. Rajee KrishnaSwamy

SOLVING CONGESTION BECOMES A REALITY
The justification behind congestion pricing. Hunter Schloss

PHYSICS: QUANTUM ENTANGLEMENT
A basic understanding of one of the greatest mysteries in physics today. Rishabh Jain

BOOK REVIEW: PUSHING PILLS
The proliferation of prescription drugs is reshaping American life. Chenghong Huang

TANGENTS: THE GOAL OF EDUCATION
Do we need a change in perspective? Tushar Khanna
Psychology: Better for Beauties

Attractive people get better jobs and salaries, are perceived as smarter and more extroverted, and possess greater social skills than unattractive people. Even infants prefer attractive people to unattractive ones. Penn professor Ingrid R. Olson and his colleague at Yale, Christy Marshuetz, recently investigated how these phenomena throughout our society occur.

They discovered that it does not take long for subjects to assess beauty. Even in a time frame as short as 13 milliseconds, the minimum amount of time it takes computer monitors to refresh their screens, subjects were able to determine if a face was attractive. The researchers believe this reaction was unconscious because of the short period of time in which the faces were shown. The participants stated that they did not remember even seeing the faces.

Olson and Marshuetz then tested to see if attractive faces primed subjects to identify words as good. Subjects took less time to identify good words (such as joy, peace or love) after being shown an attractive face than when they were shown an unattractive one. Therefore, the researchers believe that attractive faces may cause people to think about positive things, allowing them to identify good words more quickly. There was no change in recognizing bad words (such as agony, awful, or war).

Subjects were also shown pictures of pretty or ugly houses before words and asked to identify the quality of the word. There was no change in response time. This result suggests that the brain processes faces differently than it does inanimate objects.

After Olson and Marshuetz have systematically shown the amazing ability of humans to identify beauty, they hope to probe the role of sex and sexual orientation in people’s responses.

Biophysics: Mechanism for Molecular Mover

Molecular motors are proteins that can convert unstable particles into motion. Myosins are the most famous molecular motors in animals. They are best known for creating the contraction of muscles. Myosins can be thought of as two connected arms that pull themselves along an actin strand, a fibrous protein that forms a track for the myosin to move along in a motion similar to a rope climber pulling himself upward. The hands that do the pulling are commonly referred to as heads. Myosin V is a molecule taxi. It has been known to move organelles around a cell, taking 36 nanometer steps along actin tracks.

But how can heads that are 36 nanometers away communicate with each other? A team of Penn and Stanford researchers wanted to answer this question. To do so, they attached a bead to each end of a fiber of actin and used an optical trap—laser light so concentrated that it exerts a force—to hold it in place. They also attached a bead to the myosin. By shaking this apparatus, they were able to exert force forwards and backwards on the myosin. They tracked the motion of the bead attached to the myosin. If the bead ever stopped shaking, it indicated that the myosin was taking a step. In less than an hour, the researchers measured up to 5000 steps from a single myosin stepper.

The researchers discovered that backwards forces, which would be like a tug on the forward head, seriously decreased the rate at which the myosin could move. Conversely, forward forces had little effect. These findings explain how Myosin V moves in only one direction.

Using this information, the researchers were able to propose a model as to how myosin V moves. Initially, both the front and back heads are attached to the actin. The front head holds a molecule of ATP, the general energy currency of a cell, and the back head is empty. The front head uses the energy in the ATP as it transforms it to ADP. Because the back head is pulling the front head, the ADP cannot escape. Only when the back head binds ATP and lets go of the actin, thereby releasing the tension, can the ADP escape. The front head snaps like a spring, causing the back head to take a step...
Materials Science: An eye for an eye

Evolution has produced the most advanced optical lenses known to man. A team led by Penn's materials science professor Shu Yang recently created soft lenses whose structures are inspired by biology. Though her group had previously made rigid lenses, soft lenses were deemed preferable because an individual would be able to change their shape and size by changing their environment. To create the lenses, a gel of a copolymer of 2-hydroxyethyl methacrylate and methyl methacrylate was soaked with chemicals that would partially solidify portions of the gel if light were to shine on it. The researchers then shined light in the desired pattern with a three-beam interference lithography and washed any loose gel away. This process effectively sculpted the gel to look like biological lenses. The researchers were able to change the shape of the lenses by adding acid or base to it. Eventually, we may see bio-inspired lenses in everything from microscopes to DVD players.

Epidemiology: It's not easy being fat

Two recent reports warn about the mental dangers of obesity.

A team lead by Penn psychiatrist Dr. Arlen Prince took a sample of 2,547 people and found a correlation between suicide attempts and body mass index (BMI). BMI is a measurement of obesity, measured by calculating an individual's weight in kilograms divided by their height in meters squared. Individuals with a BMI greater than 25 are considered overweight and those with a BMI greater than 30 are considered obese. Prince's team found that extremely obese people (with BMI greater than 40) had an 87-122% increased risk of attempting suicide versus people with BMI between 21 and 40. They were able to show this correlation between men and women, and African-Americans and European-Americans. They then validated these findings in a public database of 41,589 people. They also found an increase in suicide attempts for people who were underweight (with BMI less than 21).

In a separate study, a team led by weight and eating disorders specialist, Dr. Myles Faith, presented information that may explain this phenomena. Taking 44,800 samples from the 2001 Behavioral Risk Factor Surveillance Survey, the world's largest ongoing telephone health surveillance survey, they found that overweight (BMI between 25 and 30) and obese (BMI greater than 30) women were more likely to feel depressed for at least 7 days in a month. This was especially apparent among women 18-64 years old, who where 44-80% more likely to have felt depressed. Hispanic women were at an even higher risk than other women. Men's obesity did not have as much as an effect on their psyche, as researchers could only show a statistically significant increase in depressed mood among men aged 18-64 who were overweight.

As obesity becomes a greater problem in America, more will need to be done to treat its psychological repercussions.

Nanotechnology: A little carbon to stop the fire

New synthetic plastics are replacing traditional metals; but unfortunately, unlike metals, these new plastics are flammable. Many of the flame-retardant additives currently in use are being restricted because of their impact on the environment. A team of researchers from the National Institute of Standards and Technology and the University of Pennsylvania addressed this challenge of finding more environmentally-friendly additives, such as carbon nanotubes and carbon nanofibers, which can be added to plastics as flame retardants.

When plastics burn, they heat until they thermally degrade into small molecules with low boiling points. These molecules instantly form bubbles that rise to the surface, releasing gases, which ignite to fuel the fire. Previous studies have shown that nanoclays can be added as flame retardants to plastics. Nanoclays are composed of tiny disks. When a plastic with nanoclays is heated to temperatures at which untreated plastics would burn, the disks form a layer that prevents bubbles from traveling; however, under the pressure and temperature caused by most fires, nanoclays form cracks, which allow the bubbles to escape and the fire to flare. Carbon nanotubes and nanofibers are shaped like rods and have an extended structure that enables them to form protective layers as well.

The researchers made plastics embedded with either carbon nanotubes or nanofibers. They then burned the plastics in a furnace set at 200°C. As long as enough carbon was added to form a full layer (anywhere from 0.5 to 4% of the total weight), there was a significant reduction in the heat release rate (a measurement of flammability). Additionally, the rate of weight loss decreased as a complete protective layer formed. In fact, once a full surface of the additive appeared, there was no further release of mass. The researchers then looked at the elasticity of the burnt samples and verified that a mechanically stable network formed. The full network structure is necessary for the retardants to be most effective.

In future studies, the researchers hope to investigate other additives such as carbon sheets and nanoclays at high concentrations. They also want to investigate the role of the additive's flexibility and size.
Biochemistry/Pharmacology: Olive oil may be key to Mediterranean Diet

Researchers at Penn’s Department of Chemistry and the Monell Chemical Senses Center recently discovered a compound in premium olive oils that may explain the health benefits of a Mediterranean diet. After noticing that popular anti-inflammatory drug ibuprofen and olive oils produce the same burning sensation in the back of the throat, researchers probed closer and found the compound responsible for that sensation. They named this compound oleocanthal after olive oil (oleo), the sensation (canth for sting) and its chemical structure (-al for aldehyde).

After showing that increasing concentrations of oleocanthal purified from olive oil caused more burning sensations, to rule out the possibility of a contaminant in the purification process, they then synthesized oleocanthal from scratch and replicated the same burning sensation. The researchers then tested this compound’s ability to inhibit enzymes involved in causing inflammation. Like ibuprofen, oleocanthal was found to inhibit both COX-1 and COX-2, but not lipoxygenase.

Ibuprofen has been connected to a decreased risk for some cancers and blood clots. It may also reduce the risk of developing Alzheimer’s disease. Oleocanthal, through its COX-inhibiting activity, may act in a similar manner. The researchers estimated that someone on a typical Mediterranean diet receives about 10% of the ibuprofen dosage recommended for adult pain relief on a daily basis. While this seems low, another compound that inhibits COX enzymes, aspirin, has been found to promote heart health at low dosages. Noticing how the benefits of these anti-inflammatory drugs overlap with the benefits of a Mediterranean diet indicates that this olive oil compound may be the key in explaining this diet’s paradoxical benefits.

Neurobiology: The signature of stress

A team of Penn researchers led by John Detre reported which areas of the brain are affected by stress.

Using a type of functional MRI called arterial spin-labeling perfusion MRI, which measures the blood flow in different regions of the brain using water in arteries, they measured brain blood flow activity as subjects were put into stressful situations. Subjects first endured the low-stress task of counting backwards from 1000. They were then asked to subtract 13 from a four-digit number in their heads while being prompted to answer quickly. After each task, the subjects rated the stress, anxiety, frustration, difficulty and effort required to complete the task. Also, saliva samples were taken and tested for the presence of cortisol, a known stress hormone.

While the areas of the brain normally associated with anxiety and frustration became activated in all subjects undergoing stress, anxiety or frustration, the region of the brain known as the ventral right prefrontal cortex only became activated during stressful periods. It was equally activated under low and high stress, and remained active even after the activity causing the stress ended. The ventral right prefrontal cortex’s activation has been connected to negative emotions, such as sadness and fear, and an increased sense of vigilance. It is not surprising that stress, which is believed to have originated from a fight-or-flight response, would activate and keep active a region of the brain that increases vigilance. Even more interesting is that the region became the most active when the level of cortisol in saliva peaked.

Future research will probe the role of cortisol in this stress response.

Electronic Security: How to evade Phone Taps

As the United States increases its use of wire tapping, a team lead by Penn Computer Science professor Matthew Blaze released a report describing how to evade wire taps using publicly available information and retail, and surplus equipment.

Wire-tapping can include everything from recording what numbers a subject dials to the actual recording of
Wiretapping has a number of inherent flaws, such as the requirement that a subject use the phone or the possibility that a potential evader uses encryption, but history has shown that criminals use phones and that setting up encryption requires effort and cooperation from whoever one wants to call. Additionally, encryption can only protect the audio data, not the call data.

Blaze’s team presents a number of techniques that can be employed by the caller to prevent law enforcement from receiving information.

If the tap is a loop-extender, numbers can be disguised, caller IDs can be spoofed, and the audio recording equipment can be suppressed.

When a number is pressed on a touch-tone phone, an analog signal is produced. Each machine that interprets these signals has its own way of deciding where to make the cutoff between interpreting a signal as one number or another. A potential evader can test to see what the cutoffs are for his phone company’s machine by programming a computer to make a series of calls to nonexistent numbers (555-010X). He can then dial numbers using tones just inside the limits or just outside to evade police detection.

Loop-extender systems use a special audio signal to announce that a phone has been hung up. To prevent audio from being recorded, a subject can send an identical but bogus audio signal. On some equipment, this will end the recording being made. It takes that machine 30-45 seconds to begin recording again. As long as the signal is sent every 30 seconds, nothing gets recorded. The hang-up signal can be played at levels as low as a whisper. If it is played continuously, no audio will be recorded on any machine.

There are also ways to evade detection on some CALEA systems. Because line-extender CALEA systems use the special audio hang up signal, some recorders and decoders use the signal to decide when to stop recording or when to stop sending an audio signal.

Blaze and his colleagues recommend that law enforcement officials move away from old systems and stop using the hang up feature on CALEA systems and recorders. Instead, they advise the use of call data to decide when to stop recording a phone call. These changes should secure our wire-tapping system, which is so crucial in securing the United States.

**Nanotechnology: Insulator to semiconductor**

Penn researchers Hugo E. Romero and Marija Drndic were able to turn an insulator into a semiconductor. Quantum dots, also known as nanocrystals, of Lead (Pb) and Scandium (Sc) 5.5 nanometers wide (for reference, a human hair is about 55 microns, or 10,000 times as wide) were allowed to crystallize in films 3 clusters thick. These crystals of crystals are known as “artificial solids.” Initially, these films were insulators, but as they were heated in a vacuum, they began to act as semiconductors, so that the level of conductance could vary over 10 orders of magnitude. Electron microscopy found that the heating causes the quantum dots to move closer together, which causes the increase in conductance. These PbSc artificial solids are expected to play a role in developing the next generation of optoelectronics (electronics that interact with light such as LEDs, solar cells and lasers).

---

Steve Hershman is a junior in the Vagelos Scholars Program studying biochemistry. He is the President of the Triangle.
Get it Out There!
The Business of Venture Initiation

By Karishma Mehta

Imagine you’re in a computer laboratory, performing the same brain-numbing coding experiments that have been performed by and inflicted on students for the last twenty years. You get distracted by Facebook, and suddenly are inspired by a business idea. Your idea is great, and you pursue it until you think that you can actually sell it to the world.

In 1975, a young man dropped out of college in his junior year to start his own company. Today, Microsoft is the world’s largest software company and Bill Gates is worth an estimated $50 billion. A few years later, in 1984, another young man dropped out of college to concentrate on a company he founded in his dormitory room. Today, Dell is, according to Fortune magazine, the most admired company in the US, and Michael Dell is the 4th richest man in the country. Facebook was created by another Harvard dropout (seems to be a trend), Mark Zuckerberg, just two years ago, and now has the largest number of registered users among college-focused sites (at over six million US college student accounts with an additional 20,000 new accounts being created daily).

These men had guts. They had patience. And they had ideas. There are thousands of students scattered in colleges all over the world with ideas to implement and technologies to commercialize, but how many actually do? This is a brief guide to technology transfer for anyone with an incredible idea and a streak of entrepreneurship.

In order to help us with this issue, the Pennsylvania Triangle approached Mr. Rob Weber, managing director of Antiphony Partners, LLC, who teaches MGMT 237: Management of Technology and MGMT 235: Technological Innovation and Entrepreneurship at Wharton. Mr. Weber is himself a highly successful technology entrepreneur. After graduating from the Jerome Fisher M&T program at Penn in 1982, Mr. Weber helped write the business plan for a musical instrument company called Ensoniq, eventually becoming the company’s director of marketing. In just four years, the company grew to about $24 million in sales. Mr. Weber left soon after and some time later ran a company called Elastomeric Technologies, a manufacturer of specialized electronic components known as connectors.

He sold the business in 1995 and now has his own strategy and management consulting firm, Antiphony LLC, focusing on emerging growth technology companies. The overview that follows is extracted from his opinions and advice.

**SO I HAVE AN IDEA**

If you have an idea, something that you feel passionately about, great, but it is important to analyze its sustainability. While showing enough promise, the idea should provide a sustainable competitive advantage such that customers are prepared to pay enough for it to create a profitable business. Moreover, there should be enough scalability in the idea so that it has the potential to grow into something significant. A feasibility study, which is either a formal or an informal assessment of the feasibility of the business, can be performed. This sort of analysis can be helped by market research—by going around and asking people what they think about the idea and how much would they be willing to pay for the product.

The figure above shows the transition of an idea into market commercialization through the three phases of pure scientific research, development of the technology and finally market presence through commercialization. After completing the scientific research...
phase, to get past technical development into the commercial application phase requires a lot of deep thought about the product and the process used for its development.

**What are my Options?**

*Pursue it*—go ahead and start the company. If this is your strategy, read ahead, we’ll tell you how to.

*Patent it*—Patenting an invention is time-consuming and expensive, so there’s no point in going through the entire process if the idea really has no commercial value. You can also file a provisional patent, which recognizes the date of your invention and provides you with one year to undertake the full patent process.

*License it*—by licensing your invention to external firms, you could allow them to use your invention while paying you royalties for it.

**I Need a Team**

A critical factor for business success is to have a good set of people, and more importantly, a group with a diverse skill set. It’s great to do business with a best friend, but if you and he are both computer nerds with no other sort of skill, it’s probable that you will need someone else with other capabilities. Look at what a company needs: someone to look after its financials, someone to capably market the product, someone to deal with legal or tax issues, etc.

**Getting the Cash**

Any start-up needs capital. How much you need will depend on your business. A simple financial analysis, based on anticipated production and sales, can be conducted to get a ballpark estimate of the initial or seed capital your business will require. For a business that is not expected to grow very fast in the next few years, it may be sufficient to use personal funds or those of your family. However, it will be essential to borrow externally for a high-growth business. So what are the options?

*Equity*—Financing a business with equity gives the financer an ownership stake in the business. Equity has many forms, the most common being shares of stock. Equity is unique in that it’s value changes as the value of the business changes. The advantage of equity is that there is no requirement for repayment. However, the disadvantage is that you’re giving up a part of the ownership of your business, and therefore you may be giving up some control.

A popular way to finance equity is through angel investors and venture capital firms. Angel investors are mainly wealthy individuals that are willing to invest in start-up companies with high potential. These investors often finance the seed money that most start-up companies need. Angel investors usually require equity in return for the investment and can be great sources of advice for a start-up. Venture capital firms are slightly different. These are professional firms that pool together money from various investors, such as pension funds, and lend to new and growing firms. However, they are more interested in somewhat established companies and provide larger investments. They may also play a part in the management of the company, and, as a result, are often perceived as being interfering and domineering. For all these types of funding, an appealing and convincing business plan is essential.

**Debt**

Loans can be used as start-up money. The best place to look for an initial loan would be your personal bank, with which you already have a credit history. Moreover, loans can be taken from close acquaintances, including family members, but it is best to remember not to put other people’s money at unnecessary risk. For bank loans, you may probably need some sort of security or collateral, such as equity in other companies or personal assets. A

---

**Are you an entrepreneur?**

“I don’t think that you can teach somebody to be an entrepreneur. I think it’s something that you’re either born with or has developed early, usually by the time people have made it to college, and definitely by the time they’ve graduated. If they haven’t shown it it’s not likely to show itself.

Look to see if [you] did things entrepreneurial growing up. Did you have your own paper route, did you mow lawns, did you have your own little business that you set up to make some money? How are you getting yourself through college? How do you generally tend to think about things? Is it the best opportunity to be able to create something or is it to have the best company that is coming to campus to recruit? That mindset is not something I could ever teach. What I think we can do is we can give people who have that innate interest and desire some of the more interesting experiences and tools to make them more effective at doing it. If someone it trying to decide whether they’re an entrepreneur or not, then they’re not.“

-Wharton Professor Rob Weber
“Writing a business plan will help you formulate your own ideas about how the business should function.”

A loan could be obtained in as quickly as a few days or as long as several weeks, depending on the amount requested, your personal credit history, as well as collateral availability.

**What’s a Business Plan?**

A business plan is a rough guide to your business and is a sort of “road map” to where it is heading. Drafting a business plan is almost essential to starting a business. A business plan could talk about the history and development of the business, an overview of the products and services, strategies about marketing, management, funding and human resources, and about any financial projections that you may have.

A business plan has two main uses. It is usually essential to have one in case you seek financial help from angel investor, venture capitalists or banks. But, more importantly, writing a business plan will help you formulate your own ideas about how the business should function. A business plan can sometimes be time-consuming but it helps you understand your own business and makes it easier for you to be able to explain it to outside parties. Some of the usual aspects that can be included in the business plan are as follows:

*Mission Statement:* a brief description of the basic purpose of the company.

*Executive Summary:* an exciting and inspiring analysis of the entire business plan and its intentions, with a brief description of the functioning of the business.

*Industry Status:* an analysis of the industry that the business intends to enter as well as the risks and rewards of entering it.

*Target Market/Customer Base:* a description of whom it is that you are aiming to sell your product or service to. An identification of the target market is essential for the basic strategy of the business. Also, a description of the intended marketing strategy could be included.

*Marketing Plan:* a description of products or services, business locations, sales goals and your personal differentiation from any competitors.

*Production and Operations Plan:* an explanation about how you intend to produce or provide the good or service. In this section, you can talk about the facility, equipment and processes used in manufacturing and providing your product or service.

*Management and Human Resources Plan:* a description of your team and the key players of the business. Also, an explanation of the managerial structure of the business, such as a corporate hierarchy, could be included.

*Financial Plan:* your plan for obtaining funding and how you to intend to use the funds.

So what’s stopping you? It’s actually simpler than it looks, and more exciting than you can imagine. The best entrepreneurs of the world will tell you about the adrenalin rush they’ve experienced creating something of their own and watching it prosper. The first item you sell, the first dollar you make, and later on, your first office, your first public offering, these are things that people dream about. Don’t waste a terrific idea, either by not acting on it or by acting too late. Be brave enough to be the first one in a brand new field. The time to act is now.

Karishma Mehta is a junior studying bioengineering and management.
The Learning Machine

Can the $100 laptop really rid the digital divide and better education worldwide?

By Ju Tan

This fall, MIT Media Lab’s Nicholas Negroponte plans to start shipping a $100 laptop across deserts, over mountains and through forests to millions of school children in Argentina, Brazil, China, India and Nigeria. No larger than a medium sized paperback, the 1 kg laptop, dubbed the “green machine,” holds promises too big for its compact package.

The One Laptop Per Child (OLPC) non-profit organization, based in Delaware, was set up to oversee the project. Despite the enticing price tag for the laptop, OLPC has yet no plans to sell them commercially. Instead, the organization will sell them only to governments who order at least 1 million machines at a time. The plan is that these governments would then distribute the laptops to school children in their respective countries, who will use them in place of traditional textbooks.

Negroponte - the father behind the idea – presented a prototype of the $100 laptop with Secretary General Kofi Annan of the United Nations at a world summit on information technology in Tunis last November. Though they struggled to set up the malfunctioning prototype, Negroponte and Annan promised to help rid the digital divide that plagues education in rural schools worldwide.

Negroponte explained, “It’s an education project, not a laptop project. If we can make education better—particularly primary and secondary schools—it will be a better world.”

“Creating and distributing inexpensive laptops will allow students to become more active and creative, letting them take their learning beyond the walls of their schools and off the pages of textbooks and writing tablets. These machines will permit students to move beyond static, information-centric views of computing and learning by providing a vehicle for experimentation and collaboration,” said Lucy Ringland of Red Hat.

Ironically, Annan’s praises of the laptop as being “robust” and “versatile” were unhinged when he accidentally
twisted off the prototype's hand-crank during the unveiling.

Undeterred, Negroponte made plans with Massachusetts' Governor Mitt Romney to purchase and distribute this device to all schoolchildren in his state. Negroponte’s project has caught the attention of Google Inc., Advanced Micro Devices Inc., Red Hat Inc., News Corp. and Brightstar Corp., who have each pledged $2 million to fund the OLPC project.

As it is, the $100 laptop sounds like alchemy. Put technology in the hands of poor children and they will learn magically; they will rebuild crumbling infrastructures; they will create flourishing economies. That is debatable, however. Judging by the incredible manufacturing, distributional, and social obstacles, Negroponte will need to plow millions of dollars into this project in order to bring any of the promised educational and economical benefits to Third World communities.

Manufacturing Issues

Before they can ship out the laptop, Negroponte and his team at MIT's Media Lab must finish designing their laptop, ensuring that it will meet the needs of school children worldwide while enduring the extreme conditions of rural environments.

Apple’s chief executive, Steve Jobs, had offered free copies of Mac’s OS X after learning of the project. However, Negroponte chose instead to load an open-source-distribution of Linux by Red-Hat. His reason: with Red-Hat’s open-source software platform, students can learn to customize and expand their computer as their learning needs grow. What’s more, the success of the project will depend largely on the development of free language packages and software upgrades by programmers worldwide. The question is: if most of these school children have never even used a computer before, how could they possibly learn to create their own programs? Even most kids in developed countries who use computers on a daily basis do not know the first thing about programming, especially for the Linux environment.

“CommuniTech [Penn Engineering’s student organization that seeks to bridge the digital divide] has had many discussions of switching to Linux, but [we] eventually decided that it was best to keep Windows. This way, anyone trained on our computers will know how to use most computers they encounter. Linux knowledge is useless in a Windows world,” said CommuniTech’s Technical Director, Steve Hershman. Likewise, for the programming community to develop programs for each language is an impractical feat, especially when most languages cannot be referenced from keyboard inputs.

Another limitation to the proposed design of the laptop is its storage – or rather, lack thereof.

“With only 512mb-1Gb of memory and no optical drive, the only way the laptop can get content is through a wireless network to a data center or the Internet, which is not always available, or through the USB port,” said Hershman. The prototype did incorporate a Wi-Fi mesh technology that in theory will form an ad-hoc wireless network between laptops. As long as one student is connected to the Internet, the mesh network will allow other students to bond with this laptop and extend the single Internet connection. Annan hopes that “children will be able to do a lot of self-learning, opening up fronts for their education, particularly through peer-to-peer learning.”

Unfortunately, as the single Internet connection is shared between dozens of students, it will become too slow for practical purposes. Furthermore, in order for the mesh concept to work, each computer that forms the mesh network would have to remain on. Otherwise, the mesh will have broken links. In countries that do not have reliable power sources, keeping a computer powered 24/7 would be a major issue.

“Too install a computer in a developing nation, you must first buy some sort of device to regulate the voltage (spikes and surges will kill most computers in about a year). In Cameroon, it took almost a week to get electricians to buy the required equipment. During rainstorms, we had the power go out on us. In that case we would need to use a car cigarette lighter to power the computers and monitors,” said Hershman.

Luckily, Negroponte and his team at MIT's Media Lab did install a hand-crank on the side of the laptop that powers the rechargeable batteries when no power outlet is available. By winding the hand-crank for 1 minute, Negronite hopes that it will generate 100 minutes of battery life. Also, the power adaptor for the laptop will double as a shoulder strap when not...
However, if Annan had not twisted off the “alchemic” hand-crank during the demonstration, he would have realized that the 100:1 ratio for providing power is unrealistic. “A hand crank of 6 inch (15.24 cm) length operating at 2 turns per second would require a tangential force of 11.8 pounds (5.3 kg), assuming 100% efficiency of generation and storage. This would tire a strong adult quite rapidly. It would seem apparent that the figure of 100:1 was arrived at by means other than calculation,” said Lee Felsenstein of the Fonly Institute on his findings.

At the same time, credit is due to Negroponte’s team for developing a dual-mode display that has excellent sunlight readability that costs approximately one-third as much as a typical $100 LCD. To achieve this feat, Negroponte pulled in Mary Lou Jepsen from Intel’s display division. After months of research, Jepsen discovered a way of increasing the resolution on DVD player screens, which are much cheaper, to make them suitable for laptop screens (a special grating pattern is used to diffract white light into a color spectrum that aligns and illuminates their respective RGB subpixels). The dual-mode display operates in both an 800x600 pixel resolution color mode for web-surfing and a 350x470 pixel resolution black-and-white mode for conserving power while reading ebooks.

Still, the $100 price tag only allows for the general use of cheap, low-power consuming parts, such as a 500 MHz 1.0W processor from AMD. With its less-than-impressive hardware specs, we can only question just how much of Annan’s promise is true: “It is an impressive technical achievement, able to do almost everything that larger, more expensive computers can do. It holds the promise of major advances in economic and social development. This initiative is meant to bring it forth into the light of day.”

Intel Corp’s Chairman Craig Barrett argues that the green machine will not be powerful enough to suit the growing needs of computer users who demand full-functioning PCs that can run applications of “grown-up PCs.” “Mr. Negroponte has called it a $100 laptop—I think a more realistic title should be ‘the $100 gadget’,” said Barrett. “The problem is that [such] gadgets have not been successful.”

**Distributional Issues**

Though no one has attempted a large scale computer distribution project in the past, many small initiatives have been made. For example, one successful method of helping the digital divide in India was taken up by intra-dependent businessmen. In cities and suburbs, small computer shops were setup to build and refurbish old PCs before selling them to locals. The local shops were generally successful because they recognized a critical fact: used computer parts were readily available, and often free. Thus, the fixed costs of operating the shops were minimal.

For instance, Hershman revealed that only 8 of the 60 computers they installed during their trips were purchased. The rest were donated.

“It turns out that almost anywhere you’d want computers, you can find them. The key is distributing them and seeing that they [are] supported,” said Hershman.

Also, just as important, the salesmen at these shops were very flexible; building PCs that agreed with the customer’s needs, whether it was installing specific software, helping to setup the computer in homes or finding an affordable price. Instead of focusing on building the cheapest PC possible, these shops concentrated on meeting individual customer demands. Economically, these market systems were able to “accommodate themselves to changes in consumer tastes” and allocate technology and resources supplies efficiently. Thus, demand dictated supply. On the other hand, with the OLPC Negroponte is trying to dictate demand
"It is a very clever marketing tool. Under the guise of non-profitability, hundreds of millions of these laptops will be flogged off to our governments. That's the only way of achieving the necessary economies of scale to get the price low," said Mohammed Diop of Mali at the UN summit.

In essence, with the market system in India the equilibrium price of the PCs could be adjusted so that the quantity supplied equaled the quantity demanded. More so, the competition between these local shops for customers promoted a market system that was guided by an "invisible hand that channeled the pursuit of self-interest to the good of society."

Unfortunately, engineers at MIT's Media Lab have yet to see that the issue is not cutting down costs of PCs. Even if these engineers were able to reach the $100 price—1/5 the cost of a cheap commercial laptop—economists still worry about the affordability of a $100 million tab for a minimum order. For developing nations, paying for a million laptops that are obsolete to the modern PC standards and distributing them for free is intangible and impractical. Especially when

Three generations of prototypes being explored by the MIT Media Lab
considering that thousands of used PCs are thrown away each year in the US. Also, the laptops may be impersonal, manufactured with American standards.

Moreover, with all the emphasis on how to make the hardware work, Negroponte may have forgotten to consider how to make the infrastructure work – how to provide support for the laptops. In India, the shops were easily accessible by locals who needed support with their computers. Replacement parts were cheap and services were cost-effective. This support infrastructure ensured that the computer they sold worked not only today but also years down the road. Conversely, OLPC has given no consideration to such tech support for their laptops.

“I’ve noticed that just giving computers doesn’t work. It’s important to have people there to make sure the computers get used…and to make sure they get used correctly.

For example, during setup] we had many equipment failures. We sent about 30 computers to Cameroon. A few died during transit and the remaining computers’ RAM failed. In India, a few of the computers we had donated were broken as well,” said Hershman.

Even with the $10 million raised, OLPC does not have enough money to distribute the 100-150 million laptops that Negroponte wishes to ship out. If this remains the case, then the burden of distribution would rest on the shoulders of governments. These are hidden costs that would add to the already hefty $100 million price tag.

Social Issues

Besides failing to consider the cost of distribution and maintenance, Negroponte has given little consideration for the social issues that they may face. “Even if we were successful in distributing these laptops to the school children,” John Fisher, CEO of UK Charity Citizens argues, “computers still appear unfriendly and difficult to master for those who have never used them.”

In short, how can Negroponte assume that the school children will embrace these laptops with open arms? Lee Felsenstein of Fonly Institute points out that cultural barriers may hinder the acceptance of these laptops by the families of school children as well: “In developing societies[,] children are perceived to have a place in helping the family advance, not in racing ahead and leaving the family behind. Unless it is evident that the laptop will improve the prospects of the family[,] then support within the family may not be forthcoming, and the laptop will likely be converted to cash. It would seem apparent that serious social research must be done to determine family, village and societal attitudes before proceeding with a program like OLPC.”

Likewise, at the UN summit, African official Marthe Dansokho was quick to point out that the project was based on an American vision that did not address the real problems of poverty and education in these countries. “African women who do most of the work in the countryside don’t have time to sit with their children and research what crops they should be planting...what is needed is clean water and real schools,” said Dansokho.

In the wake of such incredible social, distributional and manufacturing obstacles, Negroponte’s OLPC initiative is economically infeasible. What he has done is brought to the world stage the international importance of issues of the digital divide and education. What he has not done, however, is actually bring a working solution. Instead, Negroponte’s hawked-eye focus on the hardware aspect of the project leaves prey economical and social concerns. Unless Negroponte truly recognizes that this should not be a laptop project but an education project, his dreams will never reach across deserts, over mountains, and through forests. They will, unfortunately, never reach school children worldwide this fall.

Ju Tan is a sophomore studying computer science engineering.
Few technologies exist today that can top the Internet in terms of providing a constantly expanding field whose impact on our lives continues to grow without bounds. More and more, the developments in net technology demonstrate just how much the Internet affects our lives, and, more importantly, how much more it could potentially determine the course of our lives. In fact, one need not look farther than the front pages of daily newspapers to find evidence of our society coming to terms with our newly crafted digital world. And what better example to choose to illustrate this point than Google, the company that has taken the Internet by storm over its modest seven-and-a-half-years of incorporation, and that has recently become the focus of media attention over a multitude of issues with far-reaching social consequences.

Digital Books for a Digital World:

Only a few years ago (although to some it may feel like eons) you had to spend day after day at the library to obtain all of the sources for your history paper or product study. Now, simply take a computer and a modem, connect to the Internet, and gain instant access to hundreds of thousands of terabytes of information. Few can deny the effect that the Internet has had on each individual’s ability to garner information about the world around them. As if that weren’t enough, Google is seeking to make even more information available to you online through its project to digitize millions of books, a plan followed by similar promises by other top search engines, including Yahoo. What might the implications of this effort be? Certainly there is the fact that the information at your fingertips will grow almost exponentially. And, as more and more information can be easily accessed by greater numbers of people, innovation and the marketplace of ideas are bound to grow. And if these benefits aren’t enough you need only look to some of the lingering doubts you may have in the back of your mind right now. You may be wondering what will happen to libraries if all books sooner or later become digitized? And you might be surprised to discover that if you are looking for people worried about that future, librarians may be the last group you would want to talk to. Despite or perhaps even because of the advent of the Internet, library usage across America has been increasing, and many proponents of plans to digitize point out that as more information becomes digitized, libraries will still remain hubs for people to obtain free access to the Internet, find hard copies of copyrighted digitized materials they found online, and search the vast amount of information available to them in more efficient ways. Another significant ramification exists in the legal realm, where book authors and book publishers may have to face the same piracy issues as those that currently plague the music industry. This is worrisome to say the least, but Google and other digitizers of books plan to incorporate tough copyright protection into their projects.

A Question of Rights: Privacy and the Internet:

Despite its great potential to make our lives easier and our work more efficient, the Internet, like most other technological revolutions, brings with it the potential for harm. The Internet’s pervasive presence in our lives affords it a dangerous potential that few other technologies have experienced. When the Justice Department subpoenaed Google in early January for some basic search statistics to support a case for stronger federal laws to shield children
from pornography, Americans got a taste of that potential. It should be noted that the government asked only for search statistics, nothing actually linked to users. Now, one might ask if that was indeed the case, then ‘what’s the worry?’ Well, it might surprise you to know how much search engines know about you. Google, Yahoo, and MSN, as well as other search engines, track what sites you visit through the use of cookies, and, of course, have any information you have given them when signing up for email, Messenger, and the wide array of other services that these companies offer. What’s more, all this data can, if one really wanted to, be linked together, creating a file on every searcher on the web. This implies that when the government asks for this kind of information, it is taking the first step down a path that permits your personal information, as well as a history of what sites you have visited, to be readily available to the government, or perhaps the highest bidder. Fundamentally, this conflict spotlights the ethical issues concerning how far our implicit right to privacy extends in our travels in the cyber world, and just how easy it might be for large corporations or the government to obtain information about those travels. The Justice Department isn’t asking for the information for the purpose of national security, it is asking for the information in order to support a case it wishes to make, and it doesn’t take a leap in thought to see other organizations asking for similar, if not more specific information, for their own purposes. Google has, to date, refused to hand over any information, citing privacy concerns, and it is expected that a federal judge will likely order at least some search results to be handed over.

A Question of Rights Redux: Speech

The picture of rights and freedom that Google has painted cannot be described as all good, despite its dealings with the Justice Department. Google has recently taken a lot of flak for making an agreement with the Chinese government to allow access to Google for the enormous and ever-growing Chinese population in exchange for censorship of search results and a lack of the blogging and email tools that Google has developed. Critics and proponents of Google alike have often focused on Google’s now infamous corporate ethic of “Don’t be evil,” and now critics seem to have gained some ground. Few can deny that low-towing to the repressive Chinese government sends the message of, at the very least, tacit support, and given the huge market potential in China, seems to point out that Google may be more profit-driven than it likes to advertise. However, this article does not seek to judge Google on its decision. The very fact that many argue that the only way to undermine repressive regimes is to foster whatever free access to information you can, demonstrates that there is active debate in that regard. Instead, this article simply seeks to point out that the power to control how other people can access information is perhaps the greatest power one may be afforded, and any choices that Google and other search engines make will have very pronounced ramifications in society and in how we define our rights. Given the plethora of information available on the web, search engines and Internet service providers are in great positions of power, and every individual should critically analyze the decision they make.

Conclusion:

Having read this article, you might wonder if you have just read about the portion of the Internet concerning Google, or about the technology as a whole. The key to answering this question for yourself lies within understanding the position Google finds itself in. Namely, Google has become the average web users’ portal to the web with its messaging and email services augmenting that portal. Thus, Google and other search engines like it exists on the cutting edge of information technology, the first to realize the consequences of Internet trends and the first to create new Internet trends that affect our lives. Keep watching for news about Google and its competitors and you will be sure to find the best hints at what is to come for this great technology and for society itself.

Easwaran Subbaraman is a junior studying computer science.
Greek mythology describes the story of Prometheus, the eternally condemned immortal who brought fire, a form of plasma, to humans. Over the centuries, people have molded this gift into a technological resource for emerging innovations. Today, the Ad Astra Rocket Company (AARC) harnesses the power of plasma to revolutionize our approach of space exploration.

Plasma, the fourth state of matter, is an amazing energy source comprised of ions and electrons dashing through scorching temperatures exceeding 100,000 degrees Celsius. The burning temperatures restrict any known material from handling plasma. However, magnetic forces succeed in manipulating the matter without any physical contact. The Variable Specific Impulse Magnetoplasma Rocket (VASIMR) engine, developed by the AARC under the leadership of Dr. Franklin Chang-Díaz, currently controls plasma energy to create a rocket propulsion system. The plasma motor will empower us to reach the horizon of Mars in a three month voyage and pioneer the worlds beyond.

VASIMR Technology

And how, may you wonder, do the intricacies of the VASIMR engine work? The engine not only yields impressive results, but also inherently avoids common challenges through a unique design. The VASIMR engine first ionizes a gas, typically hydrogen, into plasma. The energy is then expanded and ejected through a controlled flow, also called modulated thrust. Throughout the process, electromagnetic waves accelerate and guide the plasma through three magnetic chambers: the Plasma Source, the Radio Frequency Booster, and the Magnetic Nozzle.

As illustrated in the scheme of the VASIMR, a neutral gas is first injected into the first chamber. Once inside the Plasma Source, the gas is ionized into plasma. Electromagnetic forces then guide the plasma into the central chamber, the RF Booster. Here, radio frequency waves and ion cyclotron resonance amplify the plasma to a desired temperature and density. Finally, the Magnetic Nozzle controls the ejected thrust through exhausting the plasma with gas and magnetic forces.

Technical advantages

Why is the VASIMR's elaborate design so remarkable? To better understand the potential of the engine, we clarify two terms of rocket propulsion: thrust and specific impulse. Thrust is the force ejected from the engine. Specific impulse measures the speed of the ejected fuel, or in other words, the thrust per unit of propellant.

As the name Variable Specific Impulse Magnetoplasma Rocket indicates, the engine controls both high variable thrust and a specific impulse at maximum power. The Magnetic Nozzle controls the flow of the ejected energy through the constriction and expansion of a magnetic choke. Thus, in the future, instead of orbiting Earth to escape gravitational pull, rockets may soar directly into space. The shorter trajectory will decrease fuel costs and save valuable time. In addition, the residual magnetic forces controlling the plasma will partially protect astronauts from the radiation of cosmic rays.

Wait – there's more. The electrode-less design distinguishes the VASIMR from alternative approaches; the engine achieves greater reliability and power densities because electromagnetic waves, rather than physical matter, heat the plasma. Furthermore, hydrogen fuel not only significantly reduces costs, but is also abundant throughout the universe.

Biography of Dr. Franklin Chang-Díaz

Dr. Franklin Chang-Díaz, CEO and president of Ad Astra Rocket Company, has directed plasma rocket propulsion research over the past several decades. After completing a Ph.D. in applied plasma physics and fusion technology from the Massachusetts Institute of Technology (MIT), he began pioneering work on the guidance of fuel pellets in an inertial fu-
Born in Costa Rica, Dr. Franklin Chang-Díaz became the first Hispanic-American astronaut; he has logged more than 1,601 hours in space over the course of seven missions. His accomplishments have been honored with 7 NASA Space Flight Medals, 2 NASA Distinguished Service Medals, 3 NASA Exceptional Service Medals, and the Liberty Medal from President Ronald Regan.

Now, more than ever, Dr. Chang-Díaz propels forward the breakthroughs in the development of the VASIMR engine. In July 2005, he retired from NASA to venture into the commercialization of the plasma engine with support from NASA JSC and other prestigious institutions. This year, he established a new Costa Rican subsidiary to support the Houston-based AARC in the development of a novel prototype in 2007 and future versions for space experimentation in 2010 and 2011. Dr. Chang-Díaz hopes to promote Costa Rican technological innovations through the progress of the VASIMR engine. Urging Costa Rican youth to pursue their highest dreams, he remarked “We will contribute to the sustainable development of Costa Rica through multidisciplinary research with society. It is the knowledge-based economy. We are not cultivating potatoes or onions, we are cultivating ideas” [translated statement].

Interview with Dr. Franklin Chang-Díaz

On February 2006, Dr. Chang-Díaz shared his perspective with The Pennsylvania Triangle on the opportunities that the VASIMR brings to the world. The following is an edited transcript of the interview.

1. Your life changed the day you decided to look beyond NASA to attract private funds for plasma energy research. What is a day in your life like? What do you enjoy the most about the new stage of your life?

The days are just as busy if not busier than before. But there is a sense of empowerment and freedom that I did not have at NASA. Decisions are made much more quickly and progress is much faster. I enjoy most the adventure of trying to achieve this vision and the enthusiasm I see in my team. Now that we have healthy and stable funding, long range planning for the project is much more real and rewarding.

2. Besides rocket propulsion, you have mentioned that the VASIMR engine offers alternative applications in toxic waste destruction, solar energy and materials technology. Please tell us more about your vision in these areas. Which of these applications do you think will most likely be implemented the soonest?

The disintegration of medical waste will probably come first. It is technology that is already on the market. We are undertaking a collaborative project with Integrated Environmental Technologies to set up a working facility in Houston in support of the Texas Medical Center. Other applications of plasma technology, which we are interested in for the developing world include water purification and advanced materials.

3. What influenced you to think about plasma energy sources and their possible applications?

Plasma technology is very diverse and, thinking as a businessman, I must look after opportunities for our company to compete in the high technology market. I also believe that plasma technologies can be relevant to solving the problems of the developing world and truly reach sustainable development.

4. The new subsidiary of Ad Astra Rocket in Costa Rica is determined to support the development of the creation of a plasma engine prototype by 2007 and future models for space experimentation. Which aspects of the NASA culture do you wish to replicate in the new laboratory you are constructing in Costa Rica and which do you wish to improve upon?

I would like to bring some of the technical project management expertise that I learned over 25 years in the space flight business, the engineering rigor of spacecraft development and the configuration management aspects that ensure quality in system integration. I wish to achieve a better symbiosis between the scientist, the engineer and the manager than what I saw at NASA. All three are key and indispensable elements in a successful high technology project. Ultimately, I would like to “grow” scientists who are also good engineers and that can also manage. I also wish to improve on the speed of the decision making process by shifting decision authority deep in the organization structure, thus reducing bureaucratic layers and empowering the team members directly.

5. What potential do you see in the future of the Costa Rica Astra Rocket Company?

The potential is awesome for Costa Rica. Many of our excellent scientists and engineers could be able to participate in developing advanced technology, which would be “home grown” and hence patentable. We will help Costa Rica transition to a knowledge-based economy.

6. What are the main challenges that your research team currently focuses on overcoming?
The main challenges are engineering ones associated with the packaging of the device into a working engine. Some of the more challenging issues are system control and thermal management. A great deal of the activities in Costa Rica will help us solve these problems.

7. Ad Astra Rocket Company envisions “To revolutionize space exploration, through the development and commercialization of the VASIMR engine and related technologies.” Which of the parallel projects to the VASIMR engine do you perceive to have the largest potential to benefit humanity?

In the short term, the waste remediation technologies I mentioned before may have the greatest potential; in the medium term, the VASIMR engine itself will help expand humanity’s presence in space beyond exploration and into space industry and commerce. In the long term, I believe VASIMR is a precursor to fusion rockets, using fuels such as hydrogen and Boron 11 to sustain an ignited thermonuclear burn suitable for ultra fast space transportation throughout the entire Solar System. Perhaps in this way, we may contribute to humanity’s survival.

8. Since 1979 technological inventions have revolutionized the world. Emerging technologies have helped improve the VASIMR; such as implementing lighter superconducting magnets to control the plasma. Which other technologies have risen in the past decades that have significantly contributed to the development of the VASIMR engine?

Light weight, high temperature superconductors are certainly on the list, but there are others, such as high power, compact solid state RF (radio frequency) technology, advanced materials such as CVD (chemical vapor deposition) diamond for thermal management and certainly the major advances in supercomputers and parallel processors, which have helped us develop our understanding of the physics and aided in the modeling of the complex processes at work in most plasmas.

9. Please tell us about your dreams for the years to come. What future projects do you have in mind?

The sky is the limit…

“**The plasma motor will empower us to reach the horizon of Mars in a three month voyage and pioneer the worlds beyond.**”

Valeria Montero Garnier is a sophomore in the Wharton School of Business.
Engineering Fractals

Taming Monsters in Engineering
By Rajiv Krishnaswamy

If I were to ask you to describe Fractals in general, would you express them as “pathological” or even “a gallery of monsters”? Most of us associate fractals with esoteric patterns, shapes that provide excellent models of landscapes and natural features such as mountains and forests. But much before the term Fractal was coined by Benoit B. Mandelbrot, the class of objects now referred to as Fractals were indeed regarded as a gallery of monsters by most mathematicians who were familiar with them, shapes that did not follow the familiar patterns of Euclidian geometry.

In his book The Fractal Geometry of Nature, Mandelbrot demonstrates how the “monsters can be tamed” mathematically and argues for their use in dealing with many shapes in nature such as trees, rivers and clusters of stars, while also making use of computer simulations to show many beautiful and often stunning fractal shapes. Since its first publication in the 1970s, Mandelbrot's book has been instrumental in popularizing fractals and the study of fractal geometry, which has shown that there is some potential for their use in engineering.

What are Fractals exactly?

A fractal could be defined as something that is “self-similar”, or something that has the same shape whether its magnification is scaled up or down. A popular example to illustrate this is a coastline, which has the same shape over a wide range of magnifications. A coastline is hence considered fractal over all those ranges over which it displays the property of self-similarity. Fractals
are represented mathematically by a characteristic of theirs known as a Fractal Dimension. The concept of a fractal can be understood by considering an example of a simple fractal like a Sierpinsky Triangle shown here.

The Sierpinsky Triangle is formed by removing the center portion of an equilateral triangle in the first stage to form 3 copies of the original triangle shape. In the subsequent stages, the middle portion is removed from the copies and the process can be continued ad infinitum. The Sierpinsky triangle is found to have a Fractal Dimension of 1.585, which shows a fascinating aspect of fractals. They are not regular 1-, 2- or 3-dimensional shapes but in fact have fractional dimensions. Many fractal shapes like the Sierpinsky Triangle have been created, but it is important to note that fractals also occur naturally. Some examples of natural fractals that exhibit self-similarity over wide ranges include branches, trees, cloud patterns, lighting, or arteries in the human body. And where might fractals be used in engineering? Here is a look at some of the possible applications of fractals in technology.

Geometric Art for Simulations and Models

Not surprisingly, among the first fractal applications was in the field of computer graphics. Mandelbrot, in the Fractal Geometry of Nature, used computer simulations to demonstrate the fractal shapes and their use in the generation of realistic mountains, planets and islands and did much to stimulate interest in fractals as an art form. The book even discussed the subject of Fractals as a new form of “Geometric Art”. A direct commercial application of fractal graphics was their use in movies. One of the first movies where fractals were used for generating landscapes was Star Trek II, The Wrath of Khan. Another early interest in the use of fractals was in the area of geological and environmental sciences. Fractals have been used to model nature extremely well, and computer-generated fractal terrains can be used as accurate models to study many natural phenomena such as soil erosion or the flowing of rivers.

Image Compression

In the early 90s, Fractal Image compression techniques based on a Fractal Transform method using a fractal known as Iterated Function Systems, or IFS, seemed to be a promising fractal application. The basis for the compression technique was that many parts of an image are similar and the similarity can be used to recreate the images after compression. The Microsoft’s Encyclopedia Encarta used Fractal Image compression to store all its articles, animations and images on a single disc. However, the technology could not match its competitor JPEG and has died out in commercial applications. Yet the fact remains that fractal compression does offer several advantages over JPEG, such as faster decompression. Also, significant research has continued to be done in areas of fractal image compression and in areas using similar mathematical foundations, such as fractal imaging, fractal image recognition, fractal speech processing, fractal-wavelet hybrids and so on. Given the research that is being done in these areas and the fact that the industry is willing to look at how some of these techniques can be applied to their technologies, we can expect to see more practical applications in these fields in coming years.

Engineered Fractal Geometries

The use of physical fractal geometries in applications is a more recent study of fractals, and some these manufactured fractals show tremendous potential in improving the performances of devices or systems in a range of fields. A look at some of these fractals shows some very exciting possibilities for this field, which may eventually find increasing use in real applications. One category of engineered fractals is fluid transporting fractals, essentially fractal-shaped pipes. Many fluid processes involve scaling the fluid and transporting the fluid from one container or pipe of a certain volume to another with a larger or smaller volume. Since fractals are self-similar over various scales, using engineered fractals in these processes allow them to become less turbulent, and therefore more controlled and predictable. Complex fractals designed for this purpose have the potential for use in applications such as chromatography, ion exchange and turbulence suppression. Another engineered fractal example is the Fractal Fiber array. The fiber array is made by arranging seven fiber-optic cables with one cable in the middle and six around it. Such an arrangement resembles a fractal known as a Gosper Snow Flake. The fractal fiber array, being much more ordered than regular fiber arrays, theoretically offers better optical performance.

The Fractal Antenna

The most successful implementation of engineered fractal geometries to date is the Fractal Antenna. These are antenna elements that have been shaped to form fractals. In fact, many of these antennas are replicas of common fractals such as the Sierpinsky Triangle. The use of fractal geometry in antennas allows the size of the antennas to be decreased for a given frequency of operation. Sizes can be reduced by up to four times with surprisingly good performance. More significantly, fractal antennas, unlike normal antennas, operate optimally at
multiple frequencies, making them ideal multi-band antennas. Fractal Antennas are extremely popular and are widely used, especially in applications that require their small size. Fractal Antennas are integrated into most mobile wireless devices such as cell phones and PDAs, and are also used as base station antennas for various networks. They also make excellent conformal antennas, antennas designed to mold into irregular structures that are required in applications such as antennas for aircraft.

And what else?

So much more! Fractals are all around us, in nature and in so many of our activities and creations. It would be difficult to make an exhaustive list of the potential applications of fractals and this article is but a very brief overview. What remains to be seen is how many of those applications will translate into successful practical implementations. In any case, fractals still remain an interesting object of study.

Fractal Image compression is best suited for shapes that are natural fractals like trees and branches.

Rajiv Karishnaswamy is a second-year Masters student studying Electrical Engineering.
Venture across 34th street sometime. Depending on the time of the day, you’ll experience two very different situations. The first requires you to weave between seemingly deadlocked traffic. The second allows you to walk across with nary a car in sight. Clearly, both situations are sub-optimal; either time is wasted through congestion or capacity is wasted through a dearth of drivers. The solution to these problems is clear, and economists have been arguing for it for decades: congestion pricing.

What is congestion pricing? Broadly speaking, it is the practice of charging drivers a certain fee based on when and where they drive.

“Wait!” you say. “Not only do I have to pay for any license registration fees and gasoline, but now just for the simple act of driving?” The answer is yes, but it’s not as odious as it sounds.

Presently, driving is a bargain. Except for registration fees and gas taxes, it’s essentially free. Yet the act of driving still imposes a cost on society. The first is through pollution; the second, and more costly, is through congestion. What is congestion? Essentially, it is the condition that arises when a large number of people want to pass through a given point at the same time. This creates a bottleneck situation, whereby merely driving is enough to cause congestion behind oneself. This cost, however, is never experienced by the person who causes congestion and, as such, is never taken into account in driving decisions. In economic parlance, people base their driving decisions on the average cost, not the marginal cost, which is quite higher during periods of heavy demand. Congestion pricing is therefore just an extension of what you learned in ECON 1: make users pay the true marginal cost, and the problem should sort itself out.

“Academic hogwash!” you bellow, not wanting to believe that being forced to pay to drive is in everyone’s best interest. “Just how”, you ask, “does the problem sort itself out?”

Think of it this way: you attach some value to the time you spend at home, but you also attach some value to the ability to not be late for work. You even attach some value to being early to work, which is probably less than being at home. Everyone, therefore, wants to get to work exactly on time. This is precisely what causes congestion, which in turn
causes us to either be late to work or forces us to leave home much earlier than we normally would. Congestion, therefore, robs us of a certain amount of value. If drivers were forced to pay a certain amount based on how congested the road was, there would be no incentive for everyone to leave at the same time to get to work at the same time — what you believe to be the optimal use of your time is destroyed by the time-delay effects of congestion. Instead, forcing users to pay the “external” costs of congestion means that there is no advantage to leaving at a particular time — the cost (whether through the indirect method of congestion or the direct method of pricing) is the same in all cases. In other words, there is a disincentive to continuing current driving patterns, as moments of high congestion will now be priced higher. This effectively smooths out demand and eliminates the bottleneck, whether this is through people shifting in time entering the roadways, carpooling to decrease the average cost per passenger, or taking mass transit to avoid the charge completely. This solution is what is known as “Pareto-efficient” because there is no net benefit or loss to the system as a whole (any money paid is simply a wealth transfer to the government). As William Vickrey put it in his famous 1969 paper, Congestion Theory and Transport Investment, “[w]e thus have an example of tax revenue that not only has no excess burden, it has no burden at all!”

“Okay”, you muse, “but if there are no net benefits, why would I agree to this scheme? I am still left paying good money.”

Well, the most obvious answer is a drop in pollution. The more free-flowing traffic is, the more efficient and cleaner engines run. The less obvious answer, however, is the problem of what to do with all the revenue that congestion pricing brings in. It can be used for anything, but the best use is to plow the revenue back into maintenance of the roads, essentially making a large portion of the transportation infrastructure financially self-sufficient. After this priority, funds should be diverted into improving mass transit. This has several implications. First, users would have more choices as to how they would travel, thereby decreasing congestion even further. Second, and most politically reasonable, it would give low-income families the option of bypassing congestion pricing altogether, meaning it is not yet another regressive tax. This alleviates the feeling of inequality of having to pay for what many perceive to be a “free” activity. And we all know that SEPTA could always use more funds.

One question still remains, however: why don’t we simply build more roads? This seems reasonable. However, new roads seem to become just as congested as old roads almost instantly. The answer lies in the idea of “latent demand”. Build it and they will come, for all you Kevin Costner fans out there. New roads, being perceived as congestion-free, draw riders from other modes (such as bus and train), drivers from other routes, and even drivers who would otherwise not even drive under current conditions. These new drivers entering the system mean that the congestion problem persists, with the added cost of whatever time and money it took to build the new road in the first place.

The technology to implement such a pricing scheme is already here. Some of you have already probably used it. It’s the same idea behind EZ-Pass. Using passive RFID tags on the windshield, you can drive through a tollbooth or a specialized lane while only slowing down slightly (or sometimes not at all) to be charged. Some cities, like London and Singapore, implement congestion pricing in a slightly different way but with similar outcomes. In London, drivers who wish to venture downtown must pre-pay a fee of £8. Users’ license plates are recorded via cameras and matched up with a list of those who have paid the fee. This idea of charging across an area instead of a single road is still effective, presuming congestion is widespread enough in the area.

Congestion pricing can be and is successful. So far in London, the results have been encouraging: vehicle speeds increased 37%, congestion has decreased 30%, and the program has raised net revenues of £97 million in 2005 alone. Now imagine all those benefits for our fair city of Philadelphia, plus the added benefit of being able to walk across 34th street safely and quickly. Almost makes having class in DRL bearable. Almost.

Hunter Schloss is a senior studying systems engineering.
Quantum Entanglement: 
The Force Behind Einstein’s ‘Spooky Action at a Distance’
By Rishabh Jain

What exactly is the power of quantum entanglement? Technically, it means that the state of one object depends on the state of its partner. To get an idea of what quantum entanglement can do, imagine a pair of special ‘quantum dice.’ Let us assume that these die were “quantum entangled.” Now we will put a condition of entanglement on the dice such that whenever the dice are rolled their sum will be seven. Thus, if I roll one die and a ‘5’ appears, then without looking at the other, I know that it will show a ‘2.’ This phenomenon is already strange, but how is it that the other die knew what number was rolled on the first? To make things even more mysterious, pretend that you went to a store and bought this pair of dice with your friend, who is an astronaut going to the moon. If he keeps one die and you keep the other, and you roll it when he is on the moon, then, the instant that you roll a number, his die will show the corresponding number. That is, if you first roll a ‘4’ while on earth, the very instant that you roll that ‘4’ your friend’s die on the moon will show a ‘3.’ At first glance this seems to tell us that there is information being transferred faster than the speed of light. Many people believe that through this phenomenon of ‘Spooky Action at a Distance,’ we will be able to break the speed of light, one of the most fundamentally unsurpassable barriers in physics. However, sending information through entangled particles, theory and experiment show that this is impossible. Entanglement is the dependency of a particle’s characteristic on another particle. This dependency will exist as long as the characteristic in question is not known. This means that if we are referring to the quantum dice, then the condition of the sum equaling seven will only exist while the dice are still being rolled. Once

Quantum entanglement in nature
Anything ‘quantum’ refers to objects that are extremely small. Quantum entanglement is a phenomenon that is observed in very small particles, specifically electrons. Electrons are negatively charged particles that orbit the central nucleus. Positrons have exactly the same properties as electrons, except that they have a positive charge. A positron is an electron’s anti-matter. Is no classical analogue to spin, for our purposes we can imagine this spin to be similar to the rotation of the earth about its axis. There are two possible ways in which an electron can spin, clockwise and anti-clockwise (or rather, spin-up or spin-down). The electron-positron pair can become entangled by conditioning the spin on either particle. This means that if the spin on the electron is clockwise, then the spin on the positron is anti-clockwise. Hence, analogous to the dice example, if we have an electron on one side of the universe and its corresponding positron on the other side of the universe, once we measure the electron’s spin we will instantaneously know the positron’s spin. This phenomenon actually occurs in real life and has been tested numerous times, producing the same end results every time. All of this instantaneous transfer of knowledge seems to tell us that information might actually be traveling faster than the speed of light.

Why can’t information be sent faster than the speed of light?
Though it seems that we should be able to take advantage of this entanglement by sending information through entangled particles, theory and experiment show that this is impossible. Entanglement is the dependency of a particle’s characteristic on another particle. This dependency will exist as long as the characteristic in question is not known. This means that if we are referring to the quantum dice, then the condition of the sum equaling seven will only exist while the dice are still being rolled. Once
we know the result of the roll, the entanglement is destroyed. Although we can determine what the other die will show once we see the result on our die, we cannot force a certain number to show on our die. We cannot take one die and place it so that it shows a ‘5’ in order to get a ‘2’ on the other die, because that would mean that we already know the result of the rolls, hence destroying the entanglement. However, this does not mean that we cannot take advantage of the fact that particles are entangled. In fact, one of the hottest fields for research today, Quantum Computing, is dependent on this property of entanglement.

Applications in Quantum Computing

The fact that there can be two particles that exist such that one will show the inverse of the other has immense implications in the computing world. What this means is that a computer could do two computations at the same time, one the inverse of the other. This means that parallel processing will be taken to a whole new level. However, it will still be some time before the first quantum computers come out, and even when they do arrive, they will be for single-use only, due to the destruction of entanglement once the state of a particle is determined. This means that such computers will be used for specialized calculations only—quantum computations. Nevertheless, this technology is something to look forward to as the next big leap into faster processing.

Philosophy of Entanglement and Einstein’s Issue:

We can see that, though quantum entanglement is a strange phenomenon, it still has applications in the real world. However, beyond applications come the philosophical questions that quantum entanglement raises. How is it that a particle on the other side of the universe knows what its partner particle’s state is? One theory proposed is that the states of both of the particles were determined upon creation and that we do not realize this because we only see the phenomenon when we measure the states. This is a theory that caught Einstein’s attention. He managed to prove that this theory was wrong because it violated certain physical laws (see Bell’s Inequality for more information). This means that there is actually a way for these particles to communicate over billions of miles and tell the other particle its state. Such is the quantum world, and this is only one of the many mysteries that this world presents.

![Rishabh Jain](image-url)
Today, advertisements for prescription drugs such as Celebrex, Lunesta, and Viagra are everywhere. However, drug companies did not always directly advertise their products. In 1980, drug companies spent $2 million on direct-to-consumer advertising in America. In 2004, that number was $4.35 billion, a two thousand fold increase. What happened? Greg Crister examines this and other phenomena associated with the proliferation of prescription drugs in his informative but dry muckraking book *Generation RX: How Prescription Drugs Are Altering American Lives, Minds, and Bodies*.

Crister's central premise is that prescription drugs are much riskier than the public believes. Immediately he tells the reader, “Prescription drugs are products that highly educated people, whom we trust with our money and our lives, tell us that we need in order to survive or to avoid undue risk to our health.” But increasingly drugs are prescribed not as a necessary treatment for a life-threatening illness but as a libido enhancer or a sleep aid. Many drugs, especially Ritalin and antidepressants, may be over-prescribed and given to people who do not need them.

Unfortunately, after a gripping introduction and some shocking statistics about the spread of prescription drugs, Crister bores the casual reader with a superfluous amount of facts and details as he establishes his case. He conducts a very complete examination of the deregulation of direct-to-consumer advertisements in the 1980s, but most of it reads more like a history textbook than a narrative. His book is split into several major sections, each of which has an interesting introduction and conclusion but a prosaic body.

Some of his statistics and quotes demand the reader's attention. For instance, he reports that the average number of prescriptions per American was seven in 1993, eleven in 2000, and twelve in 2004; almost half of all Americans use at least one prescription drug a day. In attacking court decisions against deregulating direct-to-consumer advertising, he cites William Rehnquist, then a Supreme Court junior Justice. Rehnquist, who dissented against extending the First Amendment to commercial speech, worried that deregulation would result in advertisements such as, “Pain getting you down? Insist that your physician prescribe Demerol ... Don't spend another sleepless night. Ask your doctor about Seconal without delay.” Today, similar advertisements make regular appearances on television. However, Crister’s research is probably too detailed for most readers. This compounded with his dry, matter-of-fact writing style makes for a tedious read.

Perhaps the most valuable section of the book is Crister’s discussion of liver damage caused by prescription drugs, even when taken correctly. Most Americans know about cancer and heart disease, but few know about liver failure. The liver is the organ that processes all toxins, including drugs. The liver is normally a very redundant organ; it can regenerate itself completely even if most of it is surgically removed. Taking too many medications can overwhelm the liver’s redundancy and cause irreversible damage. Liver and drug interaction is also one of the least studied areas of medicine, and more research in this area need to be conducted. This section is concise and lucid, a great read.

Crister sees the pharma-patient relationship cynically. For instance, he reports that more and more often a right disease has to be “discovered” for a drug. Drug companies might develop a drug first, then determine if it could be marketed for a disease. Crister argues that drug companies created the idea of adult attention deficit disorder in order to sell more Ritalin and that the treatment of depression is becoming increasingly based on pharmacy rather than therapy. No one should be entirely comfortable with using medication, but no one should always view potentially life-saving drugs as cynically as Crister does. Most pharmaceutical companies design drugs to target specific diseases, and while it is true that some drugs have multiple uses or turn out to be better at treating a
disease different from its original target, these cases are not the norm.

Crister also attacks the drug companies’ drive for higher profits. Some companies persist in pushing drugs onto the market despite evidence that their products are not entirely safe. One compelling segment describes how some patients are now taking a drug to treat the side effects of another drug, but the patients are better off simply not taking either drug. His book includes several horror stories, cases of patients who either died or suffered serious side effects even when they took their drugs following all instructions. Certainly drug companies must not understate the risks of their products, but in reality such cases are isolated and not representative of the industry as a whole. Crister paints an overly grim picture of the dangers of prescription drugs. He only briefly mentions the benefits of prescription drugs, but he focuses almost entirely on their dangers. His book could be much better if it included some analysis comparing the risks of certain drugs to their benefits. The reader should be careful to understand prescription drugs can be dangerous, but not to take Crister too seriously.

Generation RX skirts the edges of greatness but falls short of its full potential. Crister succeeds in raising awareness of current industry practices and getting the reader to examine prescription drugs with a more critical eye. His most important message is that one should not shop for drugs like shopping for toothpaste or clothes, but instead one should be fully informed of their risks and benefits. However, his dry style and tedious attention to detail does not help the casual reader absorb the vast amount of information in his book. Furthermore, he is not entirely fair to the drug companies. Most notably, he does not compare the improvements in both lifespan and health of drugs to their risks and concentrates on the negatives. The casual reader is best served by reading the introduction and conclusion of each chapter, while the more meticulous reader will want to delve deeper.

Chenghong Huang is a sophomore in the College studying science.
CONGRATULATIONS
TO
THE
UNIVERSITY OF PENNSYLVANIA

TRIGEN-PHILADELPHIA
ENERGY CORPORATION

2600 CHRISTIAN STREET
PHILADELPHIA, PA 19146
(215) 875-6900
URS

Full-service engineering and consulting with over 300 employees in the Philadelphia region.

Key markets include:
- Industrial
- Water/Wastewater
- Surface Transportation
- Air Transportation

Comprehensive services to clients include:
- Construction Management
- Planning
- Hazardous Wastes
- Ecosystem Management
- Facilities
- Rail/Transit
- Federal
- Geotechnical
- Health & Safety
- Engineering/Design
- Compliance

Fort Washington • Mechanicsburg, PA
Wilmington, DE • Burlington, NJ

For more information, contact Frank Vernese (215) 367-2500

A Partner In Education

The Philadelphia Housing Authority helps build lives through our own education programs—Pre-Apprenticeship, Head Start and Skills For Life, to name a few. We’re also building homes around the city like never before, some right here in West Philadelphia.

Our new developments offer modern amenities and feature front and back yards, new streets, lighting, landscaping, and off-street parking. Our homes have become family and community assets.

We’re changing the way you think about public housing.

tryachair@spectrumworkplace.com

1003 W. 9th Avenue
King of Prussia, PA 19406
Larry Segal
610-233-4624

From supplying digital copiers to outsourcing your document production to re-engineering your entire network, IKON’s solutions are designed to do one thing... help businesses communicate.
There is a fundamental flaw with our college education system. In particular, Schools of Engineering across the country need to be reformed in a broad sense. As a community, we need a drastic change of perspective on what role education should play in molding our citizens.

In Plato’s *Republic*, there is a remarkable passage on the purpose of education. The goal of education, Plato described, is NOT to impart knowledge, and this is as true today as it was in 380 BC. According to Plato, no knowledge is retained if it is learned by force. Every college student is well aware of this, as the information forced into the brain solely to avoid poor academic performance is quickly forgotten. Plato’s belief is that education should serve to make one aware of the true extent of one’s own ignorance, and thereby empower the student with the right desires. So how does this relate to our colleges and universities? Whether stated or not, the ultimate goal of higher education should be to instill in every student a lifelong love of learning. Despite what is written in the extravagant rhetoric of school mission statements, there is something truly lacking in what is practiced.

Yet, the problem currently lies in mistaking the means for the end. Supposedly, we pay an exorbitantly large tuition to acquire the skills and tools that will enable us to succeed in the workforce. These skills could take many forms, from the prowess of artful communication, rhetoric and argumentation that is acquired from a liberal arts curriculum, to the critical problem solving of scientific and engineering principles derived from a more technical curriculum. Furthermore, we are given transcripts and grade point averages to solidify the occurrence of our classroom learning. But from the point of view of a university, this is a somewhat flawed approach to structure our education. The university’s overarching objective should be to kindle the fire of curiosity in every student, to reveal the value of learning for its own sake that will remain with us long after we graduate. We should use our classroom education, our textbooks, notes, laboratories, concepts, theorems, papers and problem sets to achieve this objective. But currently, these elements are often seen as the objective, the end and not the means, and for which we pay our tuition. In modern parlance, to be “educated” implies having learnt a certain set of information, and little else. I am suggesting that to be educated should entail having acquired a certain attitude, one that sees how all things are global and interconnected.

But what can we do to change our system? The vast majority of the time, the things people can most easily change is themselves. For instance, in Herman Hesse’s *Siddhartha*, the character of Siddhartha is an ascetic monk who travels through India, searching for enlightenment. Yet when he meets Gotama the Buddha, who is accepted to be in fact enlightened, Siddhartha does not stay long, and continues on his journey. True wisdom and knowledge are not communicable, Hesse describes, and must be discovered for oneself through action and experience. No teacher can impart fundamental knowledge for which a student seeks. Accordingly, the way classes are taught should be reformatted. Professors should focus their lectures less on recounting facts and formulas, which can be easily found in textbooks, but by convincing students that what they are teaching is important. When you reveal to a student why and how a certain topic matters, he or she will be inspired to pursue that topic independently. But here, the burden of responsibility is not only on professors; students must be willing to exhibit a substantial amount of independence, and be happily willing to put in the time and energy in tackling tough concepts by themselves. In this
way, the student will discover things for himself, and the knowledge gained will be more everlasting. But there is one detail that might ease the uncertain student: every topic, if approached and engaged in the right way, can be found to be fascinating.

Why then isn’t this approach to education a current reality? Why is the goal to instruct, and not to inspire? The surface reason is apathy. Instruction itself can be a challenging procedure, requiring great knowledge of the subject and good skills in communication. Yet it is even more difficult, however, to inspire; to convince a future businessman to learn economics purely for its own sake, or a future doctor to learn organic chemistry purely for its own sake, is not an easy task. It requires being creative and conveying everything in relation to the “big picture.” Likewise, to go above and beyond the boundaries of what is covered in class requires a student to invest time and energy in a cause that will not be recorded or be directly beneficial. But the more fundamental reason this approach isn’t a reality is because it involves, on the part of everyone involved, tremendous risk. A professor might ask, if we don’t make concrete curriculums and relay a specific set of material, what exactly are we teaching students? Can we be held accountable as having taught anything at all, if our only objective is to inspire students to learn the material for themselves? Likewise, a student might ask, if I go through all the effort of trying to discover why a certain topic is relevant for its own sake, and study it independently, will I be wasting my time if that material is not covered on midterm exams? Will I be wasting my energy in distilling course knowledge in my brain that I won’t be required to know once I complete the class? It is this cloud of risk that looms like a dark haze.

Yet even if one accepts that a certain amount of risk is necessary, there lingers another far more piercing objection to my argument. My proposal to revamp higher education presupposes that college students don’t already possess this quality of wanting to learn for its own sake. Yet why should we make this assumption? Isn’t it more appropriate to assume, as we seem to currently do, that the vast majority of college students are naturally curious and intellectual individuals, and that colleges and universities don’t really need to provide an environment that tries to generate these qualities? My answer is that this general quality of wanting to constantly learn for its own sake is impossible to achieve in its ideal form; all we can hope to do is enhance this quality as much as possible. It is the nature of students to avoid subjects and topics with which they have difficulty. Everyone has their own natural predilections towards certain areas of study, and most tend to stay within the boundaries of their comfort zones. It is the nature of students to become disinterested in areas where they experienced frustration. However, what about those who appear to be fascinated by and excels in virtually every subject? Even among such students, these qualities are often transient. As one matures into greater adulthood, responsibilities and priorities change, and so does one’s mindset. The goal of our universities should be to instill in every student a desire for knowledge that is permanent, one that will last the tenure of one’s life—a love of learning that is not for this thing or that thing, but for everything. Even in Schools of Engineering, where the education is quite specific and professional, this should be the overarching goal.

As a case in point, Olin College of Engineering, a new school that has recently opened in Massachusetts, provides some remarkable insights in accomplishing this goal. The curriculum is totally integrated, where students learn about engineering, physics, and calculus, for example, by investigating the relationships between them. This interdisciplinary nature extends towards their arts and humanities as well, where courses center on broad topics such as the nature of the self. Every topic explored in the classroom is approached through the lens of context. Furthermore, the education is very hands-on, where the direct experience of doing independent “capstone projects” allows learning to occur through direct experience with real-world applications. At a school with no tuition, no academic departments, no tenure, and currently no accreditation, we see an educational structure that attempts to promote lifelong learning and curiosity among engineering students in new ways. Penn, along with all other colleges and universities, should take Olin’s example and attempt to implement more changes that will improve the quality and effectiveness of higher education. Penn has already taken some steps in this direction. For instance, the Engineering School’s senior design projects involve hands-on learning and require conceiving and applying novel ideas, while the Arts and Sciences School offers broad interdisciplinary courses through their pilot curriculum. Yet more remains to be done.

But one might object, “Why should we shift the focus of our educational system, especially in Schools of Engineering? I am an ardent fan of the status quo, and I like things just the way they are right now.” The goal now is to improve education such that graduates have a greater capacity and willingness to enact positive change within our society. If we as students leave college with a lifelong commitment to learning about things for their own sake, we will be equipped with an insatiable drive to discover for ourselves. This will empower us with a newfound energy, and an almost enlightened perspective. And perhaps, this will provide us with the inspiration to invest an amount of effort in humanitarian endeavors that far exceeds what is required or even expected. After all, what do you care more about: what you do for the sake of something else, or what you do for its own sake?

Tushar Khanna is a junior studying Chemical Biomolecular Engineering. He is the Executive Editor of the Triangle.