ENGINEERS' FORUM

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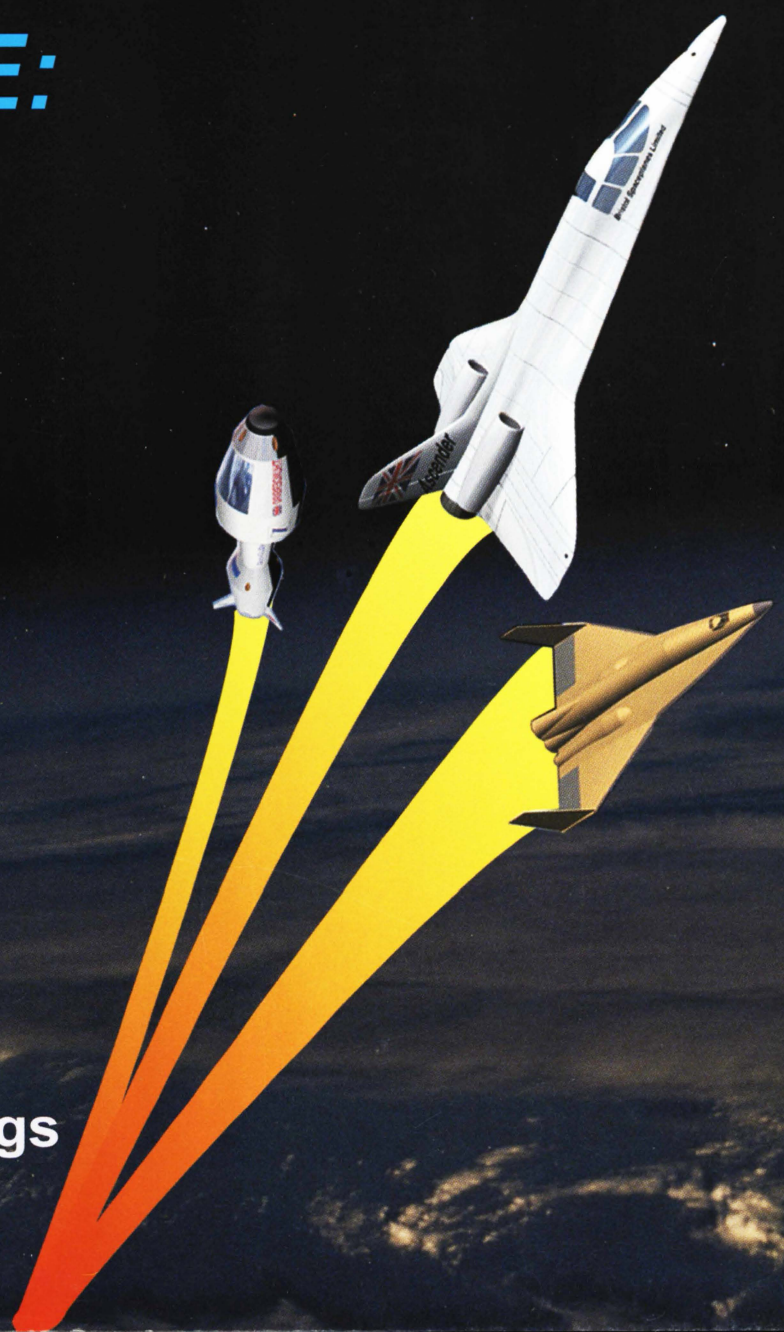
The X PRIZE: 21 private teams race into space!



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- EXPO job fair
- Fuel cells rev up
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- Mongolia shudders
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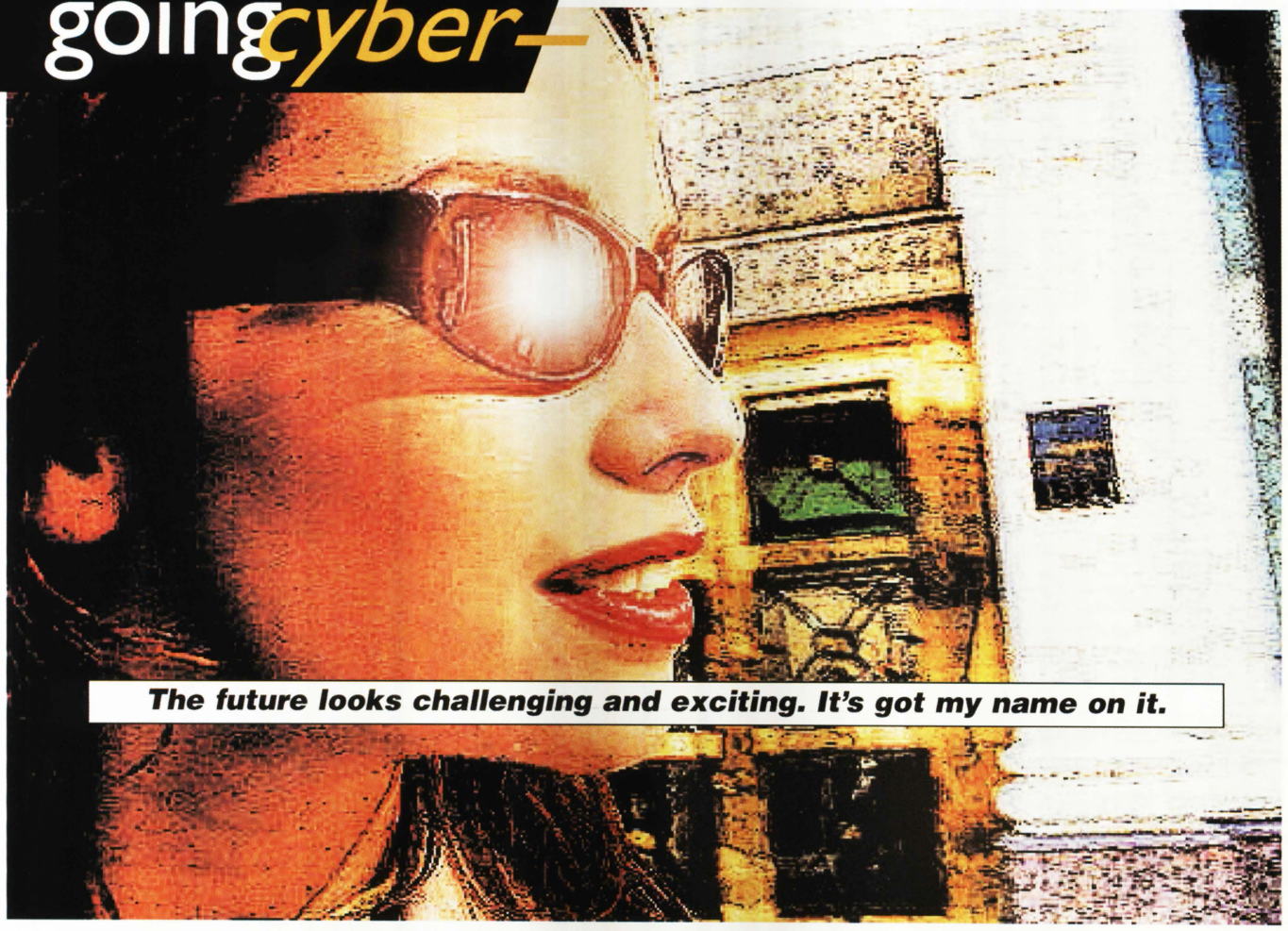
going cyber



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The Student Engineering Magazine of Virginia Tech

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Get High...erd at EXPO!

by Shuvom Ghose

The annual Engineering Expo Job Fair returns to Virginia Tech on September 18th and 19th, bringing with it high hopes and dreams for some students and fear and frustration for others.

Sure, Expo can be a place where confident, hardworking engineering students contact representatives from cutting-edge companies to secure their dream jobs.

But Expo can also be a place where nervous students who pad their resumes to mythic proportions and don't have enough communication skills to say "Hello" correctly meet distracted human resources managers who are advertising jobs their company are currently downsizing and using cheap plastic toys to attract people they are supposed to respect.

The good news is, the key to Expo happiness is simple: figure out what type of Expo-goer you are, and prepare yourself and your expectations to match. In order of decreasing seriousness, the three prototypes of most Expo-goers are: the determined job hunter, the curious meander, and the trick-or-treater.

StoryNOW! Box

What it is: The EXPO job fair from Sept. 18-19 in Owens and Squires.

You should read it if: You're looking for information on jobs, CO-OPs, and industry.

The key for the determined job seeker is a big shot of PCP: Preparation, Communication, and Professionalism. Determined job hunters definitely want that lucrative job, co-op or internship, and need to put the most time into pre-Expo preparation.

"Make sure your résumé's ready, and maybe have it proofread by either a professor or by the people in Career Services," Expo chairperson Amanda Keith says. "Make sure you're well versed on the companies that are going to be there. There'll be a booklet... put out around campus two to three weeks before the event, and that'll have all the companies' websites in it, for students."

It doesn't sound like a lot of work until you put it off and have to stay up until 4 a.m. the night before Expo trying to figure out your in-major GPA to finish your resume while your roommate sorts through a list of over 200 companies' webpages to make sure you don't apply for an aerospace engineering job at company that makes potato chips.

To prevent grief, go to the third floor of Henderson Hall and pick up the Career Services' Career Planning Guide for guidelines on resume formatting, dress codes, and interview procedures. You might want to stop by again later, because Career Services also offers walk-in resume critiques with an adviser every day from 9 to 5. And, starting September 10th, they'll start sign-ups for mock interviews which can be videotaped for later play-by-play analysis.

Also, pick up the SEC's booklet when it comes out and research the companies through their webpages, so you can swoop into this job fair and deliver your resumes to just your five top choices like laser-guided missiles, and not have to print off 205 copies to saturation bomb the whole field.

Once actually at the Expo, the determined job-seeker needs to focus on the last two letters of PCP: Communication and Professionalism.

Some students don't communicate well when talking to recruiters because they're nervous. But why be nervous? These recruiters flew all the way across the country to hire engineers like you. Their company, then, must need you. If anyone should be nervous about the prospect of messing up the contact, it should be the recruiter!

So smile, speak clearly, and communicate well. Look around, and you'll be surprised at the number of students who don't. Finally, remember to dress and act like a professional, and you'll be treated, and hired, like one.

If being a determined job hunter seems too gung-ho to you, you might be a curious meanderer. These folks are just looking for information about hiring and the

Another great EXPO match.

engineering industry in general. But is it okay to just wander around Expo without resumes, not really looking for a job?

"Yes, definitely," Amanda says. "I mean, I went my freshman year and walked around, and just, was in awe."

Look at the different company displays. Which ones seem interesting to work for? How many let you blow things up as part of your normal duties?

As you wander through the aisles of Expo displays, perusing every third one, take time on your trip for a little LSD: Learning by Seeing and Doing. What are the determined job seekers around you doing right or wrong? How would you have approached that recruiter differently? Would you have worn those white socks with those dark shoes?

Also, look at the different company displays. Which ones seem interesting to work for? Which ones would you not wish on your worst enemy? How many let you blow things up as part of your normal duties? (The number will surprise you.)

And finally, go talk to one of the recruiters. He's going to ask for a resume you don't have, but just tell him you're on a LSD trip to expand your horizons, and he'll explain things slowly to you. Ask all the questions you want; that's why the companies send the human and not just the display board.

But what to do if you really aren't looking for a job, don't particularly need engineering industry information, but just have a few hours in between classes to burn? Can you still benefit from Expo? Sure, as a trick-or-treater! Use the time to get bagloads of free toys!

The governing laws of trick-or-treating are as simple and rigid as trigonometric identities. Every recruiter brings approximately 10^{15} silly plastic toys with his company logo on it to hand out to students at the Expo. If the recruiter doesn't give all the toys away, she'll have to take them back to the office with her, which is a chore. Thus, the company representatives want to give you the toys as much as you want to get them.

This leads to the trick-or-treaters' attitude of POT: Perfectly Okay for the Taking. But still, is it really okay to go to Expo just for the toys?

"I don't *encourage* that," Amanda stresses, "But yes, that's fine. I understand that people love to get their goodies and maybe they'll strike up a conversation with the attending company."

Which is, of course, the entire point of the mysteriously addictive toys in the first place. To make both the recruiter and you feel good about the toy exchange, you'll have to play the part of the curious meanderer for a while. Stroll up to the table laden with the toys you want- but don't look directly at them! Gaze over the display board first, and strike up a conversation with the recruiter as if you had never heard about the company: "My-Crow-Soft? What do you guys do?" Ask some questions, sound interested, and as you're leaving, pretend to notice the toys for the first time and casually ask, "By the way, could I take one of these mousepads/pens/cups/random blinking orbs?" Calmly take the toy when it's offered, then run and show all your friends. High-fives all around are then appropriate.

Once familiar with the three types of Expo-goers, it becomes obvious why some people get dissatisfied with the Expo-experience. How would you feel if you really needed PCP, but had used LSD instead? Or wanted POT but tried PCP by mistake? It would kind of mess up your whole day, wouldn't it?

So, to make sure Expo is a high and not a low for you, just be sure you know what you need to use to get the effect you want, take enough to get you through the day, and then just enjoy the ride.

Isn't that what engineering's all about?

EF

EXPO Do's and Don't's:

Do talk to the engineer from the CIA; it is as James Bond-ish as you think.

Don't wear a suit and tie the first day; it'll get hot, and you'll be over-dressed.

Do get a map of booth locations; you shouldn't rely on The Compass of Luck to find your dream job.

Don't interview at a company you wouldn't work for just to get practice; that's not professional.

Mongolia Must Die!

by Ben Bentely

America! Our nation now faces its greatest threat – itself. In the years since Vietnam and the Cold War, we have driven a wedge between the public and our government. Far removed from the days when our civilization took great pride in its ability to obliterate everyone else in a nuclear manner if necessary, we've reduced ourselves to settling ancient disputes in small countries that we don't really care about by wielding our military might like a huge electronic club.

The result tends to be several people dead on both sides, a few American casualties, and the people we just bombed hating each other just as much as they did before, with a fair amount of dislike for us, because we were likely responsible for killing on both sides, one in the form of direct bombing, but the other, more severe form being the forced escalation of an already existing conflict.

That's bad. But something happens because of it that's even worse. The average American citizen no longer has faith in the government to do the "right" thing. A lot of people can point to Vietnam as one of the primary causes for our mistrust. One can go on and on about how the "Pentagon Papers" and Bill Clinton showed us that we could only trust our President as far as we could throw him, and the Secret Service won't even let us do that these days.

I don't think Vietnam, or any given event, caused America to distrust its elected politicians. I think that this is a natural state of affairs brought on by the lack of better things to do. When the Soviet Union went under, something died inside us as well. We stopped hating Communism. Now we deal freely with Communist China, offering them diplomatic encouragement in the form of a boy named Ted, who brings Jiang Zemin (The President of China) small notes during breakfast each morning that read "Hey, just wondered if you'd like to be a Democracy now. Take your time. –USA"

America, we need our unreasonable hatred back! This state of affairs has gone on for too long, and we've become arrogant and complacent with our place in this world. The greatest mistake we've made this century was letting Communism off the hook and not finding a replacement. Well, here's your replacement: America, we must unite to defeat Mongolia!

Some of you may be asking "What for?" I urge you to not take such an unpatriotic attitude! Nobody went around during the Cold War saying, "Wait a second, why are we and the Russians amassing a ton of nuclear weapons against each other? When you get right down to it, what's the point of all this?" The point was that America was united (except for the whole racism thing, but that's an article in and of itself).

Part of the reasoning for declaring war is to unite our country, but there are many other benefits to a good, old-fash-

The Patriotic American's Mandatory Mongolia Quiz

Question 1: Pick out Mongolia's borders from Afghanistan and a free-hand scribble.

Question 2: Which best represents the governmental system of Mongolia?

a) Communist b) Socialist c) Monarchy d) Democracy e)Anarchy

Question 3: True or false, Mongolia never once aided the United States in the Revolutionary, Civil, World, Korean, Vietnam or Iraqi wars.

Answers: 1. b, 2. a, 3. True, those selfish bastards!

StoryNOW! Box

What it is:

Reasons why America MUST go to war with...Mongolia?

You should read it if:

You watched Dr. Strangelove and said, "Yeah, that could happen."

ioned conflict. Technology, for one, skyrockets, resulting from the development of better killing machines and other useful devices. The economy swells as factories hurriedly convert to the production of vehicles and equipment to fuel the ever-growing anti-Mongolian war machine. Unemployment drops below the 0% mark, meaning that even illegal immigrants and children benefit! As for rationing... well, most of us are overweight anyway.

So, now that I've made my point, I'm also going to show you how we go about winning the war against Mongolia. First, we need to round up all five Mongolian-Americans in this country and determine whether or not they are spies. So now we've already started off with a good old-fashioned witch-hunt. Now, the particular circumstances involved in this war are somewhat different, because there aren't enough Mongolian-Americans in this country to go around. There's no fun if you've got all five locked up in leftover internment camps, because there's no more to find after the first couple of days. So what we do is, once you find a Mongolian-American, you ask them very directly if they are spying on the United States for Mongolia. Then you go away, leaving them for someone else to find, the same way you're supposed to leave Easter Eggs for your siblings.

Some of you may find fault in this, stating that if there are Mongolian-American spies in our country, then we should round them up and stop their spying activities. I disagree. We should obey the golden rule, since we do not want our spies caught or detained in other countries, we should not detain foreign spies in ours.

So then, after America has had its internal witch-hunt, we should be convinced of the threat that Mongolia poses to us. After all, Mongolia has in its possession military technology that our greatest generals could only dream of using in modern warfare. Did you know that none of our current aircraft, even with millions of dollars worth of the most advanced military technology our scientists can come up with, have no defensive system to protect them against slingshots? That the M-1 Abrams, our main battle tank, was never designed to deflect spears? With the current gap in technology, an arms race would be futile.

Nobody died in battle during the Cold War, so that's the model we should follow in fighting future wars. Done correctly, we could very well make Mongolia the first "Humane War".

We've still got the ultimate weapon however: Lack of understanding! Less than 1% of Americans can name the capital, governmental system, and primary exports of Mongolia. A substantially larger portion of us can locate it on a map, if only because it's a pretty big country. But don't go and find these things out! Simply be content to hate Mongolia like everyone else, and you, like your friends, will have the common enemy that America so desperately needs today.

We face another problem, perhaps the most serious one we've had in the history of warfare. We've gotten really squeamish about letting our own soldiers get killed. Every time one of our soldiers dies off in some Eastern European country that we can't find on a map we go back to questioning why we're there in the first place (Vietnam again). No worries, my proposal for anti-Mongolian warfare will take care of that. No Americans will have to die in this war. No Mongolians either.

You see, we should learn from past mistakes, but we should learn more from past triumphs. Nobody died in battle during the Cold War, so that's the model we should follow in fighting future wars. Done correctly, we could very well make Mongolia the first "Humane War". Due to the gap in technology, this may well be the only feasible way to fight them.

Our engineers will need to build more suitable war machines (see below). In

Help the War Effort: Design a less efficient war machine!

Like the Germans sending zepplins filled with hydrogen gas to bomb hostile territory or the Russians training dogs to run at Nazi tanks with dynamite strapped to their backs, some countries have shown their utter contempt for the fighting ability of their opponent by deploying weapons which not only had little chance of completing their mission, but promised to result in many friendly casualties as well.

In that vein, what greater way for America to affirm its lone superpower status than by throwing away its modern, lethal weapons and deploying systems so inefficient that our enemies will shudder and flee from our arrogance?

And you, as America's rising citizens, can rally to support the cause! Submit a drawing and explanation of your idea to the Engineers' Forum mailbox at 333 Norris or send them to forum@vt.edu. The most creative entry, (as judged by our staff), will win a $50 prize, be featured in the December issue, and win the acclaim of generations to come*!

*Acclaim not guaranteed.

the meantime we will start numerous aid projects designed to lull the Mongolians into a false sense of security. By assisting them in industrial and education programs, we'll cause them to think that we aren't planning a massive attack. It will also allow our agents to access information pertaining to their military might, and we can get definite numerical counts of how many cavalry they have. I'm sure they have a surplus left over from the war that caused China had to build the most impressive military defense the world had ever seen for hundreds of years.

After they're sufficiently lulled into thinking that we have no earthly reason to attack them, we'll hit them with an air campaign that should rival or exceed Operation Vittles, which caused the Russians to back down in 1949. From then on, we will continue the air campaign and the war for as long as it benefits us. (There should be no need for a land war, since Mongolia is a really annoying place to have to walk to, we'd need to move troops through China or the former Soviet Union. Not a good political move.)

Should all go according to plan, it could be the greatest victory in the history of warfare. Once we've won it, America can go hate something else. Like telephone solicitors. EF

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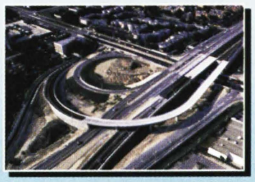

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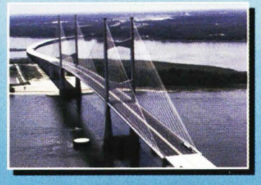

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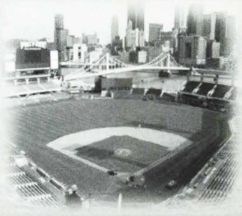

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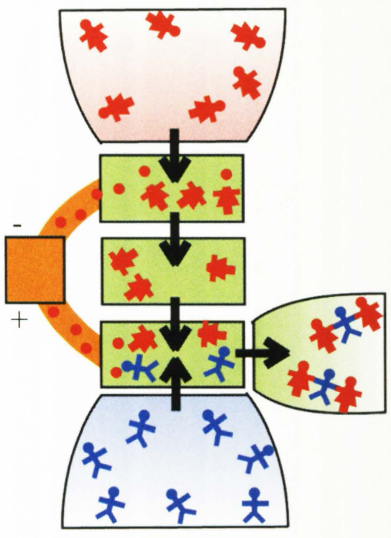
Fuel Cells:

Driving Gas Engines . . . Off the Road?

by Patrick Hummel

With fossil fuels becoming exhausted, increased ozone depletion, and rising gasoline prices, the need for alternative forms of power is increasing. According to most studies, the supply of crude oil will run out in less than one hundred years. Therefore, we will have no gasoline for our cars in the next century. What then, will we use to power our automobiles? The most promising answer to this question is the fuel cell engine.

In a recent speech to the Automotive News World Congress, William Clay Ford Jr., chairman of Ford Motor Company, said, "I believe cell-fuel vehicles will finally end the 100-year reign of the internal combustion engine as the dominant source of power for personal transportation."



How a fuel cell works: Hydrogen (red) is split by a catalyst into protons and electrons (red circles). The electrons pass through an electric load (orange) while the protons move through an electrolyte to the remixing chamber. There, another catalyst combines oxygen (blue) with the protons and electrons to form pure H_2O as the exhaust.

Fuel cells convert the chemical energy of a fuel into electricity. The fuel of choice for most fuel cell engines is hydrogen. This is because hydrogen can be used directly; hence, no energy is lost converting it into another fuel. Another reason why hydrogen is used is that the only emission of these vehicles is water. Fuel cell engines are better than the conventional internal combustion engine in many aspects. To name a few they are cleaner, more energy efficient and quiet. According to California Fuel Cell Partnership's website, fuel cell engines are at least 50 percent more efficient than conventional engines. However, there are still problems with fuel cell engines that need to be addressed if they are to be a good alternative to internal combustion engines. One main difficulty is trying to create fuel cell engines that are powerful enough to operate automobiles and cost as much as a conventional engine. However, in order to meet low emission standards and solve the dilemma of the need for alternate forms of power, automakers are already testing fuel cell engines in cars today.

The fuel cell concept is nothing new; in 1839 W. R. Grove first discovered the essential features of fuel cells and revealed how they produced an electric current. Fuel cells have been pursued to such a great extent ever since because they have a very high efficiency. The reason they are so efficient is because they use chemical versus mechanical energy to produce electricity. By doing this no energy is lost through friction, heat, etc. Many scientists first tried carbon-consuming fuel cells, but many difficulties arose; because of these difficulties, scientists tried hydrogen as an alternative, and this proved to be a much better option. Much of the excitement in fuel cells was caused by F. T. Bacon's pioneer work and his experiment with a hydrogen-oxygen fuel battery. However, before World War II, only the basic principles and functions of fuel cells had been discovered. The majority of fuel cell work was accomplished after WWII. This was mainly due to the attempt to reduce atmospheric pollution and the demanding needs of the space program, where fuel cells were the main source of electric power for some manned U.S. spacecrafts.

StoryNOW! Box

What it is:
A technology moving to replace the internal combustion engine.

You should read it if:
You want to know what will be under the hood of the cars your kids will drive.

Fuel cells are not all that complex; in fact, they function similar to batteries where chemical energy is converted into electricity and heat. Yet, chemical energy within a battery becomes exhausted fairly quickly with use and can only be

recharged a few times. As long as a fuel cell is provided with fuel it will produce energy (electricity and heat) practically forever.

The two main chemicals contained in fuel cells are hydrogen and oxygen. Oxygen is usually obtained from the air and hydrogen is either supplied directly to the cell as fuel or it is obtained from natural gas that is converted to hydrogen before entering the cell. The two chemicals are then combined inside the cell to produce water and electricity. The primary components of fuel cells are two electrodes, two catalysts and an electrolyte membrane. Thus, a fuel cell contains no movable parts. This makes it a quiet and dependable source of power.

One electrode is positive (cathode) and one is negative (anode). The two electrodes sandwich the electrolyte membrane. Hydrogen enters the cell through the anode side, passes through the center (electrolyte), and exits through the cathode. The anode, combined with a platinum coating (a catalyst), separates the protons and electrons of the hydrogen gas. The electrons flow from the anode through an electric circuit containing a motor (or some other electric load) to the cathode, while the protons of the gas travel through the electrolyte and combine (under the cathode with platinum coating's power) with oxygen and electrons to produce water (H2O) and heat. Cells can be stacked to increase the amount of energy produced.

A vehicle that is equipped with a fuel cell engine is quieter, cleaner, safer, more energy efficient and provides the same range and performance as an automobile with a conventional engine. If vehicles that are powered by fuel cells were mass produced, they could benefit the economy and solve energy and pollution concerns.

Hydrogen is the most abundant element on earth; if the marketplace were to change into a "Hydrogen Economy," the name given to a market that relies on hydrogen fuel, it could give rise to a huge industry while creating domestic energy security. Hydrogen fuel can be produced in a number of ways. It can be extracted from other fuels, generated from solar or wind power, or it can be produced from enzymes. Methanol, ethanol, natural gas could all be used to produce hydrogen. Through a process known as reforming, hydrogen can be extracted from any hydrogen-rich material. Solar and wind power can be harnessed through wind turbines or solar cells and then used to electrolyze water into hydrogen and oxygen. Cyanobacteria is a single celled organism that produces naturally splits the molecules of water through its metabolic function. Thus, hydrogen can be produced in many ways, and it reduces the need for foreign fuel supplies.

As mentioned before, one of the main benefits of fuel cell powered vehicles is that they have low emissions. Water and heat are the only by-products of fuel cell engines that are supplied with hydrogen fuel. In contrast, gasoline engines' by products are carbon dioxide, nitrous oxides, and sulfur oxides to name a few. Thus, if cars were outfitted with fuel cell engines, the world's pollution would reduce great deal.

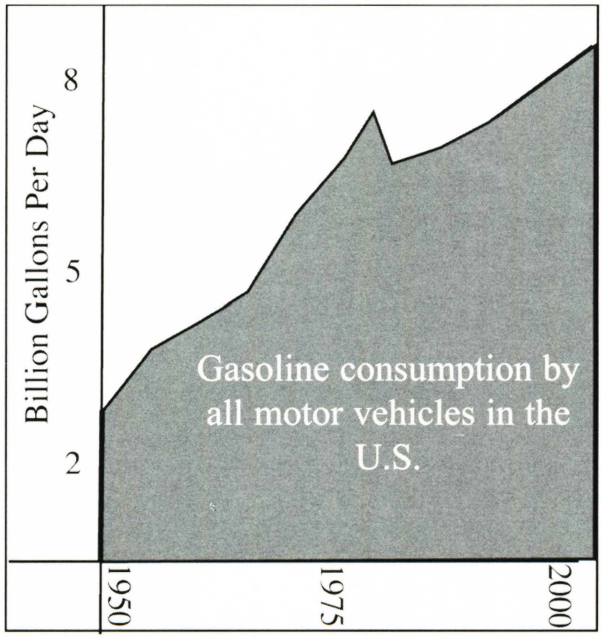
In contrast to what many believe, hydrogen is not a very volatile fuel. A safety test by Ford Motor Company for the U.S. Department of Energy revealed that the storage of hydrogen in vehicles powered by fuel cells is actually safer than the storage of gasoline. In one safety test performed by Ford, the hydrogen tank was subjected to gunfire and, in order to pass, it could not explode but only leak through the bullet-hole. Hydrogen spills are less dangerous than gasoline or oil spills. If a spill occurred, the hydrogen would evaporate almost immediately, leaving only water behind. Gasoline and oil spills, on the other hand, require a massive clean up effort. That usually only cleans up a portion of the spilled gasoline or oil with the rest seeping into the surrounding environment. Hydrogen requires a higher concentration in the atmosphere than gasoline to burn. In fact, it would take four times the concentration of hydrogen in the atmosphere than gasoline to become unstable. If hydrogen is handled and stored safely, it proves to be a much safer fuel than others.

In comparison with gasoline and electric powered automobiles, vehicles powered by fuel cell engines are quieter and recharge (refuel) faster. Unlike electric vehicles that have to be plugged in overnight, fuel cells can be refueled quickly. They are also quieter than conventional engines because they have fewer movable parts.

So, why aren't fuel cell powered cars being sold to consumers? The main reason is that they are too expensive. The fuel cell engines used in spacecraft had cost about $500,000 per kilowatt. Because of the progress being made with fuel cells, the price is now about $4,000 per kilowatt to manufacture a fuel-cell engine. However, an internal combustion engine costs about $40 per kilowatt. One of the reasons why a fuel cell engine costs a lot is because the amount of platinum (the catalyst) used is expensive. The amount needed has been cut, but needs to be cut further. Another reason is that, currently, graphite plates are being used to guide the oxygen and hydrogen gases. As an alternative these are now being replaced with inexpensive carbon composites.

Other changes to reduce the cost of a fuel cell engine are being investigated. According to The Economist these changes "should bring the cost of a kilowatt of output down to around $20, if as many as 250,000 engines a year were produced."

Another problem is fuel storage. Current methods for storing fuel for fuel



Fuel cells may be able to reduce our cars' growing thirst for petroleum.

cell powered vehicles take up a lot of space. Hydrogen gas is not very dense, and thus storing enough gas to power a vehicle takes up a lot of space and weight (reducing the miles per gallon of the vehicle).

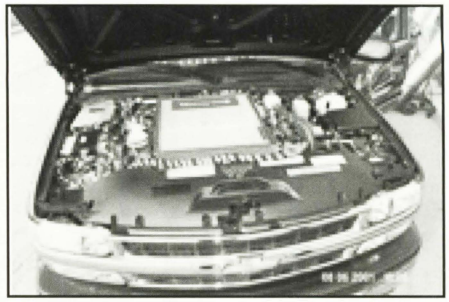
One solution is storing the hydrogen fuel as a liquid. However, this method creates energy problems. The liquefaction process uses up thirty percent of the hydrogen's energy content, thus this method wouldn't be cost efficient.

One of the most promising solutions to this problem is using methanol as the fuel. As mentioned before, using a fuel other than hydrogen would require a reformer to extract hydrogen from it. One common way of reforming the methanol is by combining it with steam and vaporizing them together at high temperatures. The gas is then passed through membranes and the hydrogen is separated. If methanol fuel is used ,an on-board reformer would be needed, however the storage methods for methanol fuel are similar to gasoline storage methods. Thus, a large amount of space would not be required and weight would not be a problem.

In spite of the obstacles, automobile manufactures are working hard to get vehicles powered with fuel cell engines on the road. Many companies, including Ford, General Motors Corporation, Daimler Chrysler, Toyota and Honda are already testing prototype vehicles and some companies are making predictions that they will have vehicles on the road in the next decade.

Chrysler has completed a Jeep Commander fuel cell/battery hybrid prototype. The battery is used for cold starts and provides extra energy for acceleration. The jeep runs on methanol, so it has an onboard reformer. It has almost zero tailpipe emissions and has double the fuel efficiency of a typical SUV. General Motors has created the HydroGen1 fuel cell. This fuel cell can start in weather as cold as –40 degrees, has a thermal efficiency of 53 to 67 percent, and produces 80 kW of power. Ford's TH!NK FC5 is a mid-size sedan powered by a fuel cell engine underneath the car floor. This design doesn't comprise passenger space and runs on methanol fuel. Ford also produced the P2000 Prodigy that runs on hydrogen and is designed perform as well as the Taurus. BMW is developing forklifts powered by hydrogen fueled fuel cell engines. They plan to release 2,000 of them in their own companies before selling them to consumers. Volkswagen has created the Bora HyMotion that is modeled after the Jetta. It runs on hydrogen and has a power output of 75 kW. Many other smaller car companies are developing fuel cell powered vehicles as well. Even engineers at Virginia Tech are working on fuel cell powered vehicles.

A team of engineers at Tech is creating the ZEBurban, a zero emissions Chevrolet Suburban. They plan to submit their vehicle in the 2000 –2001 FutureTruck competition on July first along with fourteen other universities' vehicles. The competition will be held at General Motors Proving Grounds in Detroit, MI. The ZEBurban is a fuel cell hybrid electric SUV. The vehicle is projected to get 23 miles per gallon for city travel and 25 mpg for highway travel. The SUV runs on hydrogen fuel that is stored as a compressed gas in conformable tanks at 5000-psi. The tank holds sixty percent more hydrogen gas than the conventional 3600-psi cylindrical tanks. However, as with all fuel cell powered vehicles, the SUV is very expensive, having an estimated prototype cost of $1.1 million. The main goals of FutureTruck competition are to reduce greenhouse emissions and increase the automobile fuel economy all without sacrificing a vehicle's safety, comfort, or performance. Tech has done very well in the competition in the past, placing in the top three the past four years. If all goes well this year, Stephen Gurski, the team's leader, thinks the team will continue with its success.



Under the hood of Tech's hybrid vehicle.

Stephen states, "With a functioning vehicle, I can say that we [the ZEBurban team] will place very well and have an excellent chance of winning the competition."

The fuel cell concept has been around for a long time, but the need for an alternative to the internal combustion engine is increasing. Society desires a clean energy efficient alternative that performs as just as well if not better. Fuel cell engines seem to be one solution. Yet, more research needs to be done in order for fuel cells to be a practical solution. Automakers are already at work researching ways to make the fuel cell powered automobiles a realistic alternative to the internal combustion engine.

EF

Tech's Hybrid Electric Vehicle Team looking sharp next to their creation.

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Shooting Eggs

by Candice Piercy

It was heads-up to all pedestrians who braved crossing the Drillfield last semester. Missy Cummings' EF 1016 classes congregated at the upper end of the Drillfield in front of the chapel for the conclusion of their freshmen design projects: egg launchers. The project guidelines required each team of three or four to construct a remotely activated egg launcher that would project an egg as far as possible without breaking it.

Early one day late last semester, the day's menagerie of egg launchers slowly made their way across the Drillfield: slingshots, crossbows, catapults and air cannons. However, this was simply a culmination of a semester's work. Each team's design was an original; no pre-fabricated kits were allowed. Work began early, around the end of February. Each team was to follow from beginning to end the engineering design process, from problem identification to definition of constraints and criteria to final specification to communication, concluding in a two-day competition followed by class presentations.

The first place that most teams looked for a starting place was the Internet. Egg-drop contests revealed important information concerning the protection device. Commercial water balloon launchers also provided ideas to start and build from. Those teams who decided to explore the world of compressed air launchers found a wealth of information. Other teams simply took a trip to Home Depot and wandered around, gleaning ideas about materials and other uses for common products. One team used chain link fence posts for the frame of their slingshot, recruiting the help of a welding student to fuse the metal posts together.

> Their first two launches sent the egg soaring backwards, directly into a tree. The final launch, however...

But the real action happened on the Drillfield late last semester. Adam Tyler's team constructed an eight-foot tall trebuchet, a catapult with a swinging free weight to add extra momentum. "We kept it in the second floor study lounge of Pritchard," he remarked. His team ran into problems early on. Their first two launches sent the egg soaring backwards, directly into a tree. The final launch, however, was a success. The egg survived and managed to make it in the correct direction down the Drillfield.

Brian Chapman's team built an impressive air cannon. The egg, in its peanut butter-filled PVC protector, rested inside of the barrel while the team took turns pumping the air chamber to 80 psi. Upon launch, the team opened the ball valve between the air chamber via a spring mechanism. The egg container exploded from the cannon with a spray of water used to lubricate the barrel. The container landed nearly 100 yards down the Drillfield, startling unsuspecting pedestrians. The most impressive feat of this launcher did not occur during the competition, however. After the Drillfield cleared, the team pumped the cannon to 100 psi and let fly. The container streaked through the air, coming to rest mid-Drillfield, slightly beyond Burruss Hall.

Some of the most interesting designs were not for the launcher but the egg protection devices. The hollowed Nerf ball and the simple jar of peanut butter were by far the most common solutions. Both faired reasonably well in competition, only occasionally busting the egg upon landing,

However, some launchers required a more creative solution. Brittany Schafer detailed her team's problem in choosing an egg protection design for their air cannon. "Our problem is the barrel is small, only about three inches. If we had a larger barrel it would take forever to pump up." Limitations in size beyond even that of the given constraints required creative solutions. The solution: half of an empty Hokie Water bottle filled with hair gel and Styrofoam packing peanuts. While their egg never survived, their launches were highly impressive. At an air pressure of 100 psi, their launches averaged anywhere from 70 to 100 yards. Despite their launcher's failure at producing an unbroken egg, the team remained optimistic. "Ours is most definitely the prettiest," Schafer remarked as she learned of the team's victory in the "Class Favorite" category.

Another team chose to encapsulate the egg so tightly that it would not move in its container. Matt Anderson explained the design for his team's container: "It's two PVC joints fitted together packed with foam padding. Packaging in here is

StoryNOW! Box

What it is:

EF students launch eggs to learn about design the old fashioned way.

You should read it if:

You watch "Junkyard Wars" or "MacGuyver" with your friends.

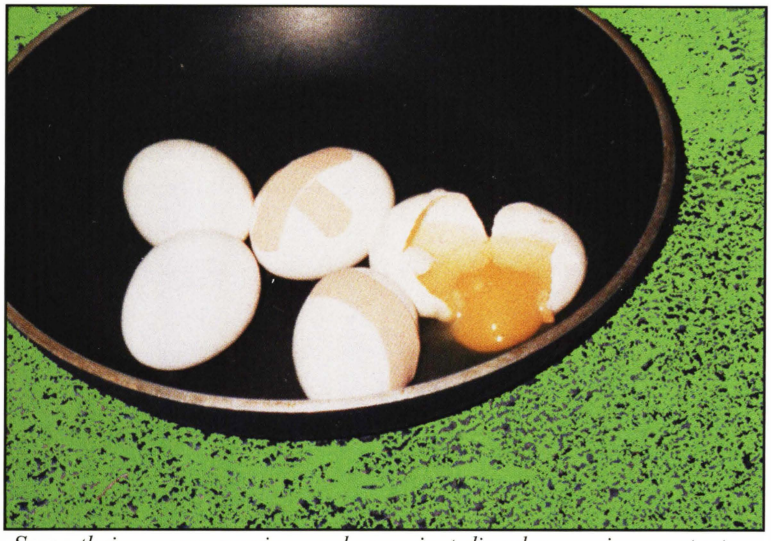
so tight we're worried it'll crack before it launches."

Other teams discovered unique ways of protecting their egg through sheer accident. Neil Schafer and Lauren McNair detailed their story of how they decided to cushion their egg with banana puree: "At first we were going to use something foamy, then something from part of an epoxy, then Neil said, 'Why don't we mush up bananas?'" The banana did work; the team's egg survived.

Ashley White discovered the secret to her team's egg protection through a mishap with a broken egg. After a test involving a raw egg and a stairwell, the inside of their Nerf ball egg protector was in need of cleaning. After being saturated with water, the foam became more elastic. The water was the key to getting the egg to survive.

While the object of the design project was to design a launcher and a protection device that would preserve an egg, many teams discovered problems with the Drillfield terrain. Scott Wise commented after his team's second egg broke, "The ground out there is really packed. It's like landing it on asphalt." Luckily, their third egg survived after a minor adjustment with the launch angle and a last ditch effort to angle the launcher so the egg would hit softer ground.

Improvisation and experimentation proved to be invaluable to the student engineer teams. Several original designs broke upon initial testing, requiring a re-evaluation of the design. Additional support proved to be the most common addition to designs. Legs, stakes, cross supports, wider bases—anything to stabilize the apparatus, proved to be invaluable in producing a successful launcher. Learning to re-evaluate and redesign was one of the most important lessons of this design project.



Some thrive, some survive, and some just die when engineers start launching eggs.

Despite being a freshman design project, the egg launchers attracted a good deal of attention. Several parents of prospective Tech students wandered from the campus tour to check out the launchers. The Roanoke Times sent a reporter to cover the event.

The successes and the failures of each team serve as important lessons in engineering design. They will surely show themselves to be vital as the students proceed in their careers at Tech and in the engineering world. EF

Space: The $10 Million Frontier

By Shuvom Ghose

Sometimes people just need an excuse. Many engineers have dreamed of building and flying in their own rocket to the edge of the Earth's atmosphere, but "Because it's cool!" isn't enough justification to cover millions of dollars of equipment and years of labor. Especially not to non-engineer spouses and mother in-laws.

But, with the founding of the X PRIZE in 1996, all those closet astronauts finally got the excuse they needed. Suddenly, these space enthusiasts weren't just pursuing a hobby, they were involved in an officially sanctioned "Race to Space". The 21 teams from across five countries who quickly registered were no longer chasing some foolish childhood dream, they were trying to win a very adult $10 million prize!

A quick look at the contest rules shows that the St. Louis-based X PRIZE Foundation isn't just giving a catalyst excuse to a few individuals, but to an entire industry.

First, all entries must be privately financed and built. This keeps out entrenched aerospace mega-companies and national governments, along with their disregard for cost efficiency, commercial viability, and innovation.

Second, a winning entry must complete two flights to an altitude of 100 km (62 miles) while carrying three humans (or one human and two passengers' ballast equivalent) within 14 days. This altitude is high enough to allow for space tourism and satellite launches but not so high that the ships require exotic heat shielding for re-entry. As a neat bonus, it also clears the Air Force's 50 mile altitude requirement for earning

StoryNOW! Box

What it is:

21 teams building their own spacecraft for a $10 million prize.

You should read it if:

You ever wanted to by a ticket to orbit.

astronauts' wings.

Finally, no more than 10% of the vehicle's non-fuel mass may be replaced between the two launches in the 14 day period. This will require the winning vehicle to be fully reusable, have a short turn-around time, and be reliable enough for frequent use, three vital steps toward the contest's true goal of founding a successful commercial industry.

"We hope the X PRIZE will be the first step in a viable and vibrant sub-orbital space tourism business," X PRIZE Chairman and President Peter Diamandis says. "Already, companies like Space Adventures are offering advanced ticket sales at a price tag of $100,000. Once someone wins the X PRIZE there will be a lot of business waiting for them, and they'll have the publicity they need to raise the money to perfect/improve their spaceship."

The need for an X PRIZE-type vehicle to jump start the space-liner industry is obvious, considering the current alternatives. If a start-up spaceflight company wanted to match the daily air traffic of even a small airport like Roanoke, America's only current option, the Space Shuttle, would sorely let them down.

Besides each Space Shuttle mission costing over $400 million, the Shuttle discards both two solid rocket boosters and its large external tank on every mission. The boosters can be recovered at sea and reused after a round trip by rail to a Utah facility, but a new 66,000 lb. external tank must be made fresh for each launch. Even though Roanoke only takes 50 planes through its gates every day, the math really gets fun.

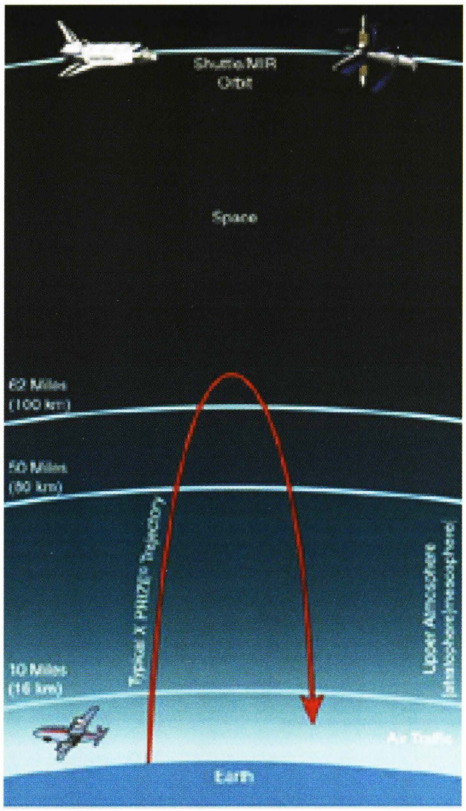
In order to match the daily traffic of a regional airport, a Shuttle-based spaceflight company would, in the course of one year, spend $7.3 trillion dollars on operations, send 18,250 trains to Utah and back, and let 1.2 billion pounds of external tank shell burn up in the atmosphere. (For perspective, that's 80% of the United States' Gross Domestic Product, 19% of all Amtrak train trips, and 22 times the weight of the Statue of Liberty plus its base.)

Add in the fact that about 1 in every 100 Shuttle launches fails (or one every two days at a Roanoke flight rate), and it becomes clear why you can buy tickets to fly on a Boeing 747 but not the *Columbia*, *Discovery*, *Atlantis* or *Endeavor*.

So why do the X PRIZE founders think their contest can take spaceplanes from Shuttle backwaters to jumbo-jet-like commercial maturity? Because 90 years ago, contests just like it took airplanes along the same route.

When first invented, airplanes were slow, barely controllable, and prone to frequent breakdowns. (Remember that Orville Wright's first successful flight covered only 120 feet, lasted 12 seconds, and came in between three crashes on the same day.)

Yet, only six years later, two designs very different from the Wright Brothers' were flown by two inventors unrelated to Orville and Wilbur, in a competition



To win the X PRIZE, a ship must go 10 times higher than any plane, but less than half as high as most Shuttle missions.

to cross the English Channel which only one plane completed. A year after that, two more pilot/inventors, with still more different designs and names, raced neck-and-neck across a 185 mile course from London to Manchester, which only one plane completed.

In 1911, one persistent aviator tried to fly across America in a month but gave up 49 days and 68 stops later, and soon crashed to add to the just 17-year old list of 100 airplane fatalities. By 1927, when two French pilots died trying to fly non-stop from Paris to New York, the cumulative airplane death toll barely budged. What caused so many different people to enter this new field and risk their lives to push its limits so urgently?

For being the first to fly across the Channel, Louis Bleriot won the Daily Mail's 1,000 pounds (the British money, not the weight) prize, which gave him enough notoriety to sell scores of his Bleriot XI plane. Louis Paulhan received 10,000 pounds (money, not weight) for winning the London-to-Manchester race. A $50,000 prize from the Hearst Group prompted Galbraith Rogers' torturous attempt to cross America in under 30 days, and it was winning the $25,000 Orteig prize for flying non-stop from New York to Paris that catapulted Charles Lindbergh and the Spirit of St. Louis into aviation immortality.

Lindbergh's flight also proved to the entire world that airplanes could cross long distances over water safely, navigate accurately in the absence of landmarks, and arrive when expected. Without those points being made to gain people's trust, airlines could not have grown into the $200+ billion dollar industry we have today.

But the learning curve for the X PRIZE teams will be much steeper than it was for the airline prize competitors of the early 1900's. When airplanes were made of wood, cloth and 12 horsepower home-built gasoline engines, anyone could tinker in their garage for a few years and gain enough experience to complete a working design.

By comparison, some of the best aerospace engineers at NASA and Lockheed-Martin failed to come up with a working prototype for the Single-Stage-To-Orbit X-33 launch vehicle, even after using the best equipment in the world for 4 years

and spending $1 billion. Then again, NASA also spent $1 million in the 1960's to invent the astronaut pen to write in weightlessness, while Russian astronauts simply used pencils.

Astronaut pens aside, getting three people to 100 km in X PRIZE fashion will be a delicate balancing act between vehicle mass, thrust per fuel consumed, and cost.

Vehicle mass is an overriding concern because each kilogram of the craft must be lifted into space by energy supplied from the fuel carried, which has mass itself. So adding more mass to the craft requires adding more fuel, which requires adding more mass... By the time this vicious cycle ends, adding just one kilogram of structure usually increases the final vehicle mass up to 7 kilograms. Letting this runaway cycle continue will result in a vehicle too heavy for the engines to lift or too expensive for the customer to launch.

An engine's thrust divided by the weight of fuel it consumes every second is called its specific impulse, and has the units of seconds. High performance rocket engines burning liquid oxygen and liquid hydrogen, like the Space Shuttle's, can reach specific impulses of 430 seconds. But that performance requires exotic fuel storage procedures like cryogenic cooling, which add complexity and thus cost. Engines burning kerosene or methane instead of liquid hydrogen are less complex, but with specific impulses around 300 s, they require more weight in fuel to get the same performance. Which requires more mass, which requires more fuel...

Cost has only recently become an independent variable in space design. After many decades of optimize-performance-and-damn-the-costs government space programs like Apollo and the Space Shuttle, many are slowly beginning to realize that, while the new Lamborgini looks great sitting on the showroom floor, a used Ford will get you home just as well.

The 21 X PRIZE teams currently registered have chosen to balance these three engineering constraints in three different ways: the pure rocket, the rocket-powered spaceplane, and the combined cycle spaceplane.

The Candian Arrow.

The Michelle-B.

The 7 Pure Rocket Entries: Canadian Arrow, Lucky Seven, daVinci, Green Arrow, Gauchito, Thunderbird, and Michelle-B

Teams taking the pure rocket path seek to reduce costs and risk by using proven technology on a no-frills shot to orbit. All of them take off vertically from a specially prepared launch pad, all carry all of their fuel and oxidizer internally, and all but one land with a drag device such as a parachute. Fundamentally, this flight sequence is no different from the one used for the very first manned space shots of Yuri Gagarin and John Glenn in 1961.

The Canadian Arrow team, however, has based its overall aerodynamic design on an even older rocket system: the V-2 missile used by the Germans in WWII. Though using modern materials and electronics, the Arrow's engine is a reproduction of the V-2's, burning a mixture of alcohol and liquid oxygen to produce an estimated 57,000 lbs. of thrust at sea level.

Landing is accomplished by a parachute splashdown in water at least 100 ft. deep, within 40 miles of the launch site.

"I have stated publicly that we expect to go after the X PRIZE in summer of 2003 and this date still stands," Geoff Sheerin of the Canadian Arrow team says. "We have secured the sponsorship required for our next step and at present are manufacturing the components to assemble our engines. After our engine tests next spring we will start construction of our flight vehicle."

The Lucky Seven team, in contrast, plans to use only a single stage, burn its rocket engines for a 90 seconds, coast past the 100 km mark, fall back to Earth, and then use a parasail and GPS positioning to steer to the designated dry landing spot.

The Canadian daVinci team has chosen a very unique site for its launch pad: a 25-story-tall hot air balloon 40,000 feet in the air! From a tether 900 feet beneath the balloon, the daVinci rocket will launch sideways to clear the launch system, its kerosene-liquid oxygen engines producing 10,000 lbs. of thrust. After transitioning to vertical flight, the daVinci will reach its maximum speed, Mach 4, and coast to a maximum altitude of 120 km. Around 10,000 feet on the way down, it will deploy a steerable parachute to glide to its landing zone.

By using their balloon launch site as a first stage to get them 40,000 ft. up, the daVinci team has bypassed the most dangerous and fuel-thirsty times of a rocket's flight: the first few seconds off the ground.

The British Green Arrow team, similar to the Lucky Seven folks, plans to use a single rocket stage which lands by parachute, and look to burn kerosene and hydrogen peroxide in their engines.

The British Thunderbird in flight.

The Gauchito, an Argentinean entry, will use two stages, the second of which has a cone shape similar to the re-entry capsules of the Apollo and Soyuz astronauts.

The British Thunderbird will also use two stages with parachute landings, and promises to turn the craft around for relaunch in just one week, seven days quicker than required.

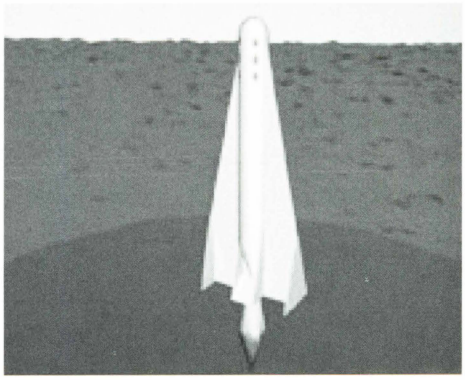
TGV Rockets, whose condensed business plan is: 1) Build rockets, 2) Fly rockets, 3) Have fun, 4) Make money, is the only team looking to execute a powered vertical landing. Much like a harrier jet or the DC-X demonstrator, the Michelle-B will use the same engines it took off with to thrust downward and slow its descent, for a soft, controlled, vertical landing.

The 3 Rocket Spaceplane Entries: Advent, The Good Ship (TGS) Kitten, and Aurora

These teams are following a path similar to the Space Shuttle by shaping their vehicle like a high-speed plane, so that it can generate lift to help in launch and to glide to a horizontal landing during descent.

The benefit of this approach is not all the upward force to reach orbit or reduce landing speed needs to come directly from the engines; the work done by the wings' lift is many times more fuel efficient than work done by a vertically thrusting rocket.

The downside is that the long, wide wing shapes most appropriate for the low speeds needed at landing are nothing like the thin, lightweight swept-back shapes needed for hypersonic flight to get to orbit. The trade-off is a hard one to make; the Space Shuttle has to land at over 200 miles per hour due primarily to its relatively small, lightweight wing and its tapered hypersonic shape.



The Advent rocketplane taking off from a water launch site.

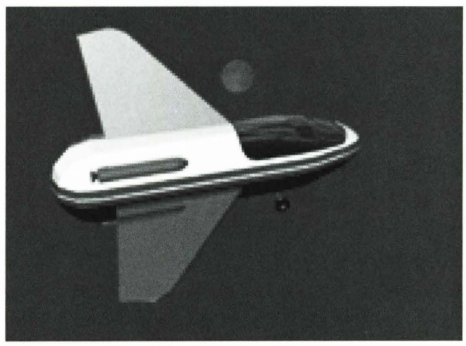
The Advent Launch Services team has chosen to take off vertically from a water launch site, and land horizontally in the water as well. Since the latitude of the launch pad affects the types of orbits a spaceship can reach, and most major cities are coastal, this will allow Advent a huge flexibility in launch operations. Enthusiasm has also helped the Advent team move quickly along.

"Our progress is amazing!" Jim Akkerman, contact for the Advent team, says. "The design changes daily, the building is progressing rapidly, and we plan to launch 'soon'."

While the humidity in their south Texas workshops does make it hard to work, especially with cryogenic systems, the team has conquered one of the biggest X PRIZE challenges.

"We have had no problem with resources," Akkerman relates. "Our retirement pay has been more than sufficient for building the vehicle. Our rocket has cost about the same as one of our buddies that's building a home-built airplane. Flight Operations will be the big cost hurdle for Advent."

The Cerulean Freight Forwarding Company's TGS Kitten will take off from a normal one-mile-long runway, climb like an airplane to 40,000 ft, then pitch upward at 75 degrees and accelerate at 2Gs for two minutes before coasting to reach its maximum altitude. It will then land normally on a conventional runway.



The TGS Kitten..

Justin McFarland, acting President and CEO of the Cerulean Freight Forwarding Company (and a Hokie), says the team is focusing on "design, design, design!"

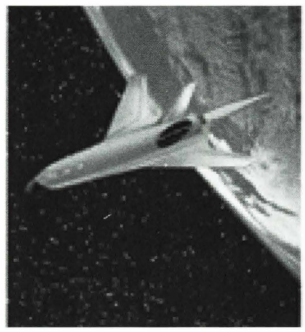
"We're revamping our current model, staked out several professional model makers, and are running simulations weekly in our basic computer simulation program to get a rough idea of 'handling' characteristics."

Though their first design had a factor of safety of 1.3 (basically meaning the components were 30% stronger than they needed to be for normal operations), simulations showed it did not meet safe landing criteria. The Kitten team is currently looking to revise the design to an overall factor of safety of 2, twice as much as commercial aircraft, but much less than the 9 or 10 used in the Shuttle. They also have a larger goal in mind.

"I believe we are the only team with aspirations focusing on the hypersonic freight aspect of space."

Unlike other companies' plans of offering space tourists a few minutes of weightlessness, Cerulean Freight looks to make money by getting your package across the world, *fast*.

"We intend on conducting normal operations from altitudes of 90 to 240 thousand feet at speeds of Mach 5-7," Justin says. "Flights are planned to be between coastal cities at first and we will attempt to break all known speed records for package delivery between Los Angeles and Tokyo and Sydney as well as New York to London."



The Aurora spaceplane.

He also states that anyone who wants to volunteer their help for The Good Ship Kitten is welcome, and that they are especially looking for an aerospace engineer to help design the craft's wings which must make the low-speed landing /supersonic flight tradeoff mentioned previously, while keeping its leading edges cool. Of course, by cool, Justin means "below 1500 degrees F."

With their current design changes, the

Kitten has a little ground to make up on the other X PRIZE teams. "At current," Justin says, "I would expect a solid design to leave our hands within 4 years, a prototype in 6, and a launch in 7."

FunTech Systems' Aurora spaceplane matches the flight sequence of the TGS Kitten, using kerosene and hydrogen peroxide engines off a runway, pulling vertical a couple of tens of thousands of feet high, and coasting to maximum altitude in a ballistic trajectory before flying to a runway for landing.

The 8 Combined Cycle Spaceplane Entries: Ascender, ComsopolisXXI, Space Tourist, Eclipse Astroliner, Cosmos Mariner, XVan 2001, Pathfinder, and Proteus

These eight teams have are all betting that aerospace technology has improved enough to allow a dream never proven successful: a ship that takes off a runway like a plane, uses air-breathing jet engines while in the atmosphere, switches to rocket power to kick up into space, and then reverts to jet engines again while it comes down for a smooth runway landing.

By using air-breathing propulsion inside the atmosphere, a combined cycle spaceplane reduces the weight of oxygen it has to lug around compared to purely rocket designs.

Bristol Spaceplanes' sleek-looking Ascender uses 2 turbofan engines to lift off the runway and climb to 8 km. Then, one rocket engine gives the Ascender the push it needs to climb vertically at Mach 2.8 on its way to coasting past 100 km altitude.

"We have an excellent design, team, and business plan," David Ashford of the Ascender team says. "We need the investment. Ascender will fly to space three years after we get the money."

About the finances, Ashford asks: "Why is it so difficult to explain the obvious (that a useful spaceplane could have been built thirty years ago and would have slashed the cost of access to space, and that the development cost now is about that of a new business jet.) to the folk with the cheque books?"

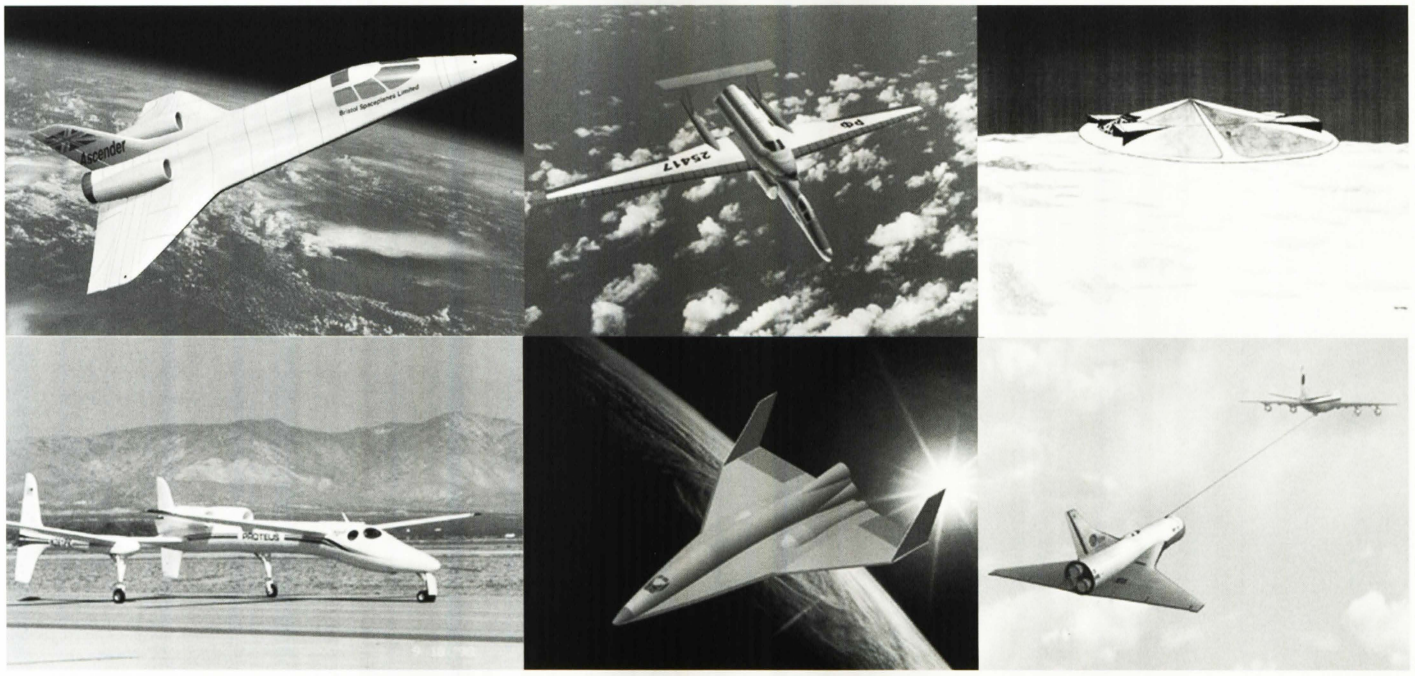
The Russian Cosmopolis XXI team plans to piggy back their craft on the roof of a M-55 Geophisika carrier aircraft which will raise them to 20 km before their second stage detaches and rockets into space. Since the M-55 is an existing, proven plane, the Cosmopolis team is already halfway to the finish line.

Though the Discraft's Corporation Space Tourist looks like a composite of the five most seen UFO designs, its operation is much like any other spaceplane: take off from a runway, breathe air until the air runs out, rocket/coast to 100 km, fly back down, make a few crop circles, and land on a conventional runway.

The Kelly Space and Technology's Eclipse Astroliner has two stages: the actual Astroliner, and a Boeing 747. The plan is to tow the Astroliner behind the jumbo jet to an altitude, then release the kerosene-oxygen burning rocketplane to reach orbit by itself. Thus, the 747 and Astroliner together make up a two-stage combined cycle spaceplane system, with one stage already having thirty years of flight experience.

Lone Star Space Access Corporation's Cosmos Mariner uses two commercial turbofans each producing 25,000 lbs. of static thrust to lift off the runway, and later turns on its three 90,000 lbs. thrust-producing rocket engines to gain the speed to reach their highest point. They are currently optimizing their design and exploring launching satellites from it.

Pan Aero Inc.'s XVan 2001 is a small, light entry, having a wingspan of only 7 meters and a takeoff mass of just 1800



Some of the combined cycle spaceplane entries:
Top row, left to right: the Ascender, the CosmopolisXXI, and the Discraft.
Bottom row, left to right: the Proteus's first stage, the Cosmos Mariner, and the Eclipse Astroliner with Boeing 747. All breathe air while in the atmosphere, and use rocket propulsion when the air gets too thin.

kg. By holding down its size and using surplus jet engines for power, Pan Aero can hold down the cost to make the Xvan 2001. Thus, it will take fewer flights to break even on their initial investment, and each seat on those flights can be sold for less.

The Pathfinder, from Pioneer Rocketplane Inc., is what some call a stage-and-a-half-to-orbit system. Using turbofans to take-off the runway, the Pathfinder will rendezvous with a tanker for an air-to-air fueling of liquid oxygen for its rocket engines. Making a separate tanker carry up some of the fuel loosens the design limits on the main craft, since it doesn't have to do all the work itself.

Scaled Composites' Proteus bears a strong resemblance to its previous Voyager craft which set records by flying non-stop around the world without refueling. By using the long, thin, wings which increase endurance at low speeds, the Proteus team is looking to simultaneously cut down on fuel weight, engine specific impulse, and cost. Just like the Cosmopolis design, the efficient, high-altitude Proteus will piggyback a smaller, manned rocketship which will release, fire its own rockets, and enter space.

While every team believes its concept will satisfy the conditions eventually, the X PRIZE is still a race. With Advent claiming to be almost finished, the Canadian Arrow predicting a Spring 2003 launch, and the Proteus carrier craft already flying and setting altitude records around 60,000 ft, which team is going to get there first?

"It's hard for us to provide any opinion on which is going to win," X PRIZE Chairman Peter Diamanis states, "But I can say that about one-third are building hardware and have serious efforts ongoing."

The only thing that is for sure is that, eventually, a team will win. When that first group of pioneers launches the first privately-built, truly reusable, commercially-aimed spacecraft, what will it mean for the rest of us?

"This will trigger a spaceflight revolution," David Ashford of the Ascender team says. "Entrepreneurs will smell the profit, and there will be a race for commercial gain."

Jim Akkerman of Advent agrees. "Rockets can be simpler than airplanes... and cost less... and be more reliable," he says. "Rockets will eventually be used for safe, economical, intercontinental travel."

"If one thing comes from the contest," says TGS Kitten team member and last-word-deserving-Hokie Justin McFarland, "it must be this: The X PRIZE isn't the goal, it's merely the starting line for the competitors."

EF

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What's the Purpose of Engineering Fundamentals?

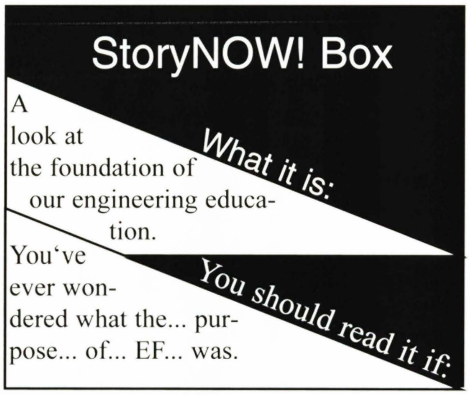
by Cliff Coates

What feelings do you get when you think of the Engineering Fundamentals (EF) Division? Do you get a nice, warm, fuzzy feeling all over? Do you feel this blissful all-encompassing wave of emotions overcome you? Okay, so you probably do not feel quite this way towards the EF division. More than likely, your feelings are not nearly this positive towards EF. Have you ever wondered though, what the purpose is of the EF division? Being an engineering student, you have probably heard rumors that EF's only purpose is to weed out students. But, is that true? Does EF really try to get rid of engineering students?

First, the issue of what the EF division's mission is. According to Professor Devens (whose father founded the Engineering Fundamentals Division), its mission is to advise and assist young engineers in their transition to college and engineering, in addition to giving them a taste for what engineering is.

Prior to the existence of the EF division, freshmen engineers would enter into the department from which they intended to graduate, at the beginning of the school year (which is what occurs at most engineering schools). This was problematic because many engineering students would discover that they did not want to pursue that particular field of engineering after having been in it for a semester or more, causing them to have to stay on extra semesters in the pursuit of their degree.

In fact, Dr. Griffin, the head of Engineering Fundamentals, said that his first three semesters were spent in a degree different from his final major. Dr. Griffin said that at his college, students had to decide before their freshman year what type of engineering they wanted to pursue. He said that "...we had to choose a major, right out of high school, and I chose Electrical Engineering, because my Dad had worked for a power company, and it seemed like a good thing to do, and after about two-and-a-half semesters it became clear that there was no way I was going to do it, [Electrical Engineering]...so then I ended up changing majors, sort of in the middle of my sophomore year, and I lost one course, and I was kind of behind in the Mechanical Engineering curriculum."



One of the reasons that Dr. Griffin says that Virginia Tech does not have that problem is because all freshmen engineers enter as "undecided," allowing them to make an educated decision. This has resulted in relatively few engineering students changing majors past their freshmen year. An even greater problem than this was that the College of Engineering was losing too many students; approximately only one-third of freshmen engineers remained in engineering through graduation. This was not good for Virginia Tech because too many potential engineers were calling it quits. This was occurring for a variety of reasons.

Professor Devens says that engineering students felt lost their freshman year and did not have much personal contact with faculty. By focusing on advising, the EF Division tries to give freshmen a place to call home and help them to meet faculty. Thus, the problem needed to be corrected, and the solution that was created was the Division of Engineering Fundamentals. All incoming freshmen engineering students would be required to enter into Engineering Fundamentals, and from there, decide the major that he/she wished to pursue. This would allow freshmen engineers the opportunity to learn about each major from the EF classes and to make an informed decision. In order to fulfill the advising aspect of its mission, EF teachers are available to advise students about each department of engineering. The combination of advice and information is designed to assist freshmen engineers in choosing what branch of engineering they wish to pursue. A further reason for the creation of the EF Division was to allow freshmen engineers the opportunity to meet and interact with each other. Through group projects in both EF classes, it is hoped that freshmen will get to know other freshmen

By focusing on advising, the EF Division tries to give freshmen a place to call home...

and have a more positive first year. Thus, the mission of Engineering Fundamentals is to better our experience as VT engineering students.

Now that we know the mission of Engineering Fundamentals, it's time to look at the changes that have occurred in the division. Each year, both EF 1015 and 1016 are evaluated in order to try to improve their curriculums. This is done in an attempt to make the courses more interesting for students.

In the past several years, EF 1015 has seen many changes. According to Professor Devens, the number of computer languages a student must learn during their first semester has been reduced from three to one. This was done so that students could focus on problem solving using the computer as a tool rather than learning multiple languages and respective programs. For students who have never had any prior programming experience, this greatly decreases their frustration. According to Dr. Kampe, coordinator for EF 1015, in the fall of 1999, a greater emphasis was placed upon programming to prepare students for future programming courses, while the amount of mechanics covered was decreased, since it was believed that students will see that material often in future courses. Another improvement that was made to the EF 1015 curriculum was the removal of energy problems. This was started in fall 2000 in order to give students more time to learn and review the other material presented in the course. Now the last three lessons of EF 1015 consist of workshops to enhance a student's comprehension of the material. Professor Kampe states that the idea behind the workshops is that a professor will help each student set up the assigned problem so that he/she will be able to solve the problem later that day. Once the professor is done discussing the problem, he/she walks around the room looking for people in need of assistance. In order that students may further learn the material, the problems that are assigned in the workshop combine material from different areas of the course; this forces students to start reviewing for the final exam earlier than they normally would, which results in them being better prepared.

Contributing to the better preparation of students is an initiative run by Professor Knott. Professor Knott started a one credit elective seminar that is linked to specific sections of EF 1015 which is designed to give additional math assistance to students in need. Due to different backgrounds, there are many freshmen engineers that have holes in their math background; this course tries to bring everyone up to speed as well as to provide studying and test-taking strategies.

All these changes have helped students to learn the material better and resulted in a passing rate of 78% for the EF 1015 fall 2000 classes!

In order to further review the EF 1015 course material, Engineering Fundamentals instructors hold a help session on Reading Day to assist students in preparing for the final exam. All these changes have helped students to learn the material better and resulted in a passing rate of 78% for the EF 1015 fall 2000 classes!

In addition to increasing student understanding of the material, it is also the desire of the EF division that future freshmen find the courses exciting. In order to make the EF classes more interesting, future engineering students will encounter a greater emphasis on design in both EF courses. According to Dr. Griffin, future EF classes will experience design starting in EF 1015. As he states, "The material is dry, and it's not clear what relevance it has to being an engineer." Dr. Griffin further went on to say that through the early introduction to design, it is hoped that the material presented in EF 1015 will not seem detached to students and they will be motivated to rise up to the challenge. His desire is to "spice it up a little bit, not make it easier."

Right now, you are probably asking yourself, how does the division of Engineering Fundamentals expect to make their courses more exciting? The answer is that this fall all sections of EF 1015 will experience design through the use of hands-on exercises in class. The hands-on in class exercises will involve students working on team projects that demonstrate engineering design and principles. These projects will require high levels of student participation in order that students may feel as much like engineers as possible. To further the amount of design experienced in the freshmen year, eight sections of EF 1015 will use "MacGyver" boxes this fall (a gift from the Student Engineers' Council).

According to Professor Kampe, the "McGyver" boxes will be very similar to a pilot project run by Professors Goff and Connor previously. The idea behind the "MacGyver" boxes is that you are an engineer, and your boss comes up to you, like in the movie Apollo 13, dumps out a box of supplies, and says, "We have this problem and here are your supplies. Come up with a solution using only these materials!" Thus, each engineer has to be like MacGyver and create a solution to a given problem from basic materials. Each "MacGyver" box will consist of various supplies, such as pieces of dowel and different tools. Teams of four freshmen engineering students will be assigned a problem and then they have to use their creativity to design a solution to the problem. This also allows each student to see some of the mechanics concepts in EF

1015, such as tension in cables and reaction forces. This is important because once an individual has a feel for a concept, they are often more motivated to learn about it. Professor Kampe expresses her hope that this increased emphasis on making engineering exciting will encourage more students to stick with engineering.

"We're trying to bring more of the excitement of engineering, because engineering is an exciting field. And what's sad to see is when someone comes in wanting to be an engineer, and they don't see the excitement, and they leave."

Before we get to the question of whether EF courses are designed to weed out students, it should be addressed as to the success of the EF division in helping students choose a major. Nathan Wright, a rising junior in Aerospace engineering, says that he does not feel that the EF courses significantly influenced his decision of Aerospace engineering. He felt that "it has very little relevance to aerospace engineering, that I saw. It had more relevance towards probably…civil, and I guess some of the sketching, maybe some of those parts could come up in mechanical engineering."

Even though he didn't see how the EF courses related directly to his major, Nathan says that he thought that the sketching taught in EF 1016 was "decent."

On the other hand, Wess Tweedy, a rising junior in Civil Engineering, says that various aspects of the material presented from the EF courses related to his major. Although he feels that the EF courses did not affect his choice of major, he has been able to use material from his Civil Engineering classes in his EF classes. He says that EF 1016 applies to Civil Engineering through the use of scales and Mechanical Desktop, both of which teach him skills that he uses in and can apply to his in-major classes. Wess says that his section of EF 1016 taught by Professor Devens has allowed him to explore Civil Engineering.

"I will say that 1016…has given me the opportunity to better find out, better focus on, like what I want to do in my major, mainly because of the way our professor treated us and because of the design project he let a group of us do."

The design project Wess speaks of is the 36-acre site development for a church. Each of Professor Devens' EF 1016 classes had a team which created a site plan for the church. Professor Devens will take the completed students' ideas, present them to the church, and let the church members decide what they like and don't like. He will then incorporate these ideas into the official church site plans. Wess says that this project has allowed him to use principles that he learned in his Civil Engineering classes, especially his measurements class. So even though EF classes seem to vary in their helpfulness with choosing a major, they do at least partially relate to the student's major as well as give him or her several extra months to make that decision.

Now, as to that pesky question of whether or not EF is trying to weed out students. It should first be noted that most other engineering colleges have approximately only one-third of students that start in engineering remain in it through graduation. That means that approximately two-thirds of their students transfer out of engineering.

Yet, according to the Dean's Office, roughly 75-80% of Virginia Tech EF students remain in engineering through graduation. That's a loss of less than 25%! This means that if the EF division really wanted to get rid of students, there are much more effective methods. As mentioned earlier, the EF division was created with the intent of keeping more students in engineering. Furthermore, Dr. Griffin said that in 1998 about 85% of students passed EF 1015 within two tries. Thus, if they are trying to get rid of students, they are not doing a very good job.

On a personal note, I would like to say that I- along with many other EF students- often thought during freshmen year that the EF division was trying to "weed us out." It was not until the middle of my sophomore year that I realized that maybe EF was not really trying to get rid of us. I say this with absolutely no malice towards anyone in the EF division; for I personally liked all of my EF professors. It was not until I approached this article with an open mind that I concluded that the EF division is not really out to get anyone. Sure it is hard and difficult, but rise up to the challenge! I guess the best way to look at Engineering Fundamentals is that it is a type of engineering boot camp; it is hard but doable. EF

"We're trying to bring more of the excitement of engineering, because engineering is an exciting field. And what's sad to see is when someone comes in wanting to be an engineer, and they don't see the excitement, and they leave."

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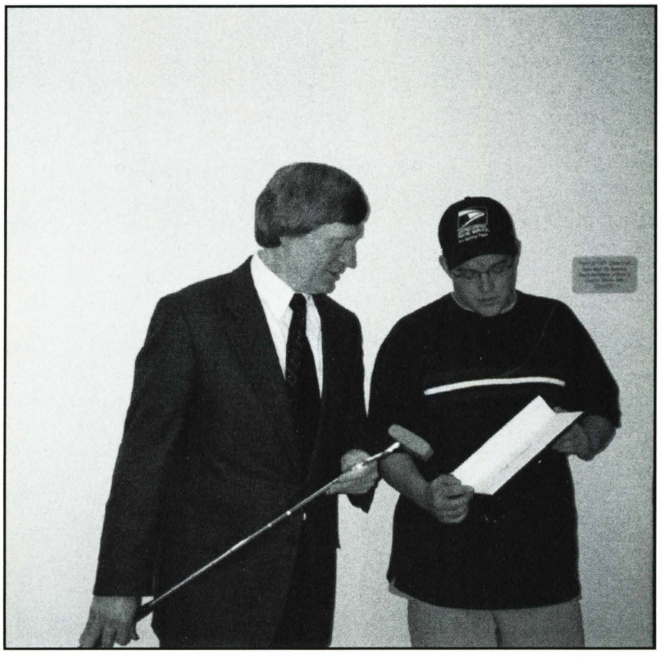
New MSE Head Is Made of the Right Stuff

by Shuvom Ghose

Forging the spearhead of a major university's Materials Science Department is tricky stuff. A man made of 100% knowledge will cut through research frontiers easily, but won't have the warmth for frequent student handling. One made of 100% compassion will have the ductility to see things from another's point of view, but couldn't carry any appreciable load.

What you're looking for is some sort of human alloy, sharp enough to cut new ground, strong enough to hold his edge, but flexible and warm enough to deal with people. If you started with a Master's Degree in Materials Engineering as your load-bearing core, injected 2 years of industrial experience to increase his malleability, dipped on a Ph.D. overcoat to make him resistant to knowledge corrosion, and then flame-hardened him over 23 years in the teacher's hotseat at University of Florida classrooms, then you might just have a workable composite. And what you would have would be Dr. David Clark, the new head of the Materials Science and Engineering Department.

Dr. Clark brings to Virginia Tech a wealth of knowledge in the materials field, a warm demeanor towards students and faculty, and a couple of hobbies not usually associated with stereotypical engineers.



Dr. Clark examines a ceramic golf club and Space Shuttle tile with MSE graduate student Jeff Schutlz.

"I love things to do with physical activity: jogging, body building, martial arts," he says. The martial art Dr. Clark has trained in is Hapkido, an eclectic Korean style centered around unlocking the user's inner strength. The style, which focuses on following balanced, natural movements, aligns perfectly with the demeanor of this sincere, soft-spoken man who has set some very lofty goals for the MSE department.

His objective is as simple as it is ambitious: make the department one of the top ten in the nation in ten years. Currently, US News and World Reports' annual survey has Tech's whole engineering college ranked 17th in the nation and just its MSE department around 25th or so. (To compare, our other nationally ranked engineering departments are as follows: Aerospace and Ocean 13th, Chemical 24th, Civil 10th, Electrical and Computer Engineering 16th, Environmental 14th, Industrial Systems 9th, and Mechanical 14th.) So what will it take for Virginia Tech MSE department to muscle past the likes of Cornell, Carnegie Mellon and Georgia Tech to claim that #10 spot in the standings?

StoryNOW! Box

What it is: A profile of our new MSE Department Head.

You should read it if: You have to deal with teachers, and want to know what makes them tick.

"We have all the potential here, in terms of faculty, expertise, and facilities to really make this happen," Dr. Clark says, but notes the department still needs to grow. "My goal is this: to have between 19-20 faculty in our department, about 120 undergrad students, about 100 graduate students." Currently, the department has 13 faculty lines, about 85 undergraduate students and 45 graduate students.

Basically doubling the size of the department won't be easy, and Dr. Clark and the MSE faculty and staff have begun a comprehensive plan to hit recruiting, in his words, "from all the different angles." Through displays to engineers already at Tech, recruitment

meetings with undecided students offered admission here, and talks to high school juniors checking out colleges for the first time, Dr. Clark seeks to overcome one of the biggest hurdles his field faces.

"One of the problems we've had in the past," he says, "is that a lot of people don't know what MSE is. They know what mechanical engineering is, they know civil engineering, they know about chemical engineering, electrical engineering, but they don't know what materials science and engineering is all about. Neither the students nor the parents know."

But they are learning. Dr. Clark relates that, after 20 minutes of talking to some families at an MSE presentation in Falls Church, VA, "one of the fathers of a student was so excited about MSE that he wanted to come back and get his degree in it!"

How could people not get excited about a department whose interests span from ceramic golf clubs to Space Shuttle re-entry tiles which remain cool to the touch even when held under a blowtorch all day? When considering if this field has a growing future, just ask yourself, what engineering product would remain useful if its key components didn't have reliable properties?

"If the right materials hadn't been there," Clark points out, "Edison would never have invented the light bulb. A lot of people don't think about these things."

> His objective is as simple as it is ambitious: make the department one of the top ten in the nation in ten years.

But Dr. Clark's main priority isn't with recruiting new students, it's with making the ones already here into solid, well-rounded engineers. While every department head says that, Dr. Clark proves it by continuing to teach classes, having an open-door policy for students looking to meet with him and staying focused on turning out problem-solving engineers, not just walking bodies of facts.

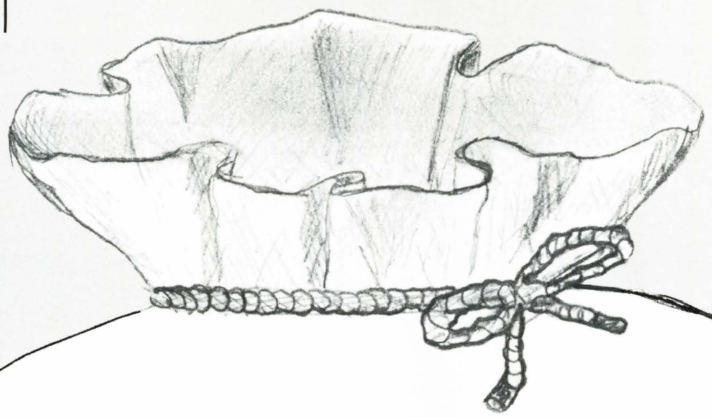
"If we simply train students here to regurgitate what they've been told, sooner or later, they probably will become obsolete," he says, adding that the two most important things the teachers can instill in budding engineers are, "how to use the tools that are available to them in terms of finding out information," and "learning how to communicate with each other in the engineering profession as well as with the general public."

Finally, to all students, Dr. Clark suggests: "Don't throw away your opportunities, whether you're here at Virginia Tech or Florida or MIT. Take advantage of what you have. This is a smorgasbord. Don't waste a minute here. Take advantage of all the things, for the most part which are free. You'll be glad you did when you get out and start working, because those same opportunities may not be there."

Good advice from a man looking to test his mettle as a fellow Hokie.

EF

e-mail bag



The Theory of Relativity in Action:

One day, when a snail was crossing the road, he was run over by a turtle. Regaining consciousness in the emergency room, doctors asked him what caused the accident. "I really can't remember," the snail replied. "You see, it all happened so fast."

The Myth of Heavy Boots (submitted to a webpage):

About 1983, I was in a philosophy class at the University of Wisconsin, Madison (a good science/engineering school) and the teaching assistant was explaining Descartes. He was trying to show how things don't always happen the way we think they will and explained that, while a pen always falls when you drop it on Earth, it would just float away if you let go of it on the Moon.

My jaw dropped a little. "But a pen would fall if you dropped it on the Moon, just more slowly." I protested.

"No, it wouldn't," the TA explained calmly, "because you're too far away from the Earth's gravity."

"You saw the Apollo astronauts walking around on the Moon, didn't you?" I countered, "why didn't they float away?"

"Because they were wearing heavy boots," he responded, as if this made perfect sense (remember, this is a Philosophy TA who's had plenty of logic classes).

By then I realized that we were each living in totally different worlds, and did not speak each others language, so I gave up. As we left the classroom, my friend Mark was raging. "My God! How can all those people be so stupid?" I tried to be understanding.

"Mark, they knew this stuff at one time, but it's not part of their basic view of the world, so they've forgotten it. Most people could probably make the same mistake." To prove my point, we went back to our dorm room and began randomly selecting names from the campus phone book. We called about 30 people and asked each this question: "If you're standing on the Moon holding a pen, and you let go, will it a) float away, b) float where it is, or c) fall to the ground?"

About 47 percent got this question correct. Of the ones who got it wrong, we asked the obvious follow-up question: "You've seen films of the Apollo astronauts walking around on the Moon, why didn't they fall off?" About 20 percent of the people changed their answer when they heard this question, but the most amazing part was that about half of them confidently answered, "Because they were wearing heavy boots."

Yeah, But At Least We Know Pi Exactly:

"Engineering is the art of modeling materials we do not wholly understand, into shapes we can not precisely analyze, so as to withstand forces we cannot properly assess, in such a way that the public has no reason to suspect the extent of our ignorance." -Dr. AR Dykes, British Institute of Structural Engineers, 1976.

letter from the editor

The Engineer's Fable

Once upon a time, there was a young man who announced that he wanted to help improve the world by becoming an engineer. His friends gasped, for becoming an engineer was fabled to be a long and arduous process, which only the most pure of purpose could accomplish. This talk did not make the young man sway or falter, but only begin his studies with a fierce determination.

All throughout high school, the young man studied dillgently the things he thought a good engineer should know. He poured over the ancient tomes of Math which had laid unchanged for generations and he devoured the dynamic books of Science, which were being rewritted almost as fast as he could read them.

The evil, misinformed lords who made the high school's curriculum also insisted that he study useless subjects like english, history and physical education. But this brave young man managed to fool the evil lords, by only paying enough attention in these classes to barely get by, while saving time for his precious Math and Science.

Even as his friends wasted their time getting together to throw a ball through a hoop or travel to see what had not yet been seen, or go to dances to press their lips (and sometimes more) against each other, the young man did not. He only did those things and joined those clubs which let him talk about engineering, so pure and direct was his purpose.

In college he was, fortunately, much the same. Though the young man went to an immense university which had more activities than one can comprehend, he would not let himself get distracted. Though others his age tried to get the young man involved in "causes" or "activities", or "socials", he did not succumb to temptation. What, after all, did those have to do with engineering and improving the world?

During his time at the great university, the young man embarked on a grand engineering quest to make Slot A fit into Slot C. For as long as people could remember, they had fit Slot A into Slot B, which then fit into Slot C. But, the almost-engineer reasoned, if I could make Slot A fit directly into Slot C, think of how much the world would improve! Many hours and much money would be saved! Why, it might even win him an award, the young man reasoned.

So he began to spend all his time on making Slot A fit into Slot C. For days and days he toiled, taking breaks in his engineering for only one thing. The man, not so young anymore, had noticed many of those his age pressing their lips (and sometimes more) against each other, and he had an urge to do so as well.

He approached the women to which he wanted to press his lips to, and asked them directly if they would. To his shock, they all declined. The man had heard from TV, books and conversations, that women wanted to press their lips against a man's. And the engineer knew he wanted to press his lips against theirs. So why did the simple, direct method not work, as it did in engineering?

Fine, he thought. Once I figure out how to fit Slot A into Slot C, *then* those women will want to press their lips (and sometimes more) against mine!

So the engineer went back into his lonely lab and re-doubled the effort on his quest. And finally, one day, he succeeded!

So thrilled was the engineer that he ran out into the street and told the first person he met about his success.

"But I have no home and must live outside in the rain and cold," the man told the engineer. "How will Slot A fitting into Slot C help me?" Undaunted, the engineer pressed on, and told the next person he met what he had done.

"But my husband has left us, and my children don't know how to read or write," the woman told him. "How will Slot A fitting into Slot C help me?"

The next person told him, "But I have a disease which is eating me up from the inside. How will Slot A fitting into Slot C help me?"

And so it was everywhere he went. If no one would praise the great step he had taken, the engineer thought, it must be because they don't know enough science and math to appreciate it. So he went to see the Brotherhood of Engineers, and finally, he found people who praised him.

"That is a very good thing you have done," the Brotherhood told him. "But now consider how to fit Slot D into Slot F. And then fit Slot G into Slot I."

As the saddened engineer left the Brotherhood, he saw standing outside the man with no home, the mother with no husband, and the man who was being eaten from the inside.

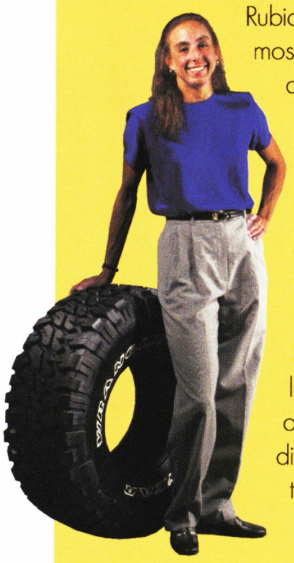
That was when the engineer laid down his precious Math and Science and went out among the crowds which he had avoided for so long. Where there was need of pushing, he pushed, and where there was need of pulling, he pulled.

And while he was out improving the world, his original goal from long, long ago, he wanted to tell all the other engineers the joy he had found in using engineering to truly help people. So he decided to write a fable.

Shuvom Ghose
Editor-In-Chief

ROCK CRAWLER

Not exactly a desk job...



It's a few mouse clicks away from a computer terminal where she designs Goodyear tires to California's Rubicon Trail, one of the most grueling off-roading areas in the world. But Stephanie Brown, BSME, VPI, '89, toughed it out to see for herself how well the Wrangler MT/R she and her team designed held up. "I've been lucky – I've been able to do a lot of different things," says the holder of more than 40 patents.

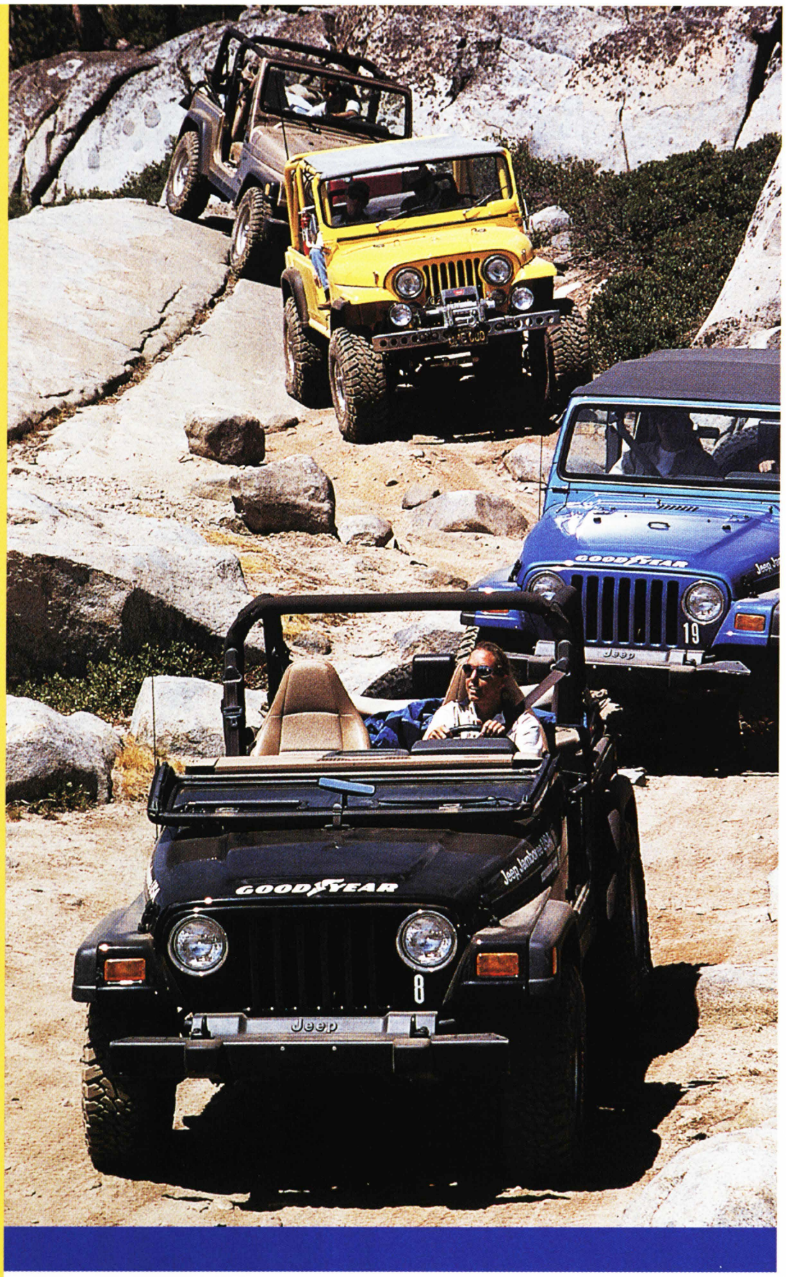
Stephanie and her team have earned several awards and accolades for the MT/R. She credits Goodyear's "squad" system of new grad hires for allowing her to focus on a career area after sampling several.

"We've hired VPI engineering graduates over the years because of their individual accomplishments and the college preparation they have received; we certainly plan to continue this successful program," said Dave Glemming, ME, VPI, '65, Goodyear's director of global tire performance prediction.

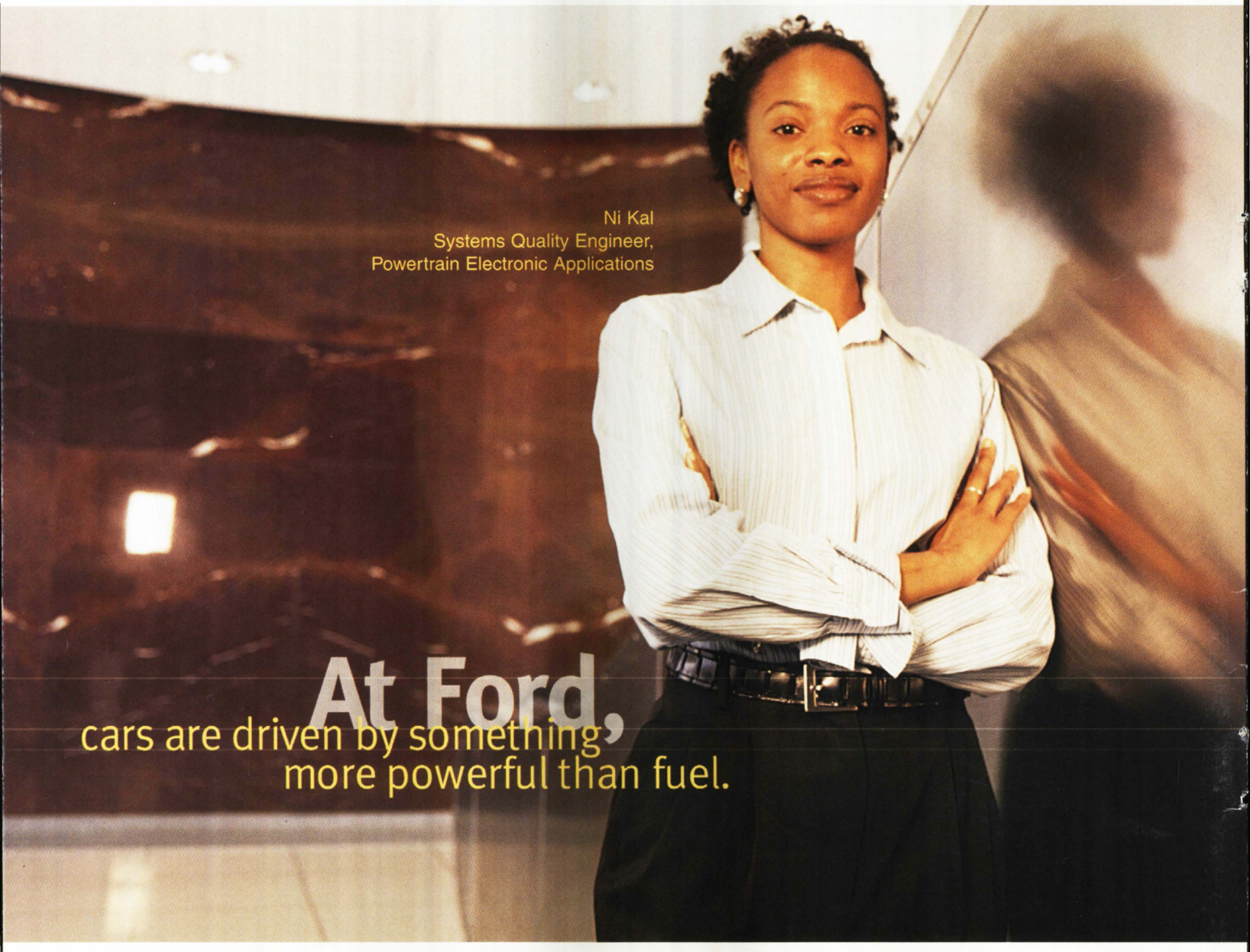
Stop in at Goodyear's booth during Career EXPO 2001 and see for yourself how the program works.

For detailed information about Goodyear and employment opportunities, visit the company's web site, www.goodyear.com.

Maybe you, too, can discover a new trail.



GOODYEAR



Just ask Ni Kal.

She tackled a cross-functional assignment in Brand Management to launch the new 2000 Taurus. Her ideas have resolved assembly issues at one of our major manufacturing facilities. And currently, she's leading a team of engineers focused on improving Powertrain Control Modules.

An impressive career for anyone. What's more impressive is the fact that Ni Kal accomplished all of this and more in just two years.

That's what the Ford College Graduate Program is all about. It gives recent graduates the opportunity to make important contributions - right from the start. Even better, it will give you the chance to create your own unique world within Ford. What do you want to accomplish in your career? Where do you want your talent to take you? The Ford College Graduate Program will give you the experience you need to find the answers.

It's a remarkable journey. And for Ni Kal, it's just beginning. For more information about the Ford College Graduate Program and current career opportunities, visit us at mycareer.ford.com. By choice, we are an Equal Opportunity Employer committed to a culturally diverse workforce.

Ford Motor Company

VOLVO mazda LINCOLN Ford Mercury JAGUAR ASTON MARTIN LAND ROVER