ENGINEERS' FORUM

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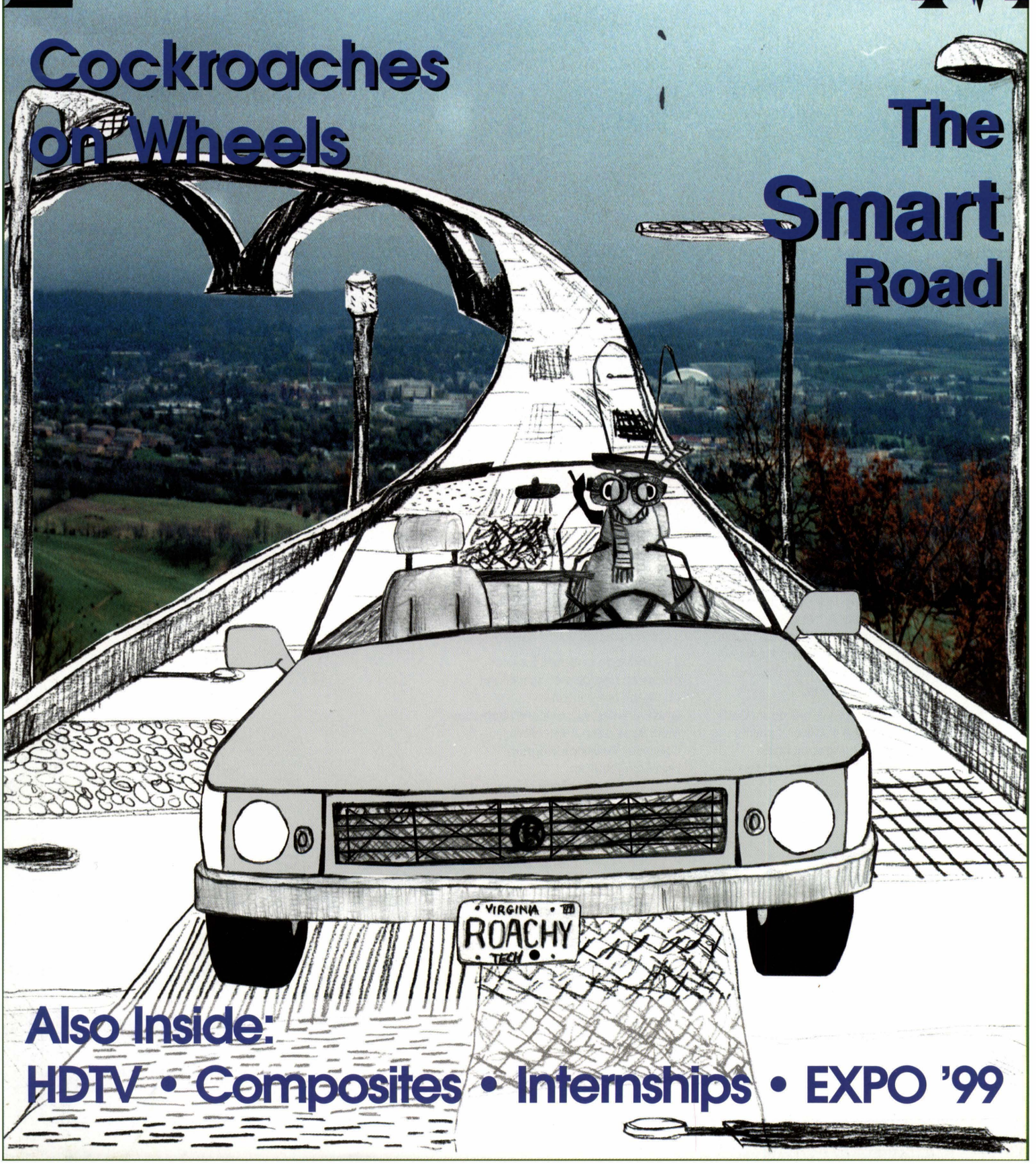
Cockroaches on Wheels

The Smart Road



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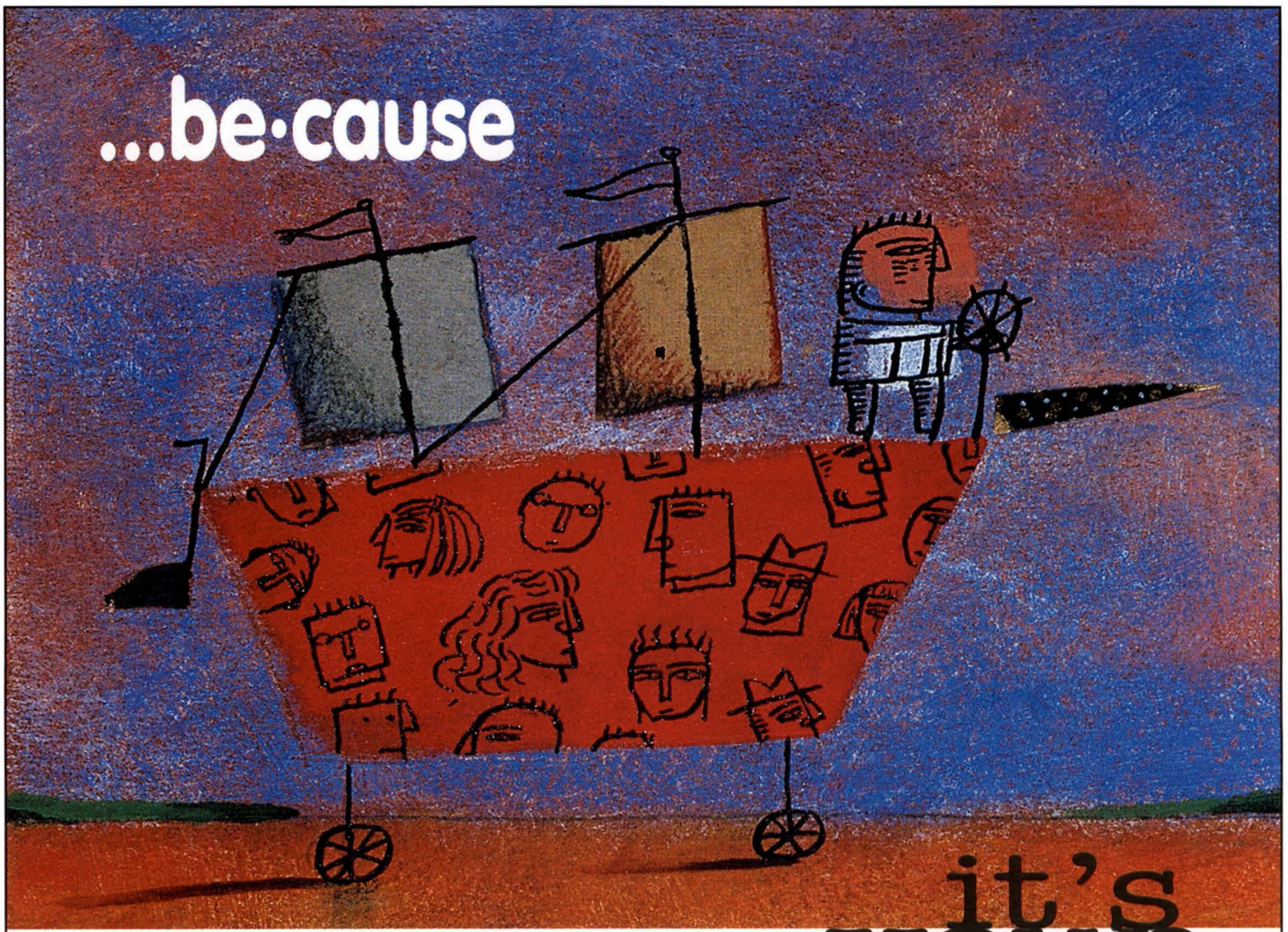

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Constructing Success:
The Smart Road Comes to Blacksburg

by Lisa Lewendowski
Guest Writer

In a small town that is home to the Virginia Tech Hokies, something big is happening in the world of transportation. In fact, it just might make Blacksburg, Virginia, the leader in high tech transportation research and development. Word is out, and people are wondering—what is this multi-million dollar road construction project, and what makes it so special?

This project is called the "Smart Road" and is currently under construction. It is the first facility of its kind to be built from the ground up with an Intelligence Transportation System as a design criteria, targeting several areas in transportation and structure research. The Smart Road project is a rare opportunity because a research infrastructure is being installed without the extreme expense of redesigning an existing roadway or inconveniencing users of an existing roadway. There is an extensive amount of time, technology, and planning being put forth to make the Smart Road project successful. It is a joint effort between The Virginia Department of Transportation (VDOT), The Virginia Transportation Research Council, Virginia Tech, and the Federal Highway Administration (FHWA). The Smart Road project will be an asset to transportation and development because it will allow the testing of driving performance under all types of weather conditions. A realistic, controlled environment will be provided that will give immediate results. This is just what the transportation industry needs in order to advance and improve our current road safety, communication and travel. The three main goals of the Smart Road project are as follows:

- To meet traffic requirements of the region
- To serve as a full scale research facility to test, evaluate and validate Intelligence Transportation Systems (ITS) products
- To foster economic development in the region.

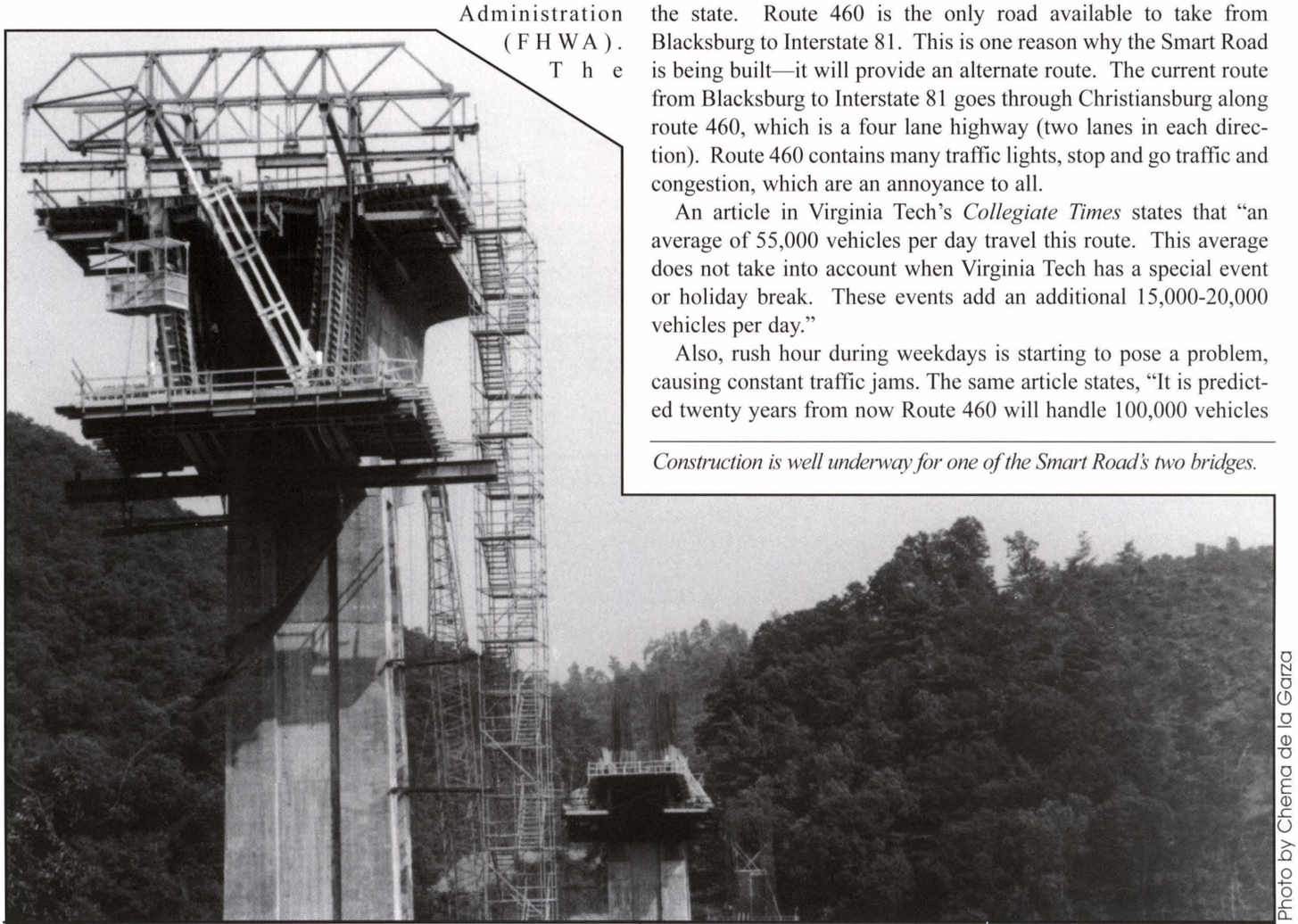
So far the Smart Road project is going well, and all that are involved continue to work hard to reach these results.

Traffic Requirements

The Blacksburg region is one of the fastest growing regions in the state. Route 460 is the only road available to take from Blacksburg to Interstate 81. This is one reason why the Smart Road is being built—it will provide an alternate route. The current route from Blacksburg to Interstate 81 goes through Christiansburg along route 460, which is a four lane highway (two lanes in each direction). Route 460 contains many traffic lights, stop and go traffic and congestion, which are an annoyance to all.

An article in Virginia Tech's *Collegiate Times* states that "an average of 55,000 vehicles per day travel this route. This average does not take into account when Virginia Tech has a special event or holiday break. These events add an additional 15,000-20,000 vehicles per day."

Also, rush hour during weekdays is starting to pose a problem, causing constant traffic jams. The same article states, "It is predicted twenty years from now Route 460 will handle 100,000 vehicles



Construction is well underway for one of the Smart Road's two bridges.

Photo by Chema de la Garza

per day." Therefore the Smart Road will be necessary to offset the growing vehicular traffic in the region. By VDOT's standards a new route is not yet needed. VDOT determines when a new lane or new road is needed by monitoring the traffic flow and capacity. If the numbers exceed VDOT's standards then the proper action is taken. In the case of the Smart Road, by building part of the roadway before traffic demand requires it, the road will be utilized for control testing and research in several focused areas. VDOT will make the decision to open the Smart Road to traffic by measuring the traffic counts on Route 460 through Christiansburg. "When it reaches a certain threshold of cars the Smart Road will be required to take some stress off Route 460," wrote Aswin Amanna in an e-mail interview.

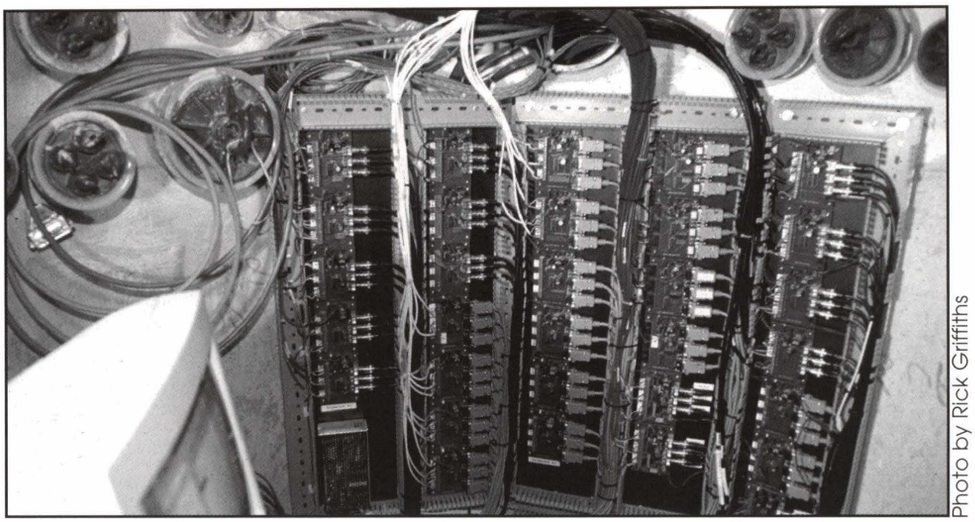


Photo by Rick Griffiths

The control center is linked through fiber optic cables to the test bed and the control tower.

Design Phases

At the final design phase the Smart Road will be a six mile, four lane divided highway with two lanes of traffic in each direction. The Road is being built in three phases and is currently in the middle of phase one. Phase one is a two mile stretch of westbound lanes, which will not initially be open to traffic and will be used for controlled research only. This two mile section of the Smart Road is known as the "test bed" and includes a control tower, snow, ice and rain making machines, lighting mechanisms, pavement testing sections, two bridges and a fiber optics system through which testing reactions and results are transmitted. A wide range of research is planned for the test bed and will work toward advancing transportation research and development. A informational packet from the Center for Transportation Research explains that the first design phase also entails "the eastbound lanes and median being excavated and graded but not paved." Phase one will be entirely complete by Fall 2001.

The second phase of the Smart Road project includes construction of the remaining four miles of westbound lanes, a 2000-foot long bridge among the westbound lanes, and an interchange at Blacksburg. The interchange is currently under construction and VDOT will decide when to extend the two westbound lanes.

When the westbound lanes are complete, traffic will run one lane in each direction. A section of the eastbound lanes running parallel to the testbed will also be paved. This will allow researchers to have control of the testbed when work is being done on it. There will be a gated detour that will allow conventional traffic to use either the testbed or the eastbound lanes. For safety reasons, no traffic will be permitted on the testbed when research testing is being conducted. This section is projected to be complete between 2004-2010.

Phase three will be completed when traffic demands require all four lanes of the Smart Road to be used by conventional traffic. This phase includes the construction of the remaining eastbound lanes. In order to continue to perform research that requires controlled conditions, traffic will be reduced to one lane in each direction on the eastbound lanes, much like Phase Two, at night or off-peak hours. This way the westbound two mile testbed can continue to be utilized. All four lanes are predicted to open to Interstate 81 and Blacksburg between 2015-2020.

What Makes This Road so "Smart"?

The test bed section of the Smart Road will be a unique opportunity to make traveling safer, easier and more efficient. This $30-40 million two mile stretch of roadway will have many innovative components to conduct ITS technology and research. For example, There will be a turnaround at each end of the testbed in order to make continuous driving possible. The turnarounds will provide for human factor studies and pavement loading.

"A section of the turnaround will have an extra wide shoulder that will be filled with aggregate to help minimize rollover and allow vehicles who have left the road to come to a complete stop as soon as possible.In addition provisions will be made for future mounting of overhead sign structures that will allow mounting of variable message signs and overhead sensors," states the information provided by the Center for Transportation Research.

However, don't believe everything you hear. Some rumors, such as automated driving being in the near future, have gotten out of control and misinformation on the Smart Road is in circulation. Ashwin Amanna, the Project Manager for the Smart Road project, said,"There is so much misinformation out there on the kinds of research we will be doing on the roadway. In a nutshell, automated driving is very far in the future. We are doing a lot of really basic research like safety and human factors, snow and ice control, pavement research, bridge and structure research, ITS sensor development and evaluation and roadside to vehicle communication. FHWA and VDOT are our sponsors and they don't see automated driving as a priority right now. They are more interested in the things you'll see in the next decade like driving assistance technologies (lane keeping and collision avoidance). These are things that will eventually work together to make a car drive by itself. But they will be used on their own in an individual vehicle first."

Ashwin Amanna was very helpful in setting the facts straight about the Smart Road. The following six sections will explain in detail what the Smart Road test bed will be composed of and what it will really have in store for us.

Control Tower

At the north end of The Smart Road, a control tower will be constructed. The data that is collected from controlled testing will feed through the fiber optics information system and go straight to the control center. The control center will allow for monitoring

of the roadway and control of some of the testing features. This setup will provide the researchers with immediate results.

There will be surveillance cameras that provide video feed of the roadway into the control room. Also located with the control room will be a shop and garage facility that will allow on-site repair and adjustment to experimental vehicles. There will be private garages available to house proprietary products.

This control tower will allow for continuous monitoring of current conditions, so the speed limits, traffic signals and ramp access can be adjusted to the current flow of traffic. Also during controlled testing, the projected atmosphere can be staged from the control center, adjusting the conditions as wanted along the way. Also during testing, safety of researchers and road conditions can be monitored. The control center is what will make the test bed work, monitoring the equipment and making it work as one to receive results.

Weather Test Bed

One of the most unique features of the Smart Road test bed will be its ability to generate all types of weather—fog, rain, snow, and ice.

There are many areas of ITS and transportation research that will benefit from a weather making capability such as human factors and safety, sensor development, structures and pavements, snow and ice control and vehicle dynamics. This all-weather testing system can created snowfall rates from flurries up to four inches per hour, the equivalent of a blizzard. Rainfall can be produced up to 2 inches per hour and using different nozzles can simulate anywhere from a mist to large water droplets. This system can also be used to create ice on the roadway by spraying the water on just the roadway in cold weather conditions.

Therefore a wide range of conditions will be able to be simulated for testing purposes, working to improve driving vision, communication and safety. The simulated weather section of the test bed will work to make road conditions safer during bad weather conditions and make drivers more aware, alert, and prepared.

There will be an estimated 73 snow making machines placed 36 feet apart. The snow making machines will each be 40 feet tall and be able to rotate 360 degrees. When not in use, the snow making machines will be able to be removed and stored or laid parallel with the ground. The machines are quite different than those one might see at a ski resort. The snow machines on the test bed of the Smart Road better simulate real snowfall because they dispense at a higher elevation and a much lower velocity. The all weather test section will be approximately 1/2 mile long and all testing infrastructure will be erected only when conventional traffic is rerouted around the test area.

Lighting Test Section

The Smart Road test bed will include a highway lighting section. The overall lighting test section will be .8 of a mile and will have master switching controls at the control center. The lighting section alone will attract many transportation researchers. Two potential research projects that would utilize an experimental lighting section include determining the new guidelines for roadway lighting (Small Target Visibility) and testing UV headlights and UV-sensitive signs and markings (Ultraviolet headlights).

The lighting system will have overhead light poles with a spacing scheme that will allow for evaluating lighting systems at 40, 60, or 80 meters.

The light poles used on the Smart Road are designed to allow for easy height adjustment for evaluation of the best light elevation. Lastly, various kinds of lighting will be tested including metal halide and high-pressure sodium.

Another kind of lighting that will be tested is offset lighting. Offset lighting will be installed to compare and evaluate it in relation to the overhead system mentioned above. This offset lighting system will have poles placed at 60 meter intervals and about seven meters off the paved shoulder. Offset lighting will help to improve night vision of the roadway and pedestrians.

Pavement Test Section

Another part of the Smart Road testbed is the pavement section. The pavement test section will enable researchers to finally discover what type of asphalt paving is the most durable, long lasting and safe in all weather conditions.

This section will have 12 hot mix asphalt sections, a long continuous concrete section and a jointed concrete pavement section. It will lie partly in the weather test section. The weather-generating capabilities will help accelerate pavement lifetimes in those sections. The goal behind this array of sensors is to gain a better understanding of how pavements react under loading.

This testing will lead to better pavement design methods that will, in turn, make our roadways last longer and reduce cost by reducing maintenance and giving us safer road conditions. The constant need for road construction and the cost of it is a major issue right now, so the Smart Road will enable researchers to find the best solution.

Bridges

The testbed facility will also incorporate research activities involving bridge design, bridge maintenance and bridge rehabilitation. The Center for Transportation Research says that "research activities include investigating cathodic prevention of corrosion in rebar and embedding sensors in bridge components." There will be a total of two bridges built within the Smart Road. One bridge will be among the test bed; therefore it will be the one used for research. A cathodic prevention system will be installed in the rebar support structure during the construction of the bridge among the test bed. This reduces the corrosion rate of a metal surface in order to make the bridge last longer. To find the best cathodic prevention system, there will be 5 different sections among the bridge. The current driving each of the five separate sections will vary between each one. Information will be sent to the main control center through the fiber optic information system. Over time these results will help researchers find the way to extend the lifetime of all bridges.

Wireless Communication

Wireless communication is another aspect the Smart Road test bed will work to improve. There needs to be a reliable and consistent communications path between the vehicles and the roadside. This pathway is essential to the development of ITS technology. Some tools that are being researched are wireless data collection from

Continued on page 26

Just think–no more getting lost, stopping to ask for directions, and long stop and go lines at toll plazas.

EXPO Fever

by Michael Carr

Welcome back to school! We have all returned to Virginia Tech to bask in the glory of those things that we love most: our friends, our freedom and our lovely school—and, yes, even Dietrick for some of us. Ahead of us lies a great semester of discovery and learning where we will be molded into the leaders, engineers, and possibly street people of the future.

Kind of scary, is it not?

No wonder some of you are already thinking of getting out of school. And for you few that wish to escape the bonds of scholarship to run free through the "real" world, here is a bit of information that might help you. There is a very powerful word that will open up opportunities for you. In the future, it may give you wealth and power. In the next few months it may begin to pay hefty dividends. And do you know what this powerful word is? Well I'll tell you what it is. It is: EXPO. Now I'll tell you what it means.

Engineering Expo is a FREE job and co-op/internship fair put on by the Student Engineers' Council (SEC) of Virginia Tech. They are the student run organization that was founded to help engineering students and other student organizations. You will see their handiwork in some of our newly renovated class rooms, our engineering learning center, and in numerous other areas.

This will be the Engineering Expo's twentieth anniversary at Tech. The Expo job fair is the largest of its kind in our corner of Virginia. Last year, there were two hundred and seven companies and corporations in attendance. This year there will be an even greater number and variety of companies at Tech. We will be hosting everyone we can fit, from GM and Lockheed Martin to Microsoft and Lucent Technologies. The fair is held on campus in the Squires Student Center as well as the Owens banquet hall for two days, Tuesday and Wednesday, September 28th and 29th. The first day is a showcase day to look through the hundreds of booths to see what is available. The second day will also have a showcase but will be primarily for interviews scheduled by the companies.

Photos by Mitch Hazam

Representatives from all different companies are at the Expo to answer any of your questions.

The Engineering Expo is an engineering student's best chance to find a permanent job or a semester co-op/internship

Also at the fair will be many other activities. Showcases of various student engineering groups will be held outside of the

Commonwealth Ballroom in Squires. Many companies will also have information sessions and shows, as well as their booths. Last year, you may have noticed racing cars parked in the Commons area, and it's quite possible they'll be back. So even if you are not looking for a job, stop by, there are always other cool things to see and do.

The Engineering Expo is an engineering student's best chance to find a permanent job or a semester co-op/internship. It is a unique occasion during the school year where you will be able to access hundreds of companies that are looking for people just like you! No matter what your engineering discipline is, you will be able to find a company looking for skilled people from your department.

To participate in the Engineering Expo, all you have to do is show up. But beyond that, if you are really interested in getting a job, you should do some other things. You should put together a resume that highlights your abilities and experience and make a few copies of it to pass out to the company representatives you approach. Second, the SEC will be putting together resume books for each company that include the resumes of all the students in their departments of interest. To be included in the resume books, all you have to do is drop a one page resume into one of the boxes littered around campus. Look for signs around campus to tell you when to drop off resumes and to find out when the fair is.

This is a good idea of what the Expo will look like.

If you want to know more about the Expo or the SEC go to their home page at http://ate.cc.vt.edu/eng/org/sec/ or ask about it at one of their meetings. Career Services is located in Henderson Hall and their phone number is 231-6241. They will be happy to help you if you talk to them before the date of Expo. EF

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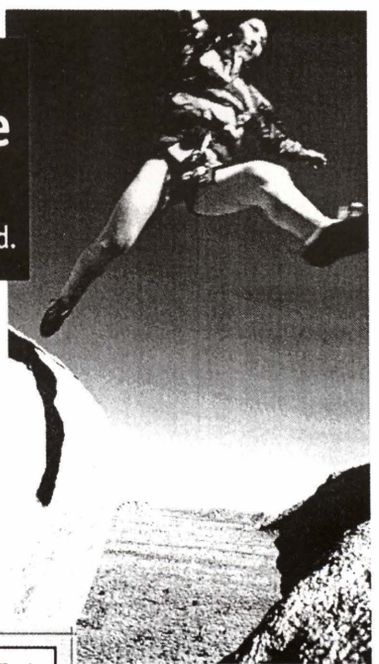

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CHALLENGING TECHNOLOGY MINUTE TO MINUTE

Cyber-Roach

by Ted Hessing

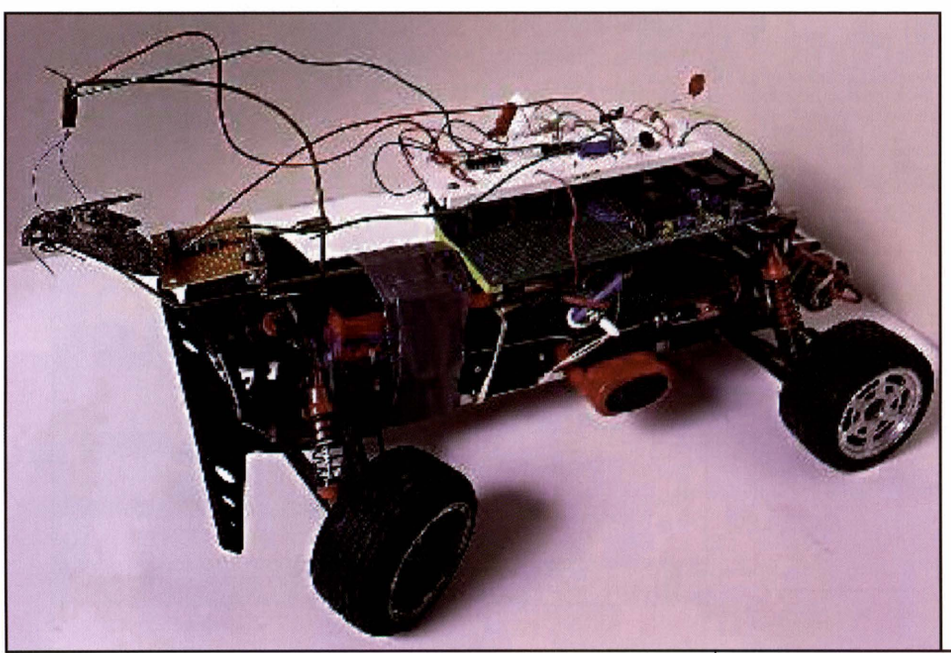
Building the Better Bug: Electrical Engineering and Entomology Collide.

The idea seems to rise from a technological thriller: machine and organism become one. The imaginative premise of biological-mechanical integration has captivated the minds of science fiction fans for years. Recently, Steven Bathiche (EE '97), now a graduate student at the University of Washington, and Dr. Jeffery Bloomquist (Associate Professor, Virginia Tech Department of Entomology) have driven these fascinations off of the screen and out of our imaginations into reality by way of insect-controlled cars.

For his senior design project, Bathiche redesigned a remote controlled car to accept impulses from a cockroach rather than a hand-held transmitter to direct its movement. These signals, in turn, drive the car according to the input of the insect. Later revisions during graduate study led to a dynamic system that incorporated speed, steering ability, and the all-important emergency 'off' switch. Summarizing his research, Bathiche had this to say, "The actual integration of a biological system with a synthetic one is revolutionary. We talk of bio-inspired systems, but the truth is that engineers are far from nature's solution to biological systems. So, what I did was instead of copying nature's implementation, I stole it. The car uses the insect to drive around, not the other way around. The car has an onboard camera, onboard obstacle avoidance system; it has an onboard biological processor that kicks the pants out of any engineered system today."

> Pedestrians beware; cockroaches are mastering America's roadways.

So how does an engineer get mixed up with creepy-crawlies that go bump in the night? In an email interview with Steven Bathiche, he explained what inspired him to merge Engineering with Entomology. "While I was an undergraduate, I took over 30 extra credits of course work outside my major to satisfy my curiosity in the biological and psychological sciences. As I took more and more biological classes, I knew I was shifting focus to the interface between the concepts of Biology and engineering. So as a self-motivated project, I wanted to do a more of a biological project, which was relatively different from most of my other engineering-based undergraduate projects. I heard of Dr. Bloomquist and thought that working with an insect's nervous system would be very good project to start building on this interface between biology and engineering."



After some pondering Bathiche approached Dr. Bloomquist with an idea—attaching a biological specimen to a circuit. "Really, the interest and the real creativity on this project was Steven Bathiche. He came to me, out of the blue, recommended by another faculty member, to interface some kind of an animal with a circuit. He [Bathiche] was interested in interfacing a biological organism with electrical systems. He had this idea to put something on a car." Bloomquist continued, "He thought that he'd try an insect. Since I'm the only insect electro-physiologist on campus he showed up and we decided to do an undergraduate research project." After some discussion, the pair conceived the idea cockroach-driven car. Some idea it was. The project tied for first place in the undergraduate category at the 1997 Virginia Tech Research symposium.

Bathiche's original proposal was to record bio-electrical activity from the brain of an insect and use the impulses to control a system of his device. It was Dr. Bloomquist's opinion that the simplest way to obtain such a signal was to measure the impulse that drives a simple activity. "We can record from the flight muscles," suggested Dr. Bloomquist. "When it starts to fly, we'll get activity and when it stops, the activity will stop. We jointly came up with the idea to use the activity of flight to control the car starting and stopping."

"The biology is really, in my estimation,

fairly trivial." the professor elaborated. "It's a simple matter to record muscle activity from insects with plain wire electrodes as opposed to the other electro-physiology at the cellular level . Recording these muscle potentials as a technical exercise was fairly simple."

Impulse action in a biological system works by sending signals down a complex path. There are motor circuits in the brain of the cockroach. There is also a collection of neurons in a cockroach's brain that are designed to coordinate electrical activity generated by other nerve stimuli and drive motor neurons that come out of the central nervous system. The motor neurons send signals which motivate the muscles to perform. The pattern of activity of the motor neurons drives the pattern of activity of the muscles.

Steven's goal was to record the impulses sent from the motor neurons and to transform them into usable electronic commands to operate the car. To obtain a usable signal, a recording electrode was implanted in the thoracic flight muscles of the cockroach. Forceps were used to peel back the overlapping plates that comprise the cockroaches abdomen allowing a very small incision to be made. The wire was placed in the incision and held in place by clotting blood.

As painstaking a process of attaching electrodes to cockroach tissue may seem, in this case size did not matter. The American Cockroach (Periplaneta americana, L.) was specifically chosen for its size and fortitude. Dr. Bloomquist explained that insect surgery is not as difficult as one might think. "An American cockroach is a fairly large insect, a couple of inches long in some cases. Working on an insect as large as the American cockroach was not a problem."

When the cockroach sent the impulse to fly to the thoracic flight muscles, the signal was passed on via the recording electrode to a biological amplifier and a filter.

A puff of air at the cockroach's feet was used to simulate a falling effect and initiate flight behavior.

The amplifier magnified the small analog voltages generated by the cockroach's muscles so they could be used by the rest of the equipment. Next, the filter sorted the impulses recorded by the electrode and passed the signals above a set threshold to a comparator (LM339). In order for the interpreted signal to be used, it was digitized by the comparator relative to a voltage reference. If the comparator decided the signal meant that the cockroach was attempting flight, a square wave with the same frequency as the action potentials was generated and passed along to a Motorola 68HC11 EVBU microcontroller. The microcontroller, in turn, interpreted the signal from the comparator and computed the period of the wave. If the period was optimal (meaning the cockroach was in flight) the motor was activated and the car was propelled forward at a rate set by an electronic speed control.

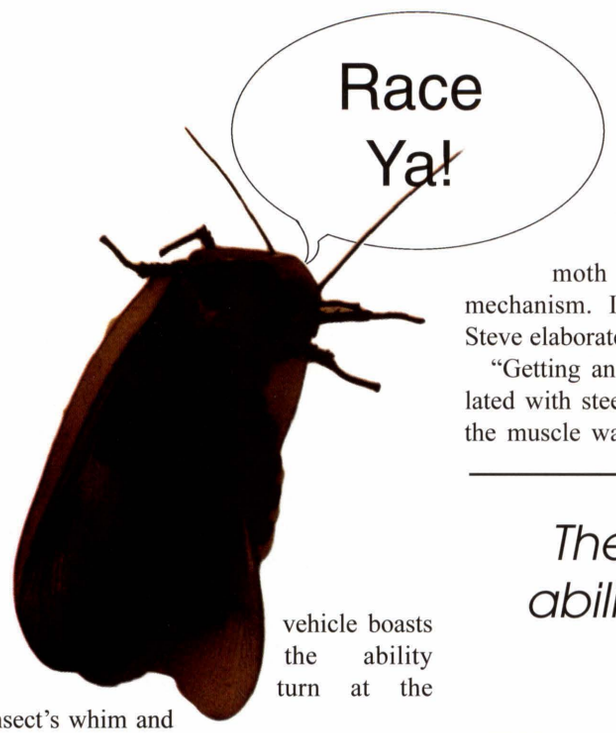
The base vehicle was a remote controlled car stripped down to the chassis, wheels, suspension, motor and gear box. A six inch boom with harness was devised to hold the cockroach and place it in front of the car. The electrodes used were run along the boom to the car which supported the bred box and microcontroller.

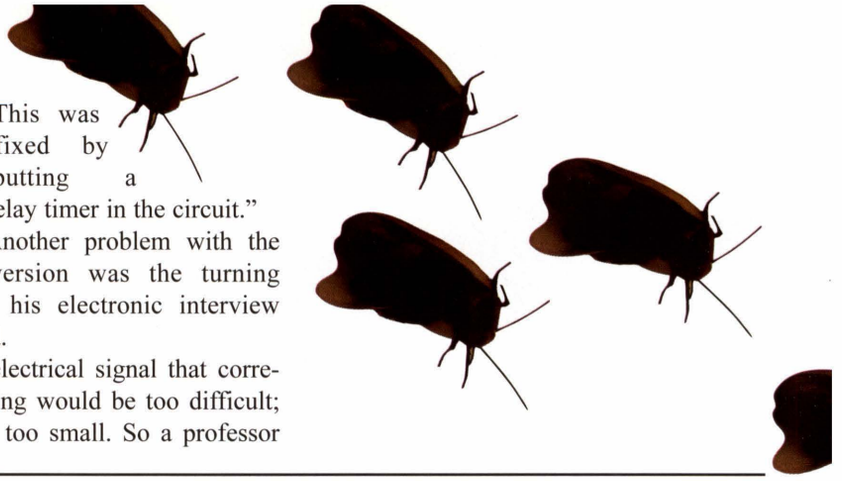
When the above technical wizardry had been accomplished, there was one final step. The cockroach had to be made to want to fly; a lazy insect would lead to a very boring performance. American cockroaches are not very active fliers, they prefer to scurry along at incredible speeds and to use their flat bodies to hide in between objects where larger creatures cannot pursue them. They tend to fly when they are falling rather than to evade a potential threat. Using this information the cockroach was mounted to the tip of the boom so its tarsi (feet) were hanging in empty air. A puff of air at the cockroach's feet was used to simulate a falling effect and initiate flight behavior.

It seems a daunting task, but through imagination and perseverance Bathiche and Bloomquist made it work. After deciding on the particulars of his final project, Steve worked for a month to design and build the circuit and the rig. One day Steve met with Dr. Bloomquist in the lab and mounted the cockroach to the car.

"The first time that we tried it, put the board on the car, got the insect attached and the wires in it and got it to fly, it worked. It was unbelievable. We did have some trouble getting it stable and refining it, but the trouble was minimal," Dr. Bloomquist recalls.

Further revisions at the University of Washington led to the use of another large insect, the hawk moth. This second version of the insect-controlled vehicle focused on expanding the technology that Bathiche had experimented with at Virginia Tech. Such improvements were generally designed to give the insect more control over the movement of the car. Previously the cockroach was limited to propelling itself at a constant speed in a straight line. The moth's new





This was fixed by putting a delay timer in the circuit."

Another problem with the moth version was the turning mechanism. In his electronic interview Steve elaborated.

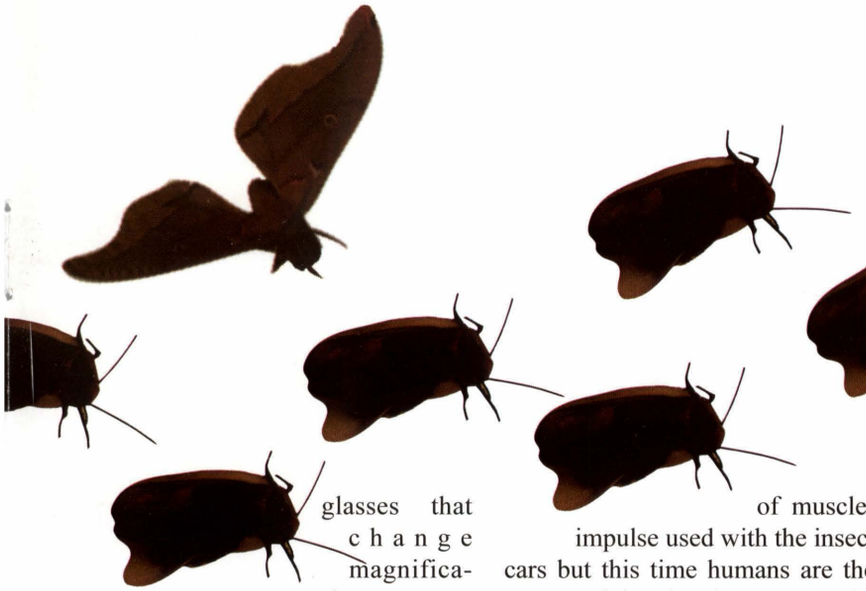
"Getting an electrical signal that correlated with steering would be too difficult; the muscle was too small. So a professor here at the UW, Dr. Daniels, recommended to use a mechanical transducer on the abdomen of the moth. Moths have a natural behavior of leaning into a turn; this lean can easily be transduced."

The moth's new vehicle boasts the ability turn at the insect's whim and to vary its speed.

vehicle boasts the ability turn at the insect's whim and to vary the speed at which it travels.

Steven ran into a little difficulty building a circuit to amplify the moth's signals. The main challenge, according to Bathiche's e-mail, was "getting the car to respond smoothly to the insect's signals. At times the insect could trick the car to think it was not flying but it really was, and so the car would stop and go in rapid successions.

The cockroach-controlled car and the later moth-operated version are the first research steps in a promising new technology; impulse-controlled movement. By harnessing the bio-electric impulses that control locomotion researchers hope to one day to give more options to those with handicaps. Paraplegics may be able to move wheel chairs through the same signals that never get to their limbs. The common bifocal lens may be upstaged by



glasses that change magnification as you focus your eyes. The military has their eyes on this technology as well. By utilizing the head movements of a pilot or a gunner, it is possible to have weapons sighted precisely on what one may be looking at, significantly reducing reaction time.

Currently, Bathiche is working on another related project. It involves using the same concepts of muscle-impulse used with the insect cars but this time humans are the source of the signals. Because the signals obtained from a human subject are more complex than that of a cockroach or a moth this research is more time consuming and difficult. For now, the rest of us will have to wait for the fruits of Bathiche's labor but successes like his will go a long way in inspiring future engineers to think past the structure of our course loads to help redefine tomorrow. EF

The Structural Revolution

by Chris Thaiss

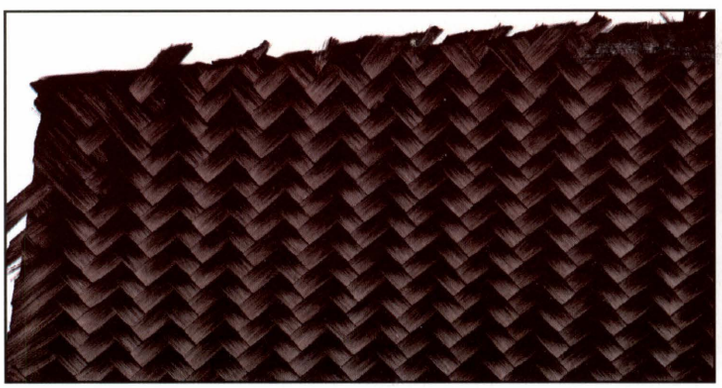
Most engineers will agree that engineering is a science of proportions. Take the aerospace industry as an example. Jerry Seinfeld put it best when he said, "If the black box is the only thing that survives a crash, how come they don't make the entire plane out of the black box?" Well, that's where the proportions come in. Aerospace engineers could make the plane incredibly strong. Think of it, a flying tank impervious to all but the most horrific crash. But, since modern economies do not allow unlimited resources to be spent on aircraft, engineers must be cost-effective first and perfectionists second.

There are thousands of attempts at present to get a little extra strength out of materials. For example, engineers create alloys that are able to withstand higher temperatures and greater stresses than previously imagined. Overall, metals' properties pose key problems when designed for fatigue requirements because of their tendency to form cracks, which causes failure of the material. Another problem is that metals are dense, and therefore heavy, a property which needs to be avoided in many engineering disciplines. That's where composites come in.

A composite is two or more heterogeneously combined materials that produce a product of superior strength to the parent materials alone. Composite structures have been around us for thousands of years. Looking back 3000 years ago, we can classify the Egyptians straw-reinforced mud bricks as a composite material. The possibilities of composites were really discovered in the aviation industry of the1920s with doped fabric aircraft surfaces. The fabric was not only extremely light, something that was needed in aircraft design because of the low-powered engines at the time, but was also easy to manufacture and had a high strength to weight ratio. Composite materials were extended to include more and more complicated matrices and fibers. The matrix is the material that acts as the "glue." The fibers are generally the primary load carrying component of the composite. In the 1930s, we saw fabric-reinforced phenolic. Phenol is basically a relatively brittle plastic, which is non-combustible, even at high temperatures. In the 1940s, we saw the first use of fiberglass with epoxy resin. The space age has now brought materials like boron and graphite fibers into play. The biggest advantage of boron fibers is their high compressive strength. Graphite or carbon fibers have high yield strength/weight and modulus/weight ratios. In comparison to fiberglass-epoxy, this means that there can be over three times less graphite fibers while retaining the same strength in the composite, a considerable weight saving. Composites are being used regularly in today's society. Fifty percent of the Harrier VTOL aircraft is graphite fiber-epoxy composite. The F-117 stealth fighter has a graphite-epoxy exterior and sailplanes are made of highly flexible fiberglass.

Composites, as great as they are for aerospace applications, have other applications besides aircraft structures. Steel belted tires are steel fibers in a rubber matrix. Reinforced concrete is steel rods in a concrete matrix. Bulletproof vests and the helmets that the U.S. Army uses are made with Kevlar. Kevlar is an extremely high modulus aramid fiber composite with high resistance to chemical and heat degradation, although it is not suited to deal with high compressive stresses. There has also been an increased use of composites in car manufacturing over the years. "Composites have great potential because of their high strength/weight ratios, long fatigue life, corrosion resistance, and tailorability," says Liz Vailhe, a Virginia Tech alumnus who is currently working for Lockheed-Martin. Unfortunately, this isn't a peaches and cream story for composites. Since you must give up something to gain something, there are a few disadvantages to composites, such as a large scatter in material properties, the need for complex analysis, and material cost. Liz tells us that the big issue with composites is "the high cost associated with them and the relatively newness of composites in aerospace industry." For example, the cost of Cyanate Ester, a resin system, can be $1000 per gallon and because wide use of modern composites in the aerospace industry is a relatively new concept, coupled with their complexity they can be easily overlooked as an alternative to the older, more time-tested metals.

When designing a composite part for use in a high stress environment, it is essential to align most of your fibers in the primary stress directions. If the composite laminate



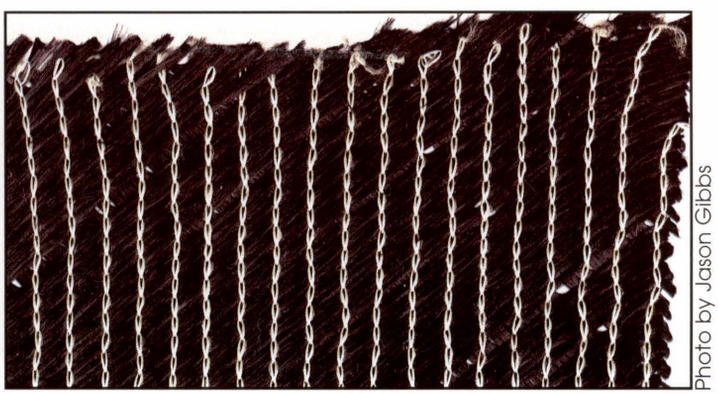


Photo by Jason Gibbs

These are examples of the weaving of carbon fibers to make a certain material.

is subjected to loads perpendicular or transverse to the fiber direction, the matrix takes most of the load. Unfortunately the matrix wasn't designed to carry very much of a load in the first place, so the composite will fail quickly with large deformation. Orienting the fibers in the 0 and 90 degree orientation will take care of tensile and compressive loads, but it does nothing for shear stresses. Fibers oriented at angles are required here, usually at 45 degrees.

There are a number of ways to manufacture composites and to get fibers oriented at specific angles. Lamination, pultrusion, filament winding, and resin transfer molding (RTM), are the predominate ways to process composites. Lamination involves hand or machine lay-up of fibers in a fabric or a pre-impregnated form (pre-preg is fibers coated in a partially cured resin). This lay-up is then molded in a press or autoclave by curing the resin (the matrix) using heat and pressure in a giant pressure vessel. Pultrusion is the continuous pulling of fibers through a resin bath, which is then cured in a die. Filament winding is continuously winding fibers that have been submersed in a resin bath around a part. Resin transfer molding is the injection of liquid resin into a mold containing the preformed fibers. All of these processes have their advantages and disadvantages, usually based on the properties of the parent materials. For instance, different temperatures and pressures vary the resin's degree of cure. This is the basic way of forming panels and shapes with several laminated layers.

A composite is two or more heterogenously combined materials that produce a product of superior strength.

To add stiffness to the panel, a honeycomb core is used to provide lightweight resistance to shear, tensile, and compressive stresses. The honeycomb that is used in composites is based on what the material's use is. The hexagonal shape of the cells formed out of lightweight aluminum, or even composites themselves gives it a high strength/weight ratio. A widely used honeycomb material is a glass-phenol blend. Sometimes, there are modifications to the hexagonal shape, but it is always basically the same in the composites business. A sandwich panel consists of two outer composite face sheets adhered to a honeycomb core. The core is there for two reasons. First, it gives the sandwich panel shear rigidity along planes perpendicular to the outer face sheets. Secondly, it resists deformations to the panel perpendicular to the face plane, while giving the panel thickness.

What is in store for composites in the future is anyone's guess, but with the technological advances in adhesives, resins, and fibers, we should be building stronger, lighter materials in the decades to come. "Composites are now seen as a lighter replacement for metallic parts in aerospace industry, but as technology evolves they will have their own specific applications," expresses Liz. Composites will form the next generation of materials that will provide a lighter and more efficient solution through the next millenium. EF

The ~~Job~~ MEAT Market

by Jeremy West

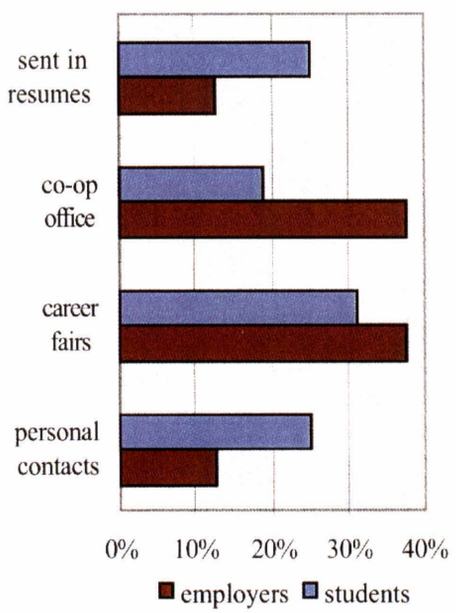
Slowly they approach the counter, their mouths salivating in anticipation. They surround the counter, carefully eyeing the cuts of meat. They point and ponder, then hesitate while exchanging glances with the butcher like long lost lovers. The poor interns in the display case are helpless. They wave their resumes and smile, show their leanest side, and hope to be noticed by the hungry employers. The career services butcher is amused by this display only because he has seen it one too many times. For those pieces of meat which are picked to go out into the real world to taste life the opportunities are endless, however, for those who are left behind there is only a cold display case and a hope that one day they, too, will be picked.

Every employer I have spoken to has said that a college graduate without work experience is at a disadvantage. Not so much that a 4.0 GPA is no longer good enough, but with so many students co-oping and interning it has become the new distinguishing criteria. Keith VanHouten, a college recruiter for General Motors, summed it up best with his comment, "You need the GPA, but the work experience is what will set you apart."

Surgeon General's Warning: 50% of Students Interviewed Were Disapointed By The "Real World"

According to all of the employers interviewed, the type of paper your resume is printed on does not make a difference.

How Students and Employers Meet



For this article, I have talked to students who have co-oped/interned and listened to how they did it. I have also seen how the other half live by talking to the employers who will be sitting across from you in your next interview to hear what they have to say on the subject.

Among the students interviewed there were four major approaches used to get work experience. The first method, saturation bombing, entails sending out as many resumes as you can print to every address you can find, and while you can expect that most of them will miss the mark, there is always the chance that one will make it through. But what do the employers think about getting these random resumes in the mail? For many smaller companies who can not afford to send their human resources department all over the country to every university, this is often the only way they will ever get your resume. However, for most of the businesses you will see at the career fairs and on campus interviews they depend on career services to do the weeding out for them and to supply them with all the resumes they need.

The second method, is

I ended up bypassing the Department, which

"I AM LOOKING FOR SOMEONE WHO IS NOT AN IDIOT."

to show up at a career fair like the Engineering Expo and, after making a quick trip to Kinkos to get the resume printed up on fancy paper, walk around shaking hands and trying to appear interested in what the recruiters are saying while eyeing the brightly colored glitter mug on the next table. Career fairs at Tech are a large source of resumes for many of the companies I interviewed, while some go so far as doing all of their hiring at these events.

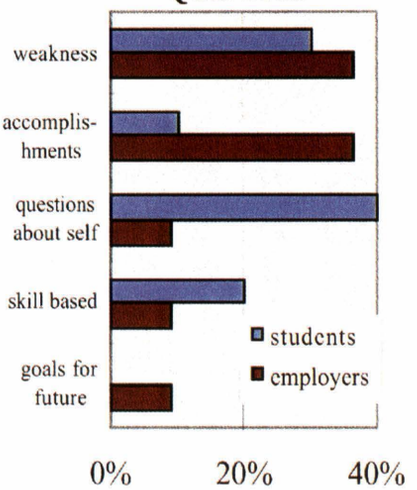
Human Resources seems to be helpful.

Career services, love it or hate it, you are probably going to need it. Of course unless you have a strong GPA they are not going to do you any favors, but the employers sure love them. The deal is, the employers send a magical sheet of paper to career services which lists all of the things they are looking for. Career services then plugs it into a computer and if your name pops up as meeting those requirements your resume gets sent, you get an interview, and you get a job. However, if your name does not pop up, you do not pass Go, and you do not collect $200. This system is great for those people with high GPA's (normally the limiting requirement), who probably do not need much help getting a job, but for the rest of us it might not be much help.

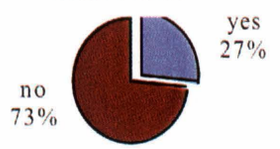
Finally, there is the "Hey Dad, give me a job" approach, and while this is highly successful, not all of us have fathers that are CEOs of major engineering firms. However, personal contacts can be a real key to unlocking the door into the corporate world. Scott Timmester, a forth year Aerospace Engineering student at UVA, explained how he got is internship, "I was Pratt & Whitney's student host at UVA's career day. I spent the day speaking with the recruiters, who later passed my resume directly to managers. In other words I ended up bypassing the Human Resources Department., which seems to be helpful." The lesson here is to always be on the look out for networking opportunities.

All right, you got your resume out there and it got noticed. Now they want to talk to you, but what do they want to hear? "I am looking for someone who is not an idiot." exclaimed Mike Rupar from the Naval Research Laboratory. Employers are looking for communication skills above all else. You can have the best ideas in the world but if you can not explain them to anyone else they do not do the company any good. They are also looking for initiative, which helps them to determine your work ethic and abilities. In speaking to the employers your ability to communicate your interest in what ever it is that they do is the one thing that will really set you apart from everyone else. Researching the company and being able to tell them things you have done that are similar to what they do will not only make you look more intelligent, but will also show that you are interested in them and not just because they are paying fifty cents more than the next guy.

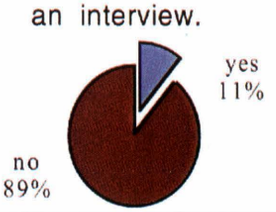
Most Difficult Questions



Students who have been asked surprising questions during an interview.

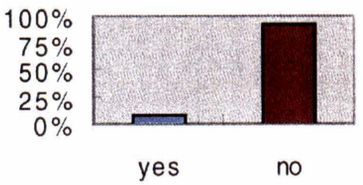


Employers who ask surprising questions during an interview.



Most of the students interviewed considered themselves good at interviewing, which makes sense, as the people who give bad interviews generally do not get hired. They advised relaxing and being confident, and they could not have been more correct. Many of the employers I spoke to sited nervousness as one of the biggest obstacles interviewees had to over come, and confidence as being an important quality they were looking for. Not only does nervousness affect your presentation and your answers, but it inhibits the employers ability to judge who you really are.

Interns who admit to having an affair with the president.



As I found when speaking to the employers, the purpose of an interview is not so much to test your skills, or knowledge, but to instead to evaluate your personality. Many employers are "looking for a fit", trying to determine how well you will work with the other members of their team. Most employers regard surprise questions or other interviewing tricks designed to "keep the interviewee on his feet" as "stupid". And though, they do ask difficult questions it is in their best interest to keep the interview session as relaxed as possible.

So what are the infamous questions which everyone has difficulty answering? The employers had no problem identifying that question which had stumped so many prospective employees, and surprisingly they shared it with me. "What is your greatest weakness?" There it is, the mystery has been solved, you can now go into your next interview knowing the one question that everyone else seems to have such a problem answering. But how do you answer a question like that? Do you tell them that you really could be doing better in school if you could only get up for those 8:00 classes, or do you tell them that you are so disorganized you have to sleep on the floor because you can not find your bed? Well, the employers have once again let the lid off that secret. This is more a question of communication skills and honesty. You have made it this far though life, so you have

Best toys: Lockheed Martin Glitter Cup, Boeing and Pratt and Whitney Gliders

Have you ever spoken to a recruiter just to get a toy?

Yes	62%
No	38%

Have you ever distracted a person who was talking to a recruiter at a career fair?

No	22%
Yes	11%
No, but I will next time!	67%

David Hanson of IBM: "We pay between $13 and $19 per hour, but good students are more than worth it."

obviously learned to deal with whatever weaknesses you have, and that is the key to answering this question. They know that everyone has faults, but not everyone will admit to them. Employers are looking for the person who knows their limitations and will know when to ask for help.

When the employers were asked what advice they would give on the subject of interviewing, their responses were uniform: act confident, be honest, and answer the questions. Not everyone is a naturally confident person, but everyone can put on a good show. As far as honesty goes, if you didn't build a space shuttle when you were twelve, admit it. This goes back to the question about your weaknesses. A person who explains that they do not know, and then follows up with how they would go about solving a problem of that nature will appear much better than a person who fumbles about trying to remember what they put on their resume. And I still can hear the voices of all of the employers exclaiming "I wish they would answer the question I asked!" This is another communication issue which most students who have problems interviewing seem to face. Students get so wrapped up in guessing what the next question is going to be, and remembering their decided answer that they do not always listen to what the interviewer is really asking. The employers' advice is to listen carefully then slow down and formulate a thoughtful answer.

Career services is a good place to go to practice interviewing, especially if you have never done it before. They are also helpful because they know very little about engineering. Which is something that happens a lot in the interview process. It is generally the human resources department and not the engineers that you will be interviewing with, and since they do not know how great AutoCAD is or why a free body diagram is so important, they are going to be asking personality questions which you may not be prepared to answer.

- 67% of interns thought they were paid enough
- 64% said that they worked harder at minimum wage jobs.
- 23% of interns made coffee of copied papers for people other than themselves.
- 67% said their offices had Dilbert characters.
- 69% used what they learned in school on the job.

But this meat market works both ways. You are not the only one who needs internships. The companies need you, not only as cheap labor, but also as a way of bringing new life into the company. General Motors, for example, on slow years, hires all of its new full time engineers from their intern program, while many other companies will make offers for full time employment to those who have worked with them in the past before even looking at other resumes. Not only is hiring a "waste of time", but it also costs the companies a lot of money. GM spends over $1000 just to make the pens it gives away at career fairs. So why do they do it? Simply put, you are worth it. When asked, most employers admitted that, though the interns are not underpaid, the company does profit from the work they do.

So what exactly will you do when you get this internship? Most of the students claim that they actually do "work", and do not just sit around playing freecell all day, or making coffee. When asked if, on the job, they used what they learned in school there were quite a few responses stating quite the opposite. Many people find themselves sitting in classrooms hearing a lecture about what they had actually done last summer.

Photo by Jason Gibbs

Will you make the cut in the real world?

So, for all of the ribeyes, pork chops, and ground chuck out there, keep showing your leanest side, be confident, and stare the butcher right in the face and say, "LET ME OUT OF THIS DISPLAY CASE!" BF

Constructing Success

Continued from page 4

sensors, dynamic in-vehicle information systems (maps, warnings of oncoming trouble), adaptive cruise control, collision avoidance, and nonstop toll plazas using automatic debit cards. Just think—no more getting lost, stopping to ask for directions, and long stop and go lines at toll plazas. Also, cars will adapt to current traffic conditions automatically reducing the risk of an accident. All such things will make traveling simpler, safer and easier.

The fiber optic system that will be placed beneath the road is what will make getting results possible. "This system will incorporate over 4 miles of fiber cable that will be used to transmit data from on-site data systems, surveillance cameras, variable message signs and other ITS sensors to the control tower," states the pamphlet from the Center for Transportation Research. In addition, the fiber optic information system will eventually interface with a wireless communications network that will be used for dedication to vehicle-to-roadside communications.

Economic Development

Jobs

The Blacksburg region will soon be a boomtown for high tech jobs. "The Smart Road is estimated to bring 300 million dollars in research and development funds to the New River (Blacksburg and Christiansburg) and Roanoke Valleys," states an article in the Richmond Times-Dispatch. A study is underway to find out just how many jobs will be available. Some of the needed positions to manage the Smart Road are technicians, scientists, engineers, operation directors, hardware supervisor, roadway operators and a clerical and accounting staff. The research and development companies that will be attracted to the area will also have many jobs to offer. William C. Neeley (President of a local Fiber Optics company) states, "You can't tell companies where to go but if you have the laboratory and they find what you do useful, they'll stay in the area and others will follow. It's (ITS technology) going to be a healthy growing industry for a long time."

One can definitely expect growth and opportunities in the New River and Roanoke Valleys in the years to come, along with many new technologies and developments.

Cost Reduction

The research that will be conducted on the Smart Road testbed will eventually lead to a reduction in cost of many things in the transportation industry. For example, asphalt paving testing results will tell what type of asphalt is the strongest, most durable, and long lasting. In turn this will be used in road construction forcing maintenance and new road construction spending costs down. Also there will be less road construction to inhibit drivers. Another example of how costs will be reduced with the new technology and research is less weather-related accidents. There will be less traffic jams, hospitalization, ambulances, police and scared drivers. This will be due to preventive road care, quick removal and safer overall awareness. A last example is fewer car accidents due to automated cruise control, telecommunications warnings and directions. Drivers will be more aware of their surroundings and more capable of handling a dangerous situation. In sum, the Smart Road will help ease a lot of driving headaches and reduce not only the transportation industries costs, but others as well.

The Smart Road project is worth talking about with all of its capabilities and all of the opportunities it will bring along with it. The Smart Road will provide an alternate route to lessen traffic problems in Blacksburg, Virginia as well as giving researchers a facility to test out their dreams and curiosities. They will be provided with a real roadway with real controlled conditions that will give them immediate results. What they find will be the future of they way we travel, and along the way it will bring economic development to the local area. The ways to improve and expand our driving conditions and capabilities will be discovered and eventually changes will be happening all over the world that will make driving safer, easier and less stressful. The Smart Road test bed findings will also lead to the reduction of costs in road construction and other related fields. There is much to look forward to in the world of transportation. EF

Gerardo Flintsch, left, a Civil Engineering faculty member, helps install sensors in the road bed.

Photo by John McCormick

The Coming of HDTV

by Jason T. Whipkey
Guest Writer

It may come as a surprise to many Americans to learn that in as little as seven years, most every television in the country will cease to function. This is the result of the television industry's transition from the current analog system of television broadcasting to digital television (DTV).

DTV will pave the way for high-definition television (HDTV), which is expected to bring the viewer a clearer picture, CD-quality sound, and more channel options. Why television news has spent little airtime on the change is understandable: Most TV stations are not happy with the transformation, as it will cost their industry billions.

The change in standards has been brought about by Congress and the Federal Communications Commission (FCC), the government agency that licenses TV and radio stations and supervises their operation. They believe that without an FCC-required transition, the industry will be unable to make the switch as a whole. Even more importantly, they believe that it's time to replace the current television broadcasting standards, which are now more than 50 years old.

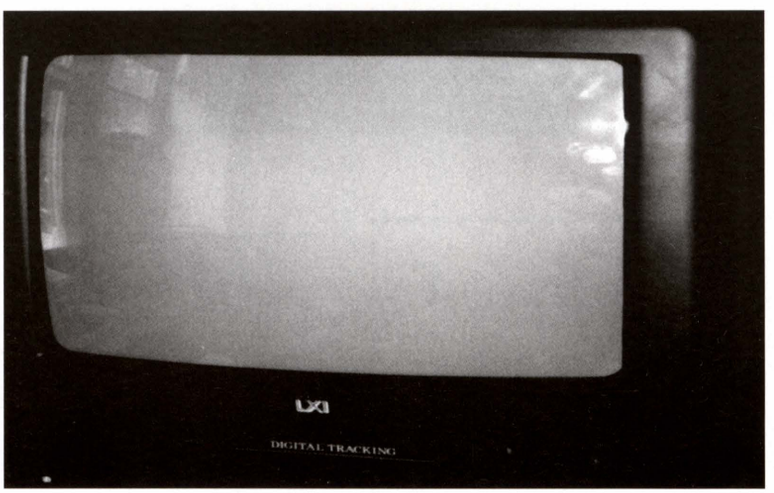
Since most of you don't operate a television station, the main question in your mind is probably "what are the costs and benefits of these new systems for me?" As we will see, there is much to consider — but if you want to continue to watch television, you will just have to open your wallet and accept the change.

THE BENEFITS OF HDTV...

To begin with, it is important to understand the difference between DTV and HDTV. DTV is a method of television transmission. It replaces the current analog transmission method with a more dependable digital method, which consists of broadcasting 1s and 0s over the airwaves. All television stations will be required to transmit digital signals by the FCC deadline, which is currently set at 2003.

The DTV format will provide more lifelike color and sound. It will find and correct errors in your television reception, which means—theoretically—your TV should be less static- and interference-prone. It will allow broadcasters to transmit as many as four channels in the same amount of "airspace" that one channel currently uses by compressing the information contained in their signals.

The main difference between your current television and DTV is the quantity of information transmitted. Once a certain level of quantity has been reached, an increase in quality occurs — and that's HDTV.



This will give you an idea as to what HDTV's will look like

HDTV increases the sharpness of the TV screen, making the picture much more lifelike than your current display. How does this happen? Well, if you look closely at your TV screen, you will see approximately 159,720 little dots called pixels that glow to display the picture. On an HDTV set, there may be as many as 2,073,600 pixels — or almost 1200% more! More pixels result in a higher resolution, or level of detail possible in a picture. It is not hard to see that a higher resolution results in an overall sharper picture.

HDTV will also increase the aspect ratio of your television screen, which is the relative relation of its width to its height. If you look at most television screens produced today, you will notice that regardless of its overall dimensions, the width of the screen is only slightly greater than its height. HDTV sets provide more of a panoramic view; their screens are almost twice as wide as they are high, with a 16:9 aspect ratio.

The only way that an HDTV picture can contain so much information is through a DTV signal — and the switch to digital will cost you.

...THERE ARE DRAWBACKS, TOO.

Unless you have bought a TV set this year and it specifically says that it is DTV-compatible, your current television set will not be able to receive DTV and HDTV signals.

If you want the high-resolution, wide-screen picture that is characteristic of HDTV, you will have to buy an HDTV set. Currently, HDTV sets cost more than $7,000, though that price is expected to drop once HDTV sets are part of the mainstream consumer electronics industry. Similarly, when color televisions were introduced, they were quite expensive, but their price fell over time.

For those who are unconcerned about receiving a high-quality picture and are more interested in receiving any picture, converter boxes will be available for use with your current TV set. These converters will allow you to receive DTV signals with a slight improvement in picture color, picture quality, and sound, but will not provide a high-resolution or wide-screen picture.

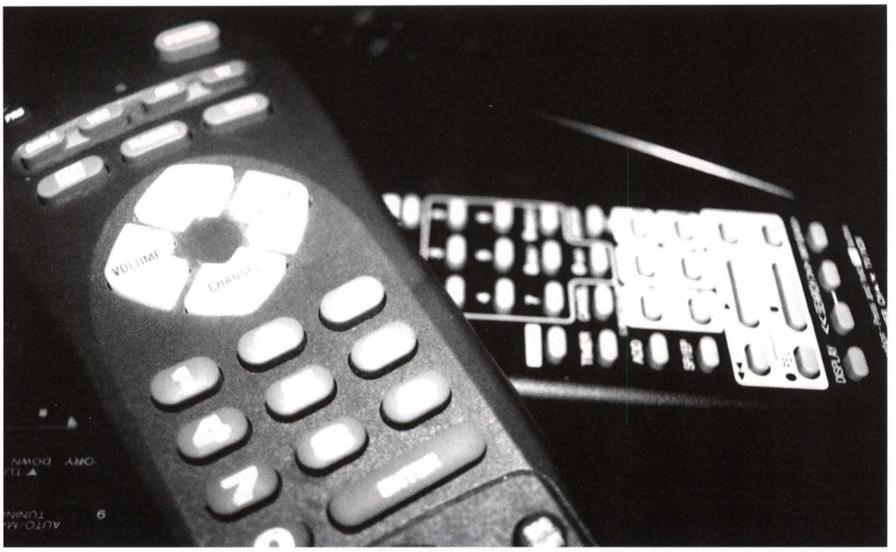
Like the new TVs, the converters are expected to be expensive at first, but prices are expected to drop as the new standard is adopted by broadcasters .

To make matters worse, today's VCRs and camcorders will not be compatible with the DTV and HDTV formats.

So after spending quite a bit of money to replace or upgrade your current television equipment, which is probably in perfect working condition right now, you should expect to receive a high-quality television signal all the time, right? Sorry to disappoint you, but there's a good chance you will not.

Currently, the FCC only requires that over-the-air broadcasters transmit DTV signals — not HDTV signals. The FCC doesn't require cable operators to carry DTV signals at all. That means that cable operators may choose to offer traditional analog signals, which will provide none of the benefits of DTV or HDTV. If your cable company decides not to carry DTV signals, you will probably need a traditional outdoor antenna to receive your local stations (such as ABC, CBS, NBC, and FOX affiliates). If your cable operator does choose to carry DTV signals, they will need to upgrade their equipment, and that cost will be passed on to you, the consumer.

Direct-broadcast satellite (DBS) owners are not free from trouble, either. DBS signals are currently transmitted in the old analog format. A change to DTV would require DBS companies to upgrade their equipment, and again, that cost will be passed on to the consumer.



Hopefully HDTV will eliminate the use of so many different remotes.

Even the digital signal itself isn't perfect. There is research that shows airplanes, tall buildings, and even seasonal changes may affect signal quality. Areas that receive a poor or "snowy" television signal with the analog system may not receive a viewable DTV transmission at all. Engineers have determined that it appears to be all or nothing when it comes to receiving DTV and HDTV signals.

Even if everything is technically perfect between your home and the broadcaster, you still may not receive the highest-quality picture.

Congress and the FCC have given broadcasters a specific amount of "airspace" to use to transmit their DTV and HDTV signals. Because of the great amount of airspace required to transmit all of the signal information that comprises an HDTV signal, the FCC gave generously. However, some broadcasters believe that a more efficient use of their new space would be to broadcast several lower quality signals instead. This would result in more revenue for them, but you would not receive the superb picture you would expect for your investment. The stations could switch from one high-quality picture to several lower quality ones, and vice-versa, as they wished throughout the day (your HDTV set would adjust automatically). Such a setup would allow them to broadcast popular programming, such as prime time, in a high-quality format, while less-popular programming, such as syndicated shows, may be broadcast simultaneously with other programming in a lower resolution.

An additional problem is presented when old programs are rebroadcast. Programs that were taped by the television station in the current television format will not have the high-quality picture or sound that HDTV does. While you will be able to watch these programs, you will not see a high level of technical quality.

The exception is the programs that were originally shot and edited on film rather than videotape. 35mm film captures a high level of quality, and this quality can be retained if the film is used for broadcast. Of course, this assumes that the producers of these shows have kept the filmed originals of their productions. In any case, the resolution of the final picture cannot be any better than the resolution of the video's source.

HOW WILL THIS HAPPEN?

Scientists and engineers recognized in the early '70s that the current television standards would not be capable of handling future communications. Consequently, engineers in the broadcast and consumer electronics industries on the Advanced Television Standards Committee (ATSC) have been working on new standards for more than 10 years now.

As soon as a station is ready to broadcast DTV, they may apply for a permit from the FCC. The FCC required all affiliates of ABC, CBS, FOX, and NBC in the 10 largest television markets (New York City, Los Angeles, Chicago, Philadelphia, San Francisco, Boston, Dallas, Washington, D.C., Detroit, and Atlanta) to broadcast DTV by May 1 of this year. The FCC also requires commercial television stations to make the switch to DTV by May 1, 2002 and non-commercial stations by May 1, 2003. Currently, there are more than 60 stations in 30 cities across the country that are broadcasting DTV simultaneously with their traditional analog broadcasts; these stations reach more than 50% of the country's television viewers. Stations will continue to broadcast both analog and digital transmissions until 2006, at which point they will end the analog broadcasts.

Many broadcasters believe that the FCC's timetable for conversion is optimistic. They aren't sure that Americans are going to willingly embrace the new formats, since it took almost 10 years for color TV to displace black-and-white TV and more than 20 years for FM radio to become more popular than AM radio. In both cases, the new equipment required of consumers was fully compatible with the old method of transmission, yet the public was still hesitant to make the switch.

The benefits of HDTV and DTV seem to be great—and so do the costs. The introduction of rentable VHS tapes in the 1980s showed that consumers are more interested in programming options than technical quality. Is this still true? Will the American public embrace the new standards and enjoy high-quality pictures and sound, or will they end up dusting off the old bookshelf and carrying on conversations instead? Only time will tell. EF

from the email bag

JOKES

Engineers think that equations approximate the real world. Scientists think that the real world approximates equations. Mathematicians are unable to make the connection.

The graduate with a Science degree asks, "Why does it work?"
The graduate with an Engineering degree asks, "How does it work?"
The graduate with an Economics degree asks, "How much will it cost?"
The graduate with a Liberal Arts degree asks, "Would you like fries with that?"

Normal people … believe that if it ain't broke, don't fix it.
Engineers believe that if it ain't broke, it doesn't have enough features yet.

On a train to a large computer convention there were a bunch of Liberal Arts Majors and a bunch of computer engineers. Each of the Liberal Arts Majors had a train ticket. The group of engineers had only ONE ticket for all of them. The Liberal Arts Majors started laughing, figuring the engineers were going to get caught and thrown off the train.

When one of the engineers, the lookout, said "here comes the conductor", all of the engineers went into the bathroom. The Liberal Arts Majors were puzzled.

The conductor came aboard, said "tickets please" and got tickets from all the Liberal Arts Majors. He then went to the bathroom and knocked on the door and said "ticket please". The engineers stuck the ticket under the door. The conductor took it and moved on. A few minutes later the engineers came out of the bathroom. The Liberal Arts Majors felt really stupid.

On the way back from the convention, the group of Liberal Arts Majors decided that they would try that method, too. They bought one ticket for the whole group. They met up with the engineers in the same car.

Again, the Liberal Arts Majors started snickering at the engineers. This time NONE of the engineers had tickets. When the lookout said "Conductor coming!", all the engineers went to one bathroom and all the Liberal Arts Majors went to the other bathroom.

Before the conductor came on board, one of the engineers left their bathroom, knocked on the Liberal Arts Majors bathroom, and said "ticket please."

letter from the
editor

A Problem-Centric Solution

As I sit here during the first day of classes, starring blankly out the window, I wonder how valuable all of the things I've learned are. I mean, I know how many thousands of dollars I owe the government for my education, but am I more valuable to the company that hires me? More valuable to society?

This is my fourth and final year in college and in about eight months, I am going to have to join the "real world". I have learned many things in school such as:

1. The reason my tires spin in the rain.
2. The probability of rolling a certain number on a pair of dice.
3. The reason not to fly in a plane with square windows.
4. Trig is easy, just draw a triangle.
5. The reason elephants don't fly.
6. The method to calculate exactly how much it will cost to own a piece of machinery—without using a computer.
7. Every Greek letter stands for something different depending on which text book you use.
8. The formula to find the center of mass of Montgomery County.
9. The history of the water wheel.
10. The equations for figuring out exactly when a leap year will occur.

Now, you tell me, do these sound like useful things?

Then every summer, I go to work in the real world, gainfully employed by a information technology company. I've worked at NASA, a commercial satellite company, and a defense contractor. In not one of those jobs did I think back to dynamics, write down a couple of simple relations that looked exactly like some example in the book and have some kind of revelation. I'll admit that I have become a better problem solver and a more logical thinker. But—did I really need 150 college credits to improve those skills? It seems to me that in many jobs, you learn as you go. The company, the boss, or the program manager already has a plan of attack and all you have to do is follow the guidelines set forth for you. Even if there aren't guidelines, anybody with some common sense and discipline can formulate a solution to a problem, even if it involves asking for help or doing some research.

Another thing I have learned from the real world is that all the education in the world won't do you a bit of good if you can't think logically or rationally. A good problem solver can take a little bit of knowledge and apply it to solve a complicated problem. A bad problem solver can take reams of knowledge and still come up with an infeasible solution.

I guess some of these problems stem from education as it stands today. Professors cover a section of the book at a time, then assign problems from that section. And then, when you have a problem with the work, you know exactly where the formulas are, where the examples are. When those problems are completed, the class moves on the the next section and repeats the same process. If you're lucky, you may get a project at the end of the term that covers three or four of those sections all at once.

Why can't classes be conducted like the real world is? Present some basic material and a problem. Allow the students to identify the issues, make some assumptions and figure out what principles need to be applied. There needs to be more group work, less focus on grades. This style of teaching and learning is more "problem-centric" and would bridge the huge gap between universities and corporations.

Some departments have a senior project that allows students to integrate all they have learned in the past. But, I have a feeling that there is a lot of time wasted on getting the hang of not having the answer in the back of the book, of not always having one correct solution, of dealing with teamwork issues. If this problem solving process had been introduced earlier, maybe all this frustration could have been prevented.

Now, obviously to propose to change the way our entire educational system works is absurd, but would a few changes hurt? The first changes should start in the Engineering Fundamentals classes. Do you want to know something fundamental about engineering? It is that no one engineer works alone. For any given product there is a team of engineers, marketing folks, accountants, administrative assistants, and so on. I understand that there is no way a team could work on the same problems currently given out, but why not make the problems more substantial? Make them more realistic. I have seen problems that ask the student how much maple syrup can be gotten from a certain tree given certain parameters. What? No one cares...There is probably one in a million that will be faced with this problem. Those first few classes are meant to show future engineers what they can expect in the future, but in fact it "weeds" them out and frustrates all the others.

If we are expected to survive in the real world, why not have our education emulate it as closely as possible. That would be a real education!

Rebecca Gassler

Rebecca Gassler

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