ENGINEERS' FORUM

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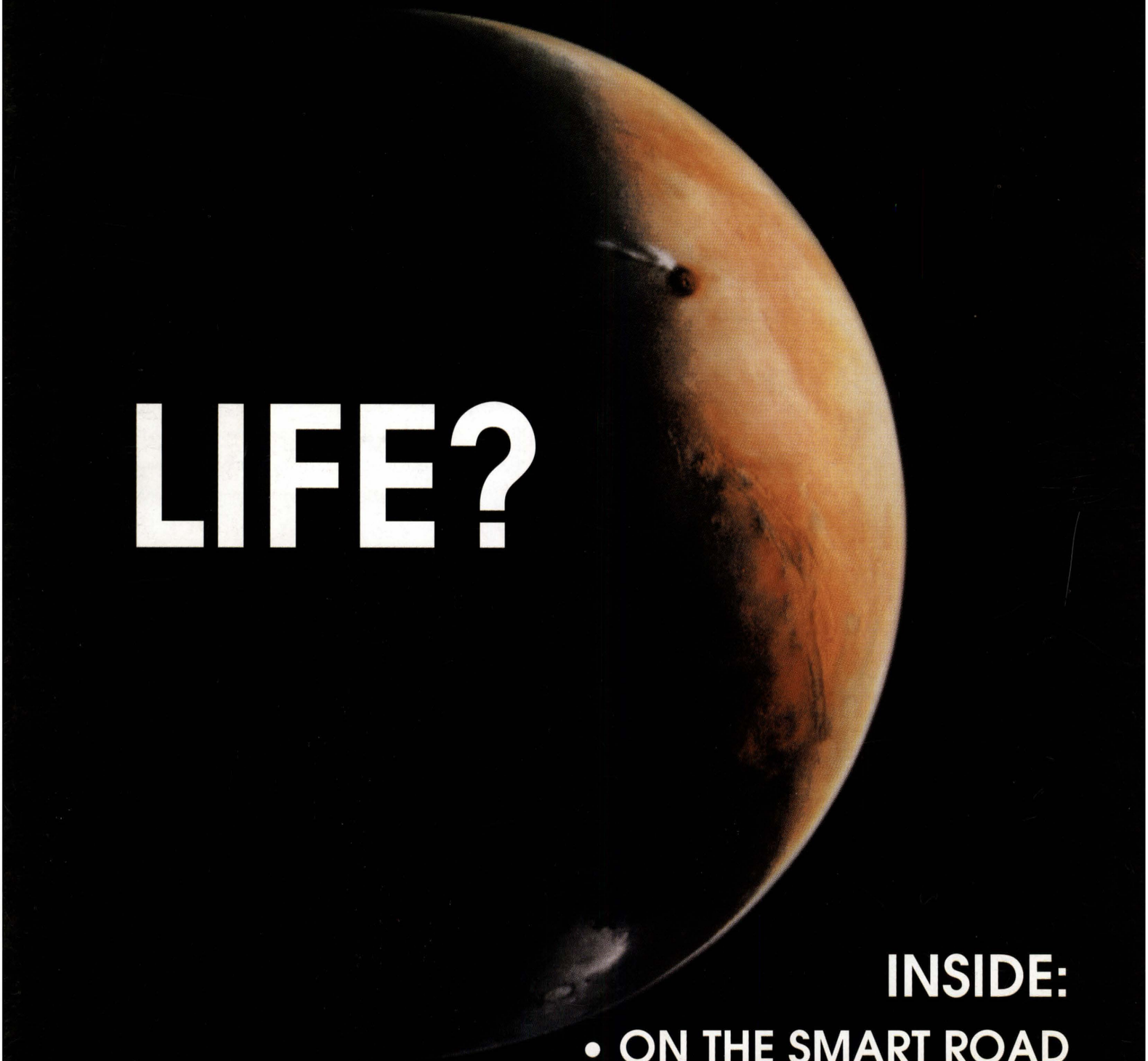

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- ON THE SMART ROAD
- A PROCESSION OF PROCESSORS
- TOBACCO: A NEW TWIST ON AN OLD DRUG

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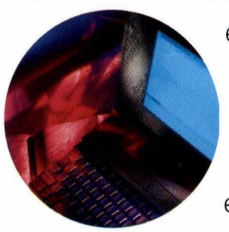

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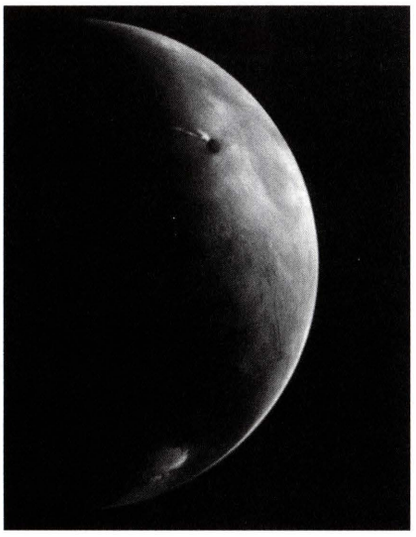
THE ENVIRONMENTALLY CONSCIOUS ENGINEER

We cannot haphazardously design products just for today's enjoyment or luxury.

On the Cover



On August 5, 1976, Viking 2 photographed the Martian surface. Photo courtesy of NASA.

Welcome back! As developing engineers, we need to learn to balance the competing demands of the environment and production of inexpensive, sustainable products.

In the past, taking a pro-environmental stance was not necessary. There was a seemingly endless supply of raw materials and landfill space, a nonchalant attitude to what was being done to the environment, and a competitive drive that left everyone and everything in the dust. Businesses cannot operate with that type of attitude any longer. To operate in today's marketplace a company must be socially, environmentally, and fiscally aware.

Engineers and scientists are at the forefront of the movement to improve the world we live on. As such, we need to learn new ways to think and design in an environmentally friendly manner. We cannot haphazardously design products just for today's enjoyment or luxury. A thorough study of the operational life cycle needs to be completed during the design process of the product: how it will be produced, how the product is going to be used, for how long will it be in use, and how it will be disposed of. Only by looking at these issues at design time will a comprehensive plan be able to be put into action that includes cost effective environmental ideals.

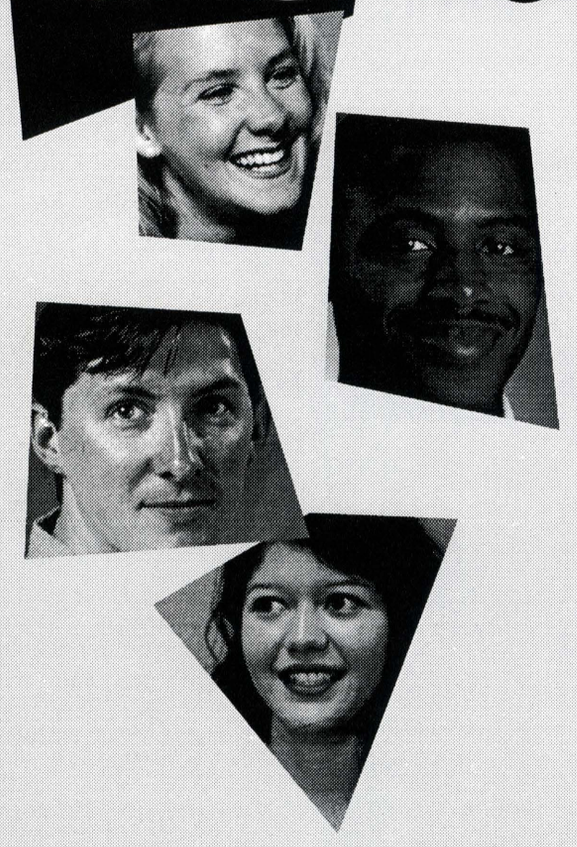
Why is it necessary to look at these issues at design time? Consider the ubiquitous laser toner cartridge. Its life does not consist of use it and toss it anymore. Today there is a brisk business in refilling and refurbishing them. When the cartridge is out of toner the consumer sends it to one of these businesses, or the manufacturer, and in some cases receives a credit towards their next purchase. They are then inspected, broken or worn parts replaced, refilled with toner and packaged for the consumer to buy again. Only when parts break which cannot be fixed are the cartridges thrown to the landfill. By looking at this cycle at the beginning of the design process, an environmentally friendlier product can be produced for less money. The product can be designed to be easily repaired, repackaged, or recycled with minimal cost and time.

This holds true for construction, plant layout, and materials design, not just manufacturing. Buildings can be made with recycled materials and designed to be energy efficient. Materials can be designed to be easily recycled. Chemical plants can be designed to produce less waste. All of these can help improve the environment of today and tomarrow, so future generations of Americans can enjoy the same beauty of this country that we do.

Lisa Traub

Lisa Traub,
Editor

a passion to be the best



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Life on Mars?

Scientists Discover Evidence of Past Martian Life

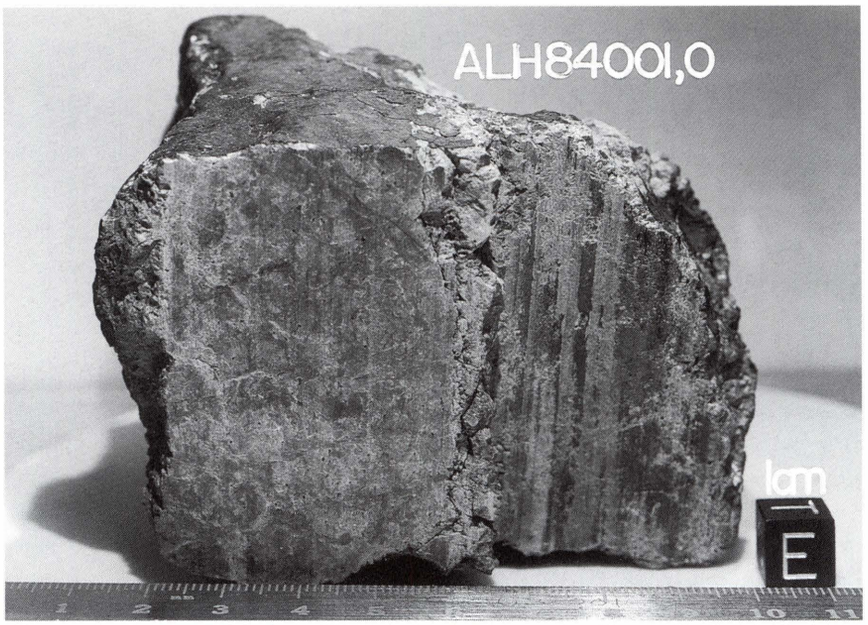
BY **RAY EASTERLING**

It may someday be hailed as the greatest scientific finding in the history of mankind.

Early August found the world's scientific community abuzz with news of the discovery of possible evidence that life once existed on our nearest planetary neighbor, Mars.

In a press conference held Aug. 7 in Washington, D.C., NASA scientists and officials confirmed they had found what they believed to be evidence of extraterrestrial life in a softball-sized Martian meteorite, labeled ALH84001. The scientists, in a paper published in the Aug. 16 edition of the *Journal Science*, report that the 4.5 pound meteorite contains the first complex organic molecules, those necessary for carbon-based life, ever found with Martian origins. The paper indicates that there are several different sources of evidence, each of which, the scientists say, can be accounted for separately without biological activity. Considering all of these factors together, however, the scientists have concluded that these sources "are evidence for primitive life on early Mars."

Notice the report indicates "primitive life."



The meteorite was found in 1984 in Antarctica in the Alan Hills ice field.

NASA administrator Daniel Golden issued a statement prior to the press conference stating "I want everyone to understand that we are not talking about 'little green men.' These are extremely small, single-cell creatures that somewhat resemble bacteria on Earth. There is no evidence or suggestion that any higher life form ever existed on Mars."

After a summer filled with such sci-fi thriller movies as "The Arrival" and "Independence Day" detailing the invasion of Earth by extraterrestrials, recent announcements from NASA scientists declaring evidence of Martian life might have seemed almost apocryphal.

Indeed, many members of the world's scientific have voiced some skepticism in the wake of the Aug. 7 news briefing detailing the findings of the research team.

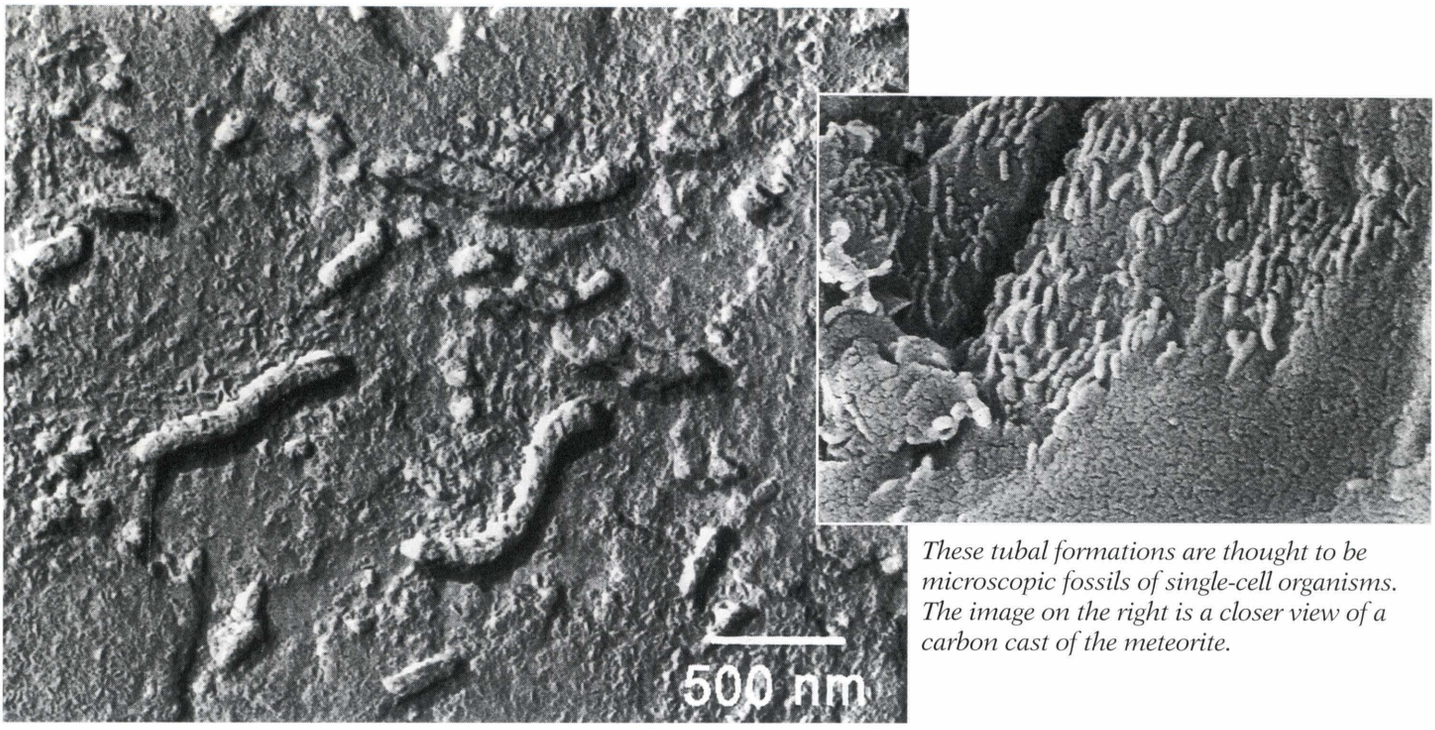
UCLA paleobiologist William Schopf indicated that to be convinced of the teams findings he would like to see evidence of the cell wall, such as data describing the mineral population distinction from the surrounding matter in which these proposed life forms are embedded.

"My first guess would be that they're not biological," he said. "There's no evidence that there's a cavity within them, a compartment, a cell," Schopf said. "Why is that important? That's where the juices reside."

Richard Zare, a Stanford scientist and part of the research team, countered. "You're looking for a smoking gun: find me DNA. When things get this old, you don't have DNA."

The residues of ancient biotic activity were found after intense study with electron microscopes, the level of which were not even created just a few years ago. The possible Martian microfossils were found inside microscopic fissures in the meteorite, which was uncovered in Antarctica in 1984. The images themselves resemble Cheetos, as *Washington Post* writer Joel Achenbach described them. These oval and tubular shapes are one one-hundredth to one one-thousandth the width of a human hair, much smaller than any bacteria found on Earth.

The meteorite itself is reported to have been crystallized from molten rock roughly 4.5 billion years ago. The carbon-based evidence which the NASA scientist point to as biotic was formed a billion years later.



Photos courtesy of NASA.

These tubal formations are thought to be microscopic fossils of single-cell organisms. The image on the right is a closer view of a carbon cast of the meteorite.

NASA will be sending a series of robotic probes to the red planet in the coming months, the first two of which are scheduled for later this year. Though the flights were planned prior to this discover, and the main thrust of their research will not be the search for life, it is hoped that future missions will focus on areas where scientist believe water might have existed, an ideal site for further, more substantial evidence of buried microorganisms.

"If it is truly a microfossil from ancient Martian history, it is a transforming discovery in the history of science," said Carl Sagan, renowned author and scientist. "Not just that, but it provides a profound perspective on our place in the universe." **EF**

The Engineering Profession:
Changing Times, Same Meaning

BY ALBERT LOWAS

Engineering is an important and learned profession. The members of the profession recognize that their work has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness and equity, and must be dedicated to the protection of the public health, safety and welfare. In the practice of their profession, engineers must perform under a standard of professional behavior which requires adherence to the highest principles of ethical conduct on behalf of the public, clients, employers and the profession.

Preamble, "Code of Ethics for Engineers"

Look around you. The air you breathe, the clothes you wear, the pen in your pocket, the chair in which you sit: All of these have changed dramatically in the past hundred years, indeed in your lifetime. Each of these changes, good or bad, represents the marriage of societal need with technological skill — "Necessity is the mother of invention." Throughout these changes, two things remain constant: first, engineering remains a vital component of society's need to create a better standard of living, and to strive for a better way of life; second, engineers must perform their function with the highest possible standards. These standards are arguably more important to engineering than Newton's Laws: For proof, you might ask the family of Mr. Ellison Onizuka, who graduated with a MS in Aerospace Engineering from the University of Colorado in 1969, and tragically lost his life in the Challenger accident ten years ago.

As the Challenger accident showed, a key reason for these standards is that engineering involves very abstract and specialized knowledge that few understand. An engineer "has undergone many years of education and on the job training and experience to learn how to be a professional," says Richard Wand, Past-President of the Virginia Tech student Chapter of the National Society of Professional Engineers. A professional engineer, according to Wand, "uses analysis, know-how, and logic to arrive at the best correct solution in the most efficient manner while abiding by the strictest ethical standards."

"Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties."

From the rocket scientists of yesterday to the computer engineers of today, we have held in awe the marvels of modern technology — although few have endeavored to understand. Only about 250 U.S. colleges offer accredited engineering programs.

These 250 schools not only standardize engineering knowledge, they create a select group of engineering practitioners. Our information-based society makes a comprehensive understanding of the engineering discipline a highly valuable resource. Few without engineering degrees understand the intricacies of computer chip design, fewer still can legally act as consultants or certify buildings, and it is very difficult to find any engineering position without an engineering degree.

Even after gaining a basic theoretical knowledge at college, the engineer must continue to update his knowledge and learn the detailed practical information necessary to perform in the workplace. For instance, most of us who are looking to graduate this year have already learned that our computer knowledge pales in comparison to the new 80486 trained freshmen. Worse, I once knew a professional engineer whose office upgraded his 80286 machine to an 80486 at work only to have him continue to use the 80286 because he could not understand the new software — and because he felt the new machine was too fast! Engineers, as the key means of introducing new technology, must keep abreast of current technology — requiring continual learning.

After this extensive training and licensing, an engineer has a unique opportunity in modern society: The opportunity for a relatively high level of autonomy in the workplace. The engineer must realize, though, that the form of that autonomy is changing. In a recent interview with Dr. Beaton of Virginia Tech's Industrial and Systems Engineering Department, he noted that "there is a trend in engineering where the engineer must work in a team environment. There are no more renaissance engineers." This new autonomy — a group autonomy, one might say — requires engineers to make "honest decisions in the contest of teams, which requires different social and professional behaviors than working alone in one's shop," according to Dr. Beaton.

Especially today, as Americans begin to question the technological competence of US companies, managers are increasingly being asked to rely on the judgment of engineers to determine what makes a better car, airplane, or other widget. Not only is this better management (letting those with more knowledge make the decisions), but it is also less expensive management (requiring fewer levels of managers to make the same decisions). This gives the engineering team tremendous authority over the project, the client, and the corporation. This is not to be taken lightly, for a false decision may have an insurmountable cost to society in terms of money and/or lives. As an extreme example, after the Challenger

accident, NASA established a hotline that any NASA engineer can call to halt the mission of a space shuttle if he believes that there is a reasonable safety issue with the flight. The authority to halt a shuttle mission is indeed the authority to save lives, but it is also the authority to cost the taxpayers millions of dollars. Again, the engineer must rely on his high standards, good judgment, professional societies, and the advice of fellow engineers in order to make the best possible decision for society — and for his immediate company or client.

So it is in holding this knowledge, power, and autonomy in society that an engineer has an obligation to society. According to Dr. Beaton: "I think ethics and professionalism is as important as any other fundamental skill that we teach. Our responsibility, as a professional practice, is to determine, are we building products that are the right products? This includes if they are useful, safe (both to the user and the environment) and do they serve a purpose." He goes on to say that it is unprofessional to make unsafe products or products that are not useful, and that a professional should always look for safety and usefulness in a product and continually ask himself if the product will "advance technology, serve the community, or integrate the community."

These ideas are further supported in the NSPE's Code of Ethics for Engineers. "Engineers shall at all times strive to serve the public interest," (III.2) and, "Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties," (II.1). As summarized by Dr. Beaton: "Engineering ethics adds to the framework by which an engineer conducts himself or herself: engineers will feel more responsible, more autonomy, and will be more accountable, and they will have to provide a quality product."

Simple ethics states: "Be honest" and "Do unto others as you would have them do unto you." However, the engineer may have obligations beyond simple ethics. The NSPE Code of Ethics for Engineers states that an engineer is obligated to "seek opportunities to be of constructive service in civic affairs and work for the advancement of the safety, health and well-being of their community," (III.2.a). According to Dr. Beaton: "To be a professional, one must be balanced, to include the skill at application of a technological knowledge, an attempt to keep up to date with technology, and a responsibility to communicate knowledge" in "teaching, services, lectures, and articles — to include both journal articles and others in, say, the Roanoke Times. It is part of being a high quality professional. It can not be required, however, because it is a professional issue more than an ethical one."

Many might think this professionalism is an extra burden in already fiscally tight times. In fact, this may not be so. Not only do many large engineering companies consider community service in promotions, but this communtiy service — altruism — brings greater credit to the profession and the engineer's professional society. Most importantly, it is an engineer's duty to his fellow man, considering the high place that the engineer holds in the functioning of society.

This is not a new theme: Indeed, this same profes-

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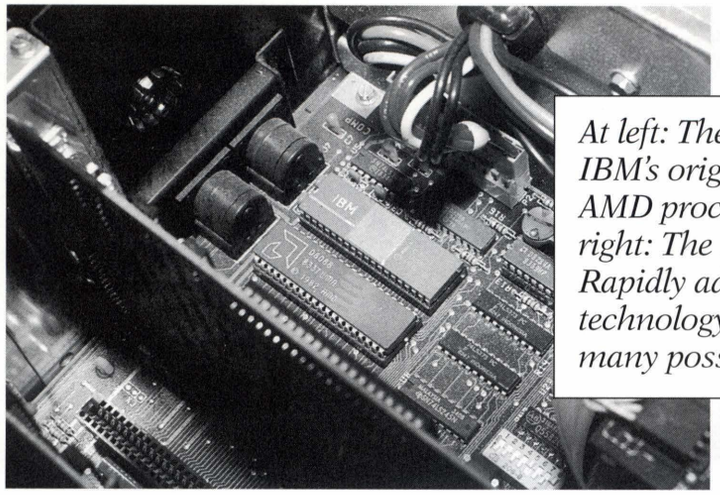
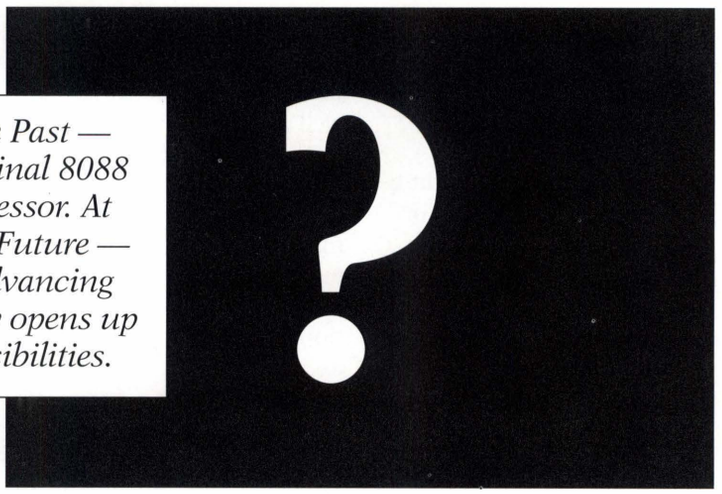


Photo by Lisa Traub

At left: The Past — IBM's original 8088 AMD processor. At right: The Future — Rapidly advancing technology opens up many possibilities.



The Pentium & Beyond

BY CHRIS LUNDBERG

The battle lines have been drawn. A war of escalation is afoot. The battlefield? The computer hardware industry. Ever since the development of the first computer microchip 25 years ago, companies have been vying for a slice of the microchip pie. Their weapons? Speed, compatibility, and aggressive marketing.

The preeminent manufacturer of the computer microchip industry, Intel Corporation, has consistently led the market with their innovative chip design, starting with the very first microchip released in 1971. As the Intel chips improved their operating speeds and data rates, and various competitors pushed the envelope of microchip technology, the computer market erupted into the juggernaut of money and information we see today.

Competition for Intel Corporation in the early years of microchip technology burned brightly but briefly, as many companies developed new chips and computer systems to compete in the fledgling market. While the wheels of capitalism weeded out the weak or under-budgeted, a few companies were able to continue making a profit selling their computer technology. A short list of these microchip development companies include Advanced Micro Devices, Inc. (AMD), Cyrix, IBM Microelectronics, SGS-Thompson, and Texas Instruments, among others.

THE CURRENT STATE OF THE ART

The computer industry is developing hardware and software at such a phenomenal rate that the current state of the art is outdated within weeks of release. The current top of the line microchip available for the PC is Intel's Pentium Pro computer chip, available in clock speeds (or core frequencies) up to 200 MHz. The Pentium Pro processor has the ability to be combined with up to three other processors, useful for multitasking applications and operating systems. No other mass produced microchip comes close to the performance of the Pentium Pro. However, the price for this high-end technology is forbidding at best.

The industry standard right now for computer microchips is Intel's Pentium series of processors, fast microchips for relatively cheap prices. This fifth generation chip is selling very well and has captured the majority of the new computer sales industry. It's a rare home computer which doesn't display the Intel Inside-Pentium logo.

Competing against Intel's powerful Pentium family are Intel's top microchip challengers, Cyrix Corporation and AMD. Both Cyrix and AMD currently field fourth generation chips designated 5x86. These chips fit into current 486 sockets and perform in the high 486 to low Pentium range. In recent months, these companies have shipped fifth generation chips, the 6x86 for Cyrix, and the 5K86 for AMD.

With its fourth generation of microchips, AMD outsold Cyrix comfortably to maintain second place behind Intel in the microprocessor race. However, due to delays in the development of the 5K86, AMD has recently fallen behind Cyrix in the chip race. The 5K86 was released later than anticipated and still needs some refining before it can compete in the current fifth generation market. However, the internal structure of the 5K86 has the potential to eventually outperform Pentium chips.

The 6x86 Cyrix chip is a huge step in bridging the gap between Intel and its competitors. In most applications, the 6x86 microchip matches and even outperforms comparable Pentium processors. However, Cyrix must still overcome the business side of technology. Cyrix chips run more efficiently than Pentium chips, so the clock speeds are lower for comparable processes. With the public eye on MHz as being the key determinant for speed, this puts Cyrix at a disadvantage in selling its microchips, even though they are compatible with most operating systems that the Pentium chip is used for.

THE P-RATING

In order to even the playing field, Cyrix, AMD, IBM Microelectronics, and SGS-Thompson have created the P-Rating Specification to rate their computer chips. The P-Rating compares the chip to Pentium processors

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and defines a rating determined by relative performance. For example, the Cyrix 6x86 133MHz might be tested as being as fast as or faster than a Pentium 166MHz, and so would be called a 6x86-P166. A /+ is sometimes added by Cyrix to indicate that the Cyrix processor exceeds performance of the comparable Pentium processor.

If the Cyrix 6x86 chips are faster than Pentium processors, then why are Pentium processor selling so fast? There are a few reasons. The 6x86 consumes up to one and a half times the power of Pentium processors, so they create more heat. This heat must be dissipated with extra fans or heat sinks, and is one of the reasons it is rare to find a 6x86 in a laptop computer. The 6x86 chips also do not have the ability to crunch floating point operations as well as the Pentium processors. This is a disadvantage in programs requiring many mathematical operations such as 3D rendering or scientific modeling. Finally, Intel is a name vendors and consumers recognize and trust, which creates a customer base that will be difficult for Cyrix and AMD to penetrate.

Ever since the development of the first computer microchip 25 years ago, companies have been vying for a slice of the microchip pie.

MOTOROLA AND IBM: BARREL OF GOOD APPLES?

The dark horse in the computer hardware race is Apple Computer, Inc. Apple has typically controlled a sizable chunk of the computer industry, particularly in the graphics presentation market. The challenge to Apple is to grab as much of the computer industry as they can by improving their current chip designs and hardware systems. Radical improvements in speed and capability for Apple computers may increase their market share. Apple is hindered in its efforts by a lack of adequate comparison tests between the PowerPC and the x86/ Pentium line of microchips, as well as limited compatibility between PowerPC processors and other microchips.

Apple's current chip designers, a collaboration between Motorola and IBM, have recently announced completed development of enhanced PowerPC 603e and PowerPC 604e microprocessors. These processors are a significant improvement over previous versions and will be available in chips running at up to 200 MHz. Apple, Motorola, and others plan to produce systems using the new processors. Only time will tell how well the enhanced PowerPC stack up against other industry strongholds and the future for Apple.

THE FUTURE

In the future of microchip technology, a few near term products are expected. An extension to the Pentium family, the P55C, is due to appear before the end of 1996. This chip will have Intel's new MMX instruction set added as an extension to the old x86 instruction set. The MMX instruction set is designed to speed up multimedia processes such as speech, real-time audio and video, and image processing. The MMX instructions will allow the P55C to outperform previous Pentium chips by more than 100% on some multimedia applications.

Cyrix and AMD both plan to incorporate multimedia instruction sets into future chips to compete for the new multimedia market. Whether these multimedia adaptations will come from Intel or from other designs is unknown.

Due to the fierce competition in the industry, companies guard their future plans very tightly. However, there are still many rumors about what is to come in the microchip battleground. The code-name for Cyrix's next part is M2, which may be an enhanced fifth generation chip with the addition of multimedia extensions and enhancements to increase the clock speed. The next chip at AMD is code-named K6, and all is known is that it may be using Intel's MMX extension.

There are many ideas about what Intel has planned for the future. Early in 1997, a Pentium Pro processor based chip, rumored as Klamath, may be revealed. This chip would have the MMX extension set and would be significantly cheaper than current Pentium Pro processors. Past this, there is a lot of talk about reduced transistor sizes, 333MHz clock speeds, 64-bit architectures, and eighth generation chips. These new developments will take the battle for microchip supremacy far into the 21st century. EF

The Smart Road: What Toll for Technology?

BY AMY SIMMS

The Smart Road is a proposed 5.7 mile highway that would provide access to Blacksburg from Interstate 81 and serve as a transportation research laboratory. It is also the subject of a great deal of controversy.

Much of the dispute comes from the Virginia Department of Transportation (VDOT) request for 140 acres of protected land in the Ellett Valley that the road would intersect. The Ellett Valley is east of Blacksburg along Luster's Gate Road.

The land was protected under state law by the 1982 Agricultural and Forestal District (AFD) act which states that it is "the policy of the Commonwealth to conserve and protect agricultural and forestal lands as valued natural and ecological resources which provide essential open spaces for clean air sheds, watershed protection [and] wildlife habitat."

To acquire land in an AFD district, a state agency such as VDOT must file a notice of intent with the local governing body. This notice should, according to state law, "contain a report detailing all reasons in justification for the proposed action including, but not limited to, an evaluation of alternatives which would not require action within the district."

The local governing body must consult with the local planning commission and the AFD advisory committee to "determine the effect such action would have upon the preservation and enhancement of agriculture and forestry and agricultural and forestal resources within the district and the policy of this chapter [AFD law]." The local government must also "determine the necessity of the proposed action to provide service to the public in the most economical and practicable manner."

In November 1995 VDOT submitted its notice of intent for AFD-7, along with an Environmental Impact Statement. The Montgomery County Board of Supervisors voted against VDOT's request by a one vote margin. This vote was rescinded a week later so the Board could obtain more information about the project, and VDOT was asked to answer a list of 92 questions and then reapply for the land.

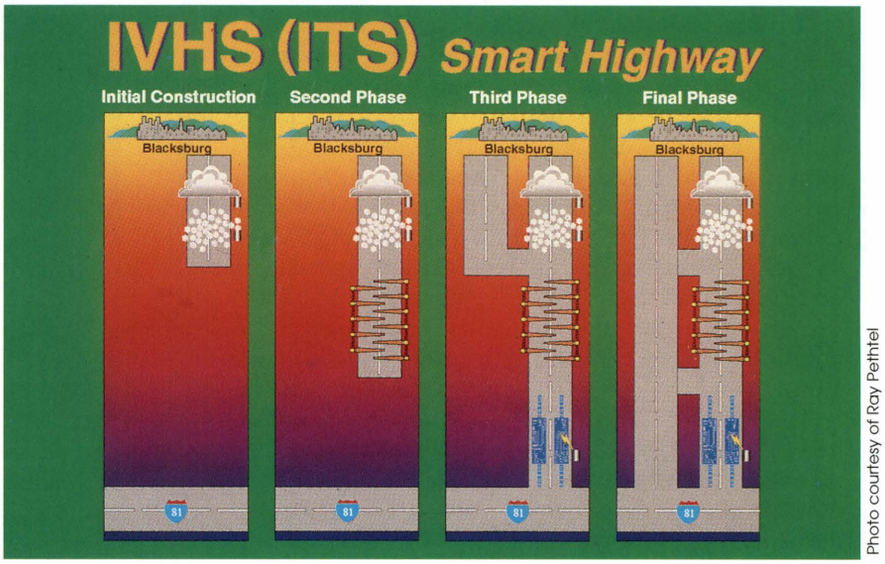

Photo courtesy of Ray Pethtel

This timetable shows how the test bed will be built in sections before the road is open to traffic.

On May 3, 1996, VDOT released a 63-page document which offered answers to these questions. Included in the report is information on funding, the necessity of the proposed location, and projections of revenue that would be brought to the Montgomery County area by the Smart Road.

VDOT asserts that the amount of land affected by the Smart Road is insignificant — only 31 acres out of a total of 2826 acres in AFD-7 and only one tenth of one percent of Montgomery County's commercial forest land. The document addresses many environmental concerns of the Board of Supervisors, and comes to the conclusion that the road will not have a significantly adverse affect on the environment or on AFD-7.

According to the Virginia Department of Forestry, the Smart Road will actually have a positive affect on future timber management and harvests, because the improved highway network will reduce hauling distances. Lowering foresting costs is important to the region because, according the VDOT document, "Montgomery County lacks competitive wood product manufacturing industries." In addition, the VDOT document states that the timber stands in the area of the Smart Road have "minimal market value due to very high harvesting costs in mountainous terrain."

Another environmental concern related to highway construction is run-off. VDOT says that the "project will comply with existing state regulations for storm water management and erosion and sediment control." Storm water management basins will be established to control the rate of flow of run-off and allow for the settling of pollutants and sediments. If problems arise, VDOT says that all necessary improvements will be made. Furthermore, since there will be little or no traffic during the first year of the road's existence, there is no chance for an immediate problem.

The underlying geology of the Ellett Valley is also a concern. By nature, this region is susceptible to sinkholes and underground caverns. VDOT conducted a field study of the test bed area and found no sinkholes. A preliminary search of the entire corridor also found no evidence of sink holes or cave openings. If any are found, VDOT will take appropriate measures to ensure the safety of the public and the construction workers. The document also states that the Smart Road will not endanger the smooth coneflower, the only threatened/endangered species within the Smart Road corridor. According to VDOT, the proposed location has the least impact on wildlife resources of all possible locations. No alignment of the road would completely avoid all protected

See Smart Road, page 24

Heigh-Ho, It's Off To The Mines We Go

BY BETH OBORN

When the incoming class size of a department more than doubles, you sit up and take notice. Over the last three years the department of Mining and Minerals Engineering at Virginia Tech has seen such an increase. Before the spring of 1992, only 15 or so freshmen entered the department, but about 35 students chose this major in both the spring of 1994 and 1995.

Dr. Michael Karmis, the head of the department, and his colleagues believe this dramatic increase is due to the expansion of the curriculum and to a growing need for mining and mineral engineers created by greater demand on mineral resources by the public.

Originally, the mining department considered only the actual mining of ores. Now concerns include industrial minerals, which range from phosphates for fertilizers to clays for glasses, and construction materials like quartz which must be extracted from the ground. These are especially important concerns at Tech since the eastern part of the country contains many of these resources. As the curriculum continues to expand, Karmis expects departmental growth to increase even more.

This increase in students could present a problem and affect the quality of the instruction. However, Karmis says that, "We're trying to ensure that it doesn't." The computer lab will be expanded and the department will offer certain courses more frequently, especially lab sections. The faculty will have more teaching responsibilities, but the students will continue to receive the same quality of instruction.

The instruction is also advanced. "We emphasize computers and design and give students flexibility to develop their own interests," Karmis said. The department's extensive corporate funding and close liaison with industry and alumni allows them to provide extra benefits to their students, including research and design opportunities and a large number of scholarships.

Photos courtesy of Dr. Chris Haycocks

Instruction doesn't stop at the exit door of the academic building. "We try to invest in student enhancement activities," Karmis said. Activities include trips to an annual professional society meeting where students can interact with working engineers and visits to actual mining operations in various parts of the country.

"We feel that it's important for the students to have this kind of interaction," Karmis said. The department also encourages students to look internationally for experience.

The department actively seeks out jobs for seniors by keeping a close relationship with industry and recruiting the smaller companies to come and interview students. With this effective program, 100 percent of the mining and minerals engineering seniors find jobs when they graduate. EF

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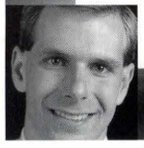

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Photo courtesy of Dr. James Wilson

Laying hens were used in a project to test the effects of boron on bone density.

BORON:
Bane for Brittle Bones

BY SCOTT WALTERS

The elderly of this country are at war, not with some foreign invader, but with their own bones. Fifteen to 20 million people in the United States are inflicted with osteoporosis. This is a naturally-occurring bone ailment which everyone gets, to some extent, as they age.

Human bones grow continuously until the age of 45. Then the bones begin deteriorating. For persons with osteoporosis, this deterioration is extreme and brittle bones occur. This condition can lead to an increased chance of fracture, slow healing of fractures, and curvature of the spine.

The key to countering this deterioration is to strengthen the bones as much as possible during the growing stage. A stronger bone is denser and less likely to be affected by future deterioration. Density can be increased by exercising, especially while young, and eating a well balanced diet. Avoiding smoking and drinking also helps.

While the elderly cannot change what they did in the past, they can change their present diet. One way many do is with dietary supplements. Calcium is currently a popular choice, but according to Professor James Wilson of the Biological Systems Engineering department, it is not the total solution.

The problem is not a lack of calcium, it is getting the bones to retain calcium. Most of the excessive calcium quantities in supplements taken by the elderly are actually passed through and not retained by the body. Certain supplements have been found to help the bones retain the calcium. One such supplement is the element boron. Boron is found in larger quantities in green leafy vegetables. Studies have shown that vegetarians have a lower number of occurrences of osteoporosis than people who eat more meat. Over the past two years, Professor Wilson has been exploring the potentials of using boron supplements to curb the effects of osteoporosis in the bones of laying hens.

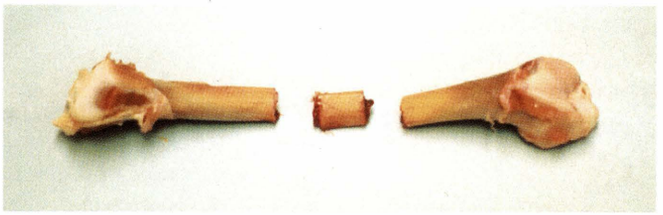
Wilson has been strength testing animal bones since 1980. He initially came across the idea of boron

supplements after reading an article in November 1987 issue of *Agricultural Research* entitled "Banishing Brittle Bones with Boron." It told of a project run by Forrest H. Nielson of the National Nutritional Lab. In 1986, Nielson conducted a study on 12 women whose diets were being supplemented with boron. Osteoporosis has a higher occurrence rate in women, making them better subjects for the study. The experiment lasted three months and found boron supplements had a positive effect on the bone condition of the women.

Wilson realized the potential of boron in the fight against osteoporosis, but he wanted to make a more in-depth study of the quantitative effects on the bones. He decided to use laying hens for the experiment. Using hens he could test the actual bones over a long term study and in large controlled quantities. The hens' life cycle also corresponded to the human cycle on scaled down terms. Wilson hoped his findings with the laying hens will be applicable to humans and their battle against osteoporosis.

Professor Wilson has been working on the project since 1994 with a number of faculty from various departments assisting him. Paul Ruszler of the Poultry Science Department has been working with Wilson throughout the project. Wilson and Ruszler received technical assistance from Steve Spradlin, Donnie Wingo, Laura Wilson, and the Poultry Farm Staff. Funding was provided by the Virginia Agricultural Council for a two year run time on the project.

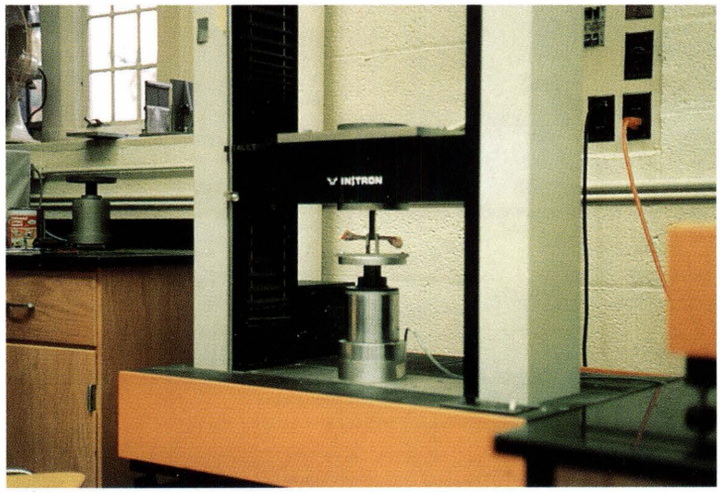
Initially, the time schedule of the experiment was divided into four phases, corresponding to the chickens' 72 week egg production cycle. The first phase included the growing phase and ended 16 weeks after the starting date. The next stage encompassed the laying phase of the chickens' life and ended at 32 weeks. The third and fourth phases ended at 52 weeks and 72 weeks and corresponded to the mature egg laying stage.



Shear testing of the femur, tibia, humerus, and radius bones took place during the project.

The actual experiment began in December 1994 with six hundred one day old chicks. The chickens were raised in the Poultry Buildings on Southgate Drive. The young hens were separated into seven groups. Each group was fed a certain quantity of boron supplement. The quantities were maintained for each group throughout the experiment. The levels, measured in milligrams per kilogram of food, were 0, 50, 100, 200, and 400. The zero group, or control group, received normal feed with boron at about 3 parts per million. The sixth and seventh group of hens were started on the 200 mg diet after the 16 and 32 week phases, respectively.

At the end of each phase, one hundred and fifty birds were sacrificed for bone testing. Twenty birds were taken from each group. The femur (thigh), tibia (leg), humerus (wing), and radius (wing) were all subjected to strength testing in an Instron testing machine in the Food Engineering Lab in Seitz Hall. The thigh and leg are very similar to human bones, however the wing bones are hollow, unlike human bones. To ensure freshness, the bones were all tested soon after sacrifice. According to Wilson, there is a significant difference in the strength results from a dry bone compared to a fresh, moist bone. The bones were broken in the press and the maximum load at the breaking point, the maximum shear stress, and the fracture energy were all recorded. The density of the bones was also calculated using an ash content method. During this test, the bones were dried to zero moisture and weighed. They were then burned to an ash and weighed again. The ash weight divided by the dry weight obtains the ash content value. The higher the value, the greater the density of the bone. A denser bone is heavier and thus stronger. In addition to the bone studies, Wilson examined the boron content of the meat, the eggs, and the manure.



The chicken bones were tested for shear strength by an Instron testing machine. (Photos this page courtesy of Dr. James Wilson.)

The first sacrifice was made after the 16 week growing phase had ended and before the egg production began. Wilson wanted to test the bones before the hens began laying eggs. The egg laying process removes calcium from the bones. He also wanted to try to make comparisons with human children. He found there was a fifteen percent increase in density in the leg bones of the chickens with the boron supplement. At 50 and 100 mg, there was a thirty percent increase in bone density. It was also found that birds fed the maximum 400 mg of boron had an overall lower body weight compared with other hens. The larger quantities were slightly toxic to the birds and caused them to eat less. Wilson explained this result, "Boron is like many things. In the right portion it helps. Too much, though, and it could be hazardous to your health."

The next phase ended after 32 weeks and included the beginning and peak production of eggs. The same trend seen in the 16 week group was found here. The tibia and femur bones were stronger and more dense in the boron supplemented birds.

Wilson also started two groups of birds on the

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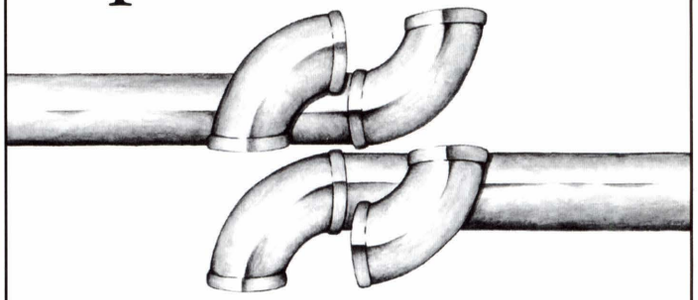

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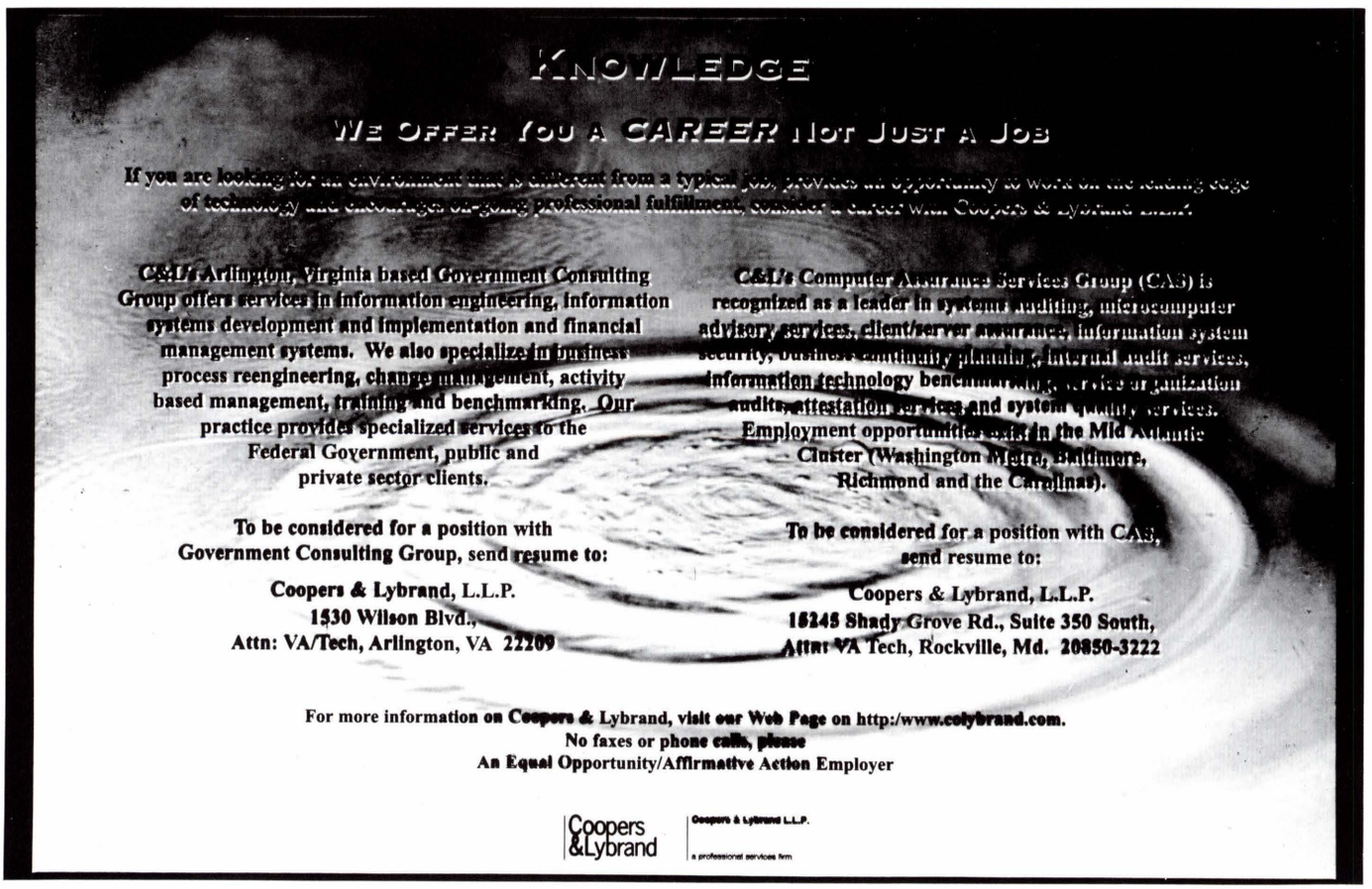


Boron

Continued from page 15
supplement later in the birds' life cycle. One group started immediately after the growing phase, the other after peak production. He found that birds on boron from the beginning were able to absorb more boron than the other groups. An important parallel can be drawn because most people do not start taking supplements until after the growing stage.

After another 20 weeks the third group of chickens was studied. According to Wilson, the chickens have reached full maturity at this point. The findings were very similar to humans in later life. There was a significant drop in the shear fracture energy in both leg and wing bones. The density was lower and brittleness increased in the 0, 100, and 200 mg levels.

The testing ended after 72 weeks with the study of the last group of chickens. Wilson explained, "Producers get rid of the birds at this point. They are not laying enough eggs to justify keeping them in the industry." Wilson scheduled the experiment around this cycle. After each sacrifice, a large amount of time was needed to analyze the 150 hens. This final sacrifice occurred at the beginning of May. Wilson should obtain results soon and final results from the experiment should be out by the end of the year.

Another factor Wilson has to take into account when analyzing the final data is that some chickens did not lay as many eggs as others. When a hen lays an egg, the calcium necessary for the egg's production is taken from the hen's bones. This lowers the calcium level in the bones and weakens them. Wilson and his assistants were careful to keep track of the egg production of the hens. Only hens having similar laying habits will be compared between the different supplement levels.

In addition to testing the bones, Wilson examined boron's effect on other parts of the hen. One of his key goals was to account for all the boron fed to the chickens. The breast, liver, and thigh meat were all tested. He found these portions had absorbed enough boron to meet approximately one-third of the daily recommended allowance. This finding presents the future possibility of boron fortified poultry.

Wilson also looked at the effect on eggs and egg production. The eggs absorbed a small amount of boron, but it had no adverse effects on the egg or egg shell quality. Egg production was also unaffected. The majority of the hens maintained average or above average egg production percentages throughout their laying cycle. The only group which experienced a drastic decrease in egg production was the 400 mg group. Wilson explained this probably occurred because of the lower body weight of this group. A decrease in body weight resulting in less egg production is a common trait seen in laying hens. The project also checked boron levels in the manure. Wilson wanted to see how much was being passed through the birds. This will be an important factor in the future when considering necessary dosages of a supplement.

For the future, Wilson would like to do a similar long term study of swine supplemented with boron. The Animal Science department has also shown interest in such a study. The bones of swine are more closely related to human bones and better comparisons could be drawn. With these more in-depth studies, Wilson hopes to move closer to winning the war against osteoporosis. **EF**

Profession

Continued from page 7
sional issue has been recognized for years. According to John Coleman, Past-President of the American Society of Professional Engineers: "Far too many of us have thought of our country as having been built by men and machines and have overlooked the priceless ingredient of morality. Engineers need to take a more active part in politics at all levels, even to running for office for they are best equipped to realize the impact of their creations and if they accept their responsibility as citizens, they will interest themselves in the affairs in order to insure the wise use of technology." He continues: "This is truly the golden age of engineering, and the profession needs to be educated and a vast majority of engi-neers alerted and aroused to the opportunity and their individual responsibility and participation as citizens."

What makes these words especially important today might well be the time when they were written: The "golden age of engineering" that Coleman refers to is the early 1950's, and those words were written in the April 1953 edition of *The Virginia Tech Engineer*. As engineers, however, we must ask ourselves: Although *The Virginia Tech Engineer* may now be the *Engineers' Forum*, and the Dean of Engineering may no longer be John W. Whittemore, has the message substantially changed? **EF**

TOBACCO *It's Not Just a Carcinogen Anymore*

BY STEFFANIE LISKY

In a lab in Fralin Biotechnology Center, Dr. Carole Cramer, associate professor of plant pathology and physiology, is busy at work breeding tobacco plants. But these are no ordinary tobacco plants. These tobacco plants are part of the research CropTech Development Corporation of Blacksburg is conducting to develop a cheaper version of the world's most expensive drug, Ceradase.

Ceradase, currently produced by Genzyme, is the only drug currently available to treat a disorder known as Gaucher's disease, a rare genetic disorder that strikes about 2,000 Americans every year. To make just one dose of the enzyme takes 2,000 to 8,000 purified human placentas. The supply of human placentas is not nearly enough to fill the demand, and is the determining factor in the price of Ceradase.

Thanks to CropTech and genetic engineering the enzyme, glucocerebrosidase, may soon be produced in the leaves of genetically altered tobacco plants. There are many reasons why tobacco plants being used for the production of this medicine. First of all, tobacco, for no clear reason, is the easiest plant to genetically engineer. Tobacco is also a good biomass producer because it grows quickly and with very little care. The plants carry no human diseases. The most impressive reason for using tobacco is its efficiency. A single plant, once genetically engineered, can produce up to 1 million seeds containing this protein.

Cramer's work is pharmaceutically and biotechnically oriented, and is considered radical by some. After completing basic research on fungi for her doctorate Dr. Cramer moved into plant molecular biology in hopes of having useful applications for her research. In the lab she uses a gene gun to actually shoot human DNA into plant cells such as soy beans, corn and tobacco. Three out of four of these cells will develop the gene and in one flowering head there will be hundreds of seeds containing the human protein. The soy bean and corn experiments are being used as models for research in disease resistance and plant growth.

To create the enzyme in tobacco plants, CropTech takes a sequence of DNA and transfers it into the plant gene. Incubating leaf cells in petri dishes allows the cells to soak up gel containing genetically altered bacteria. The bacteria transfer the human genes into the plant cells. After the plant cells begin to sprout, the saplings are planted and produce the protein as they grow. The leaves are later harvested and the protein extracted from them.

Some other possible proteins produced in this manner are a blood protein used in anticoagulants and a poultry virus protein used for edible vaccines for poultry.

It is hoped transgenic tobacco can be used in many beneficial compounds. Some examples of beneficial compounds which could use to-bacco-produced human enzymes are industrial enzymes, biodegradable plastics, pet foods, laundry detergents, and proteins in cosmetics.

Dr. Cramer's research is seeing many useful applications agriculturally, medically, and pharmaceutically. **EF**

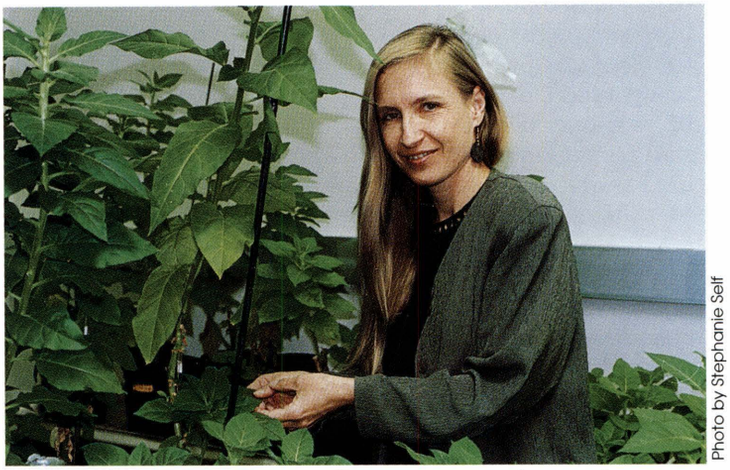


Photo by Stephanie Self

Dr. Carole Cramer is genetically engineering tobacco plants to produce a cheaper version of an expensive drug.

Rainforest May Hold Cures for the Ills of Mankind

It is a simple concept really. Plants contain drugs. And many of these drugs are beneficial for humans.

So the question is: Where do we find these plants and the wonder drugs they contain? The answer is Suriname... well, as far as Dr. David Kingston is concerned. Dr. Kingston is a professor of chemistry at Virginia Tech. He is primarily interested in organic chemistry, and is currently involved in drug research, principally cancer fighting drugs.

One reason for preserving the rain forest is its great abundance of plant life. To find just one plant extract which can be used pharmaceutically takes many samples. "It's basically a numbers game — the more tests done, the more success you get," Kingston said.

Since rain forests are primarily located in mostly poor nations, convincing the governments to preserve the rain forests takes more than merely a strong argument, it takes money. In response to this, an agreement has been worked out with the Suriname government and Virginia Tech. If any drugs are found there, a royalty will be paid to Suriname. Tech will also receive a royalty for conducting the research. The royalty will come from the sales of the drug by the pharmaceutical company which manufactures the drug. However, the chance of drugs being found in the rain forests is small because of the great expenses involved. **EF**

Tech Students Meet the 'Challenge'

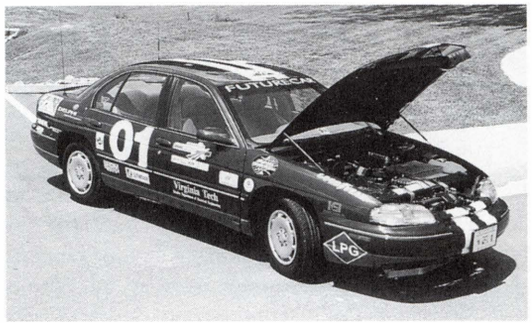
HEVT Takes First in FutureCar Challenge

BY **RAY EASTERLING**

It's clean, efficient, and it even cooks.

No, it's certainly not your roomate. It's the winning entry to this year's FutureCar Challenge, designed and built by Virginia Tech's Hybrid Electric Vehicle Team.

This modified Chevrolet Lumina gets over 49 miles per gallon of propane, does 0-60 in 12 seconds flat, and to top it all off, it has a gas grill in the trunk — for those infamous Tech tailgate parties, no doubt.



Tech's winning entry is a modified Chevrolet Lumina that runs on propane and electricity.

The FutureCar Challenge is a national competition which pits 12 engineering schools against each other to design a highly fuel-efficient vehicle while maintaining safety, comfort and affordability.

The Tech team answered this call, not only winning the overall competition, but taking several other individual first place awards along the way, including lowest emissions, highest energy efficiency, and best use of alternative fuels. The team brought back $16,500 in prize money from the June competition in Dearborn, Mich.

The competition is sponsored in part by the U.S. Department of Energy, General Motors, Ford, Chrysler and the U.S. Council for Automotive Research, all as a part of the Partnership for a New Generation of Vehicles, a consortium between the automotive industry and the government to re-tool the basic concepts behind American vehicles. Each of the 12 schools was given a Dodge Intrepid, Ford Taurus, or Chevrolet Lumina and $10,000 to begin the project. Further support was obtained from individual colleges and independent companies. The Tech team was supported in part by companies such as American Electric Power Co., Virginia Power, and General Electric's Drive Systems Division.

GE donated a drive system and electric motor, which the team combined with a three-cyclinder Geo Metro engine to form the hybrid electric propulsion system for the Lumina. The team modified the Metro engine to run on propane rather than gasoline and then used it solely to generate electricity to recharge the Lumina's 700 pounds of lead-acid batteries and, at times, to drive the electric motor.

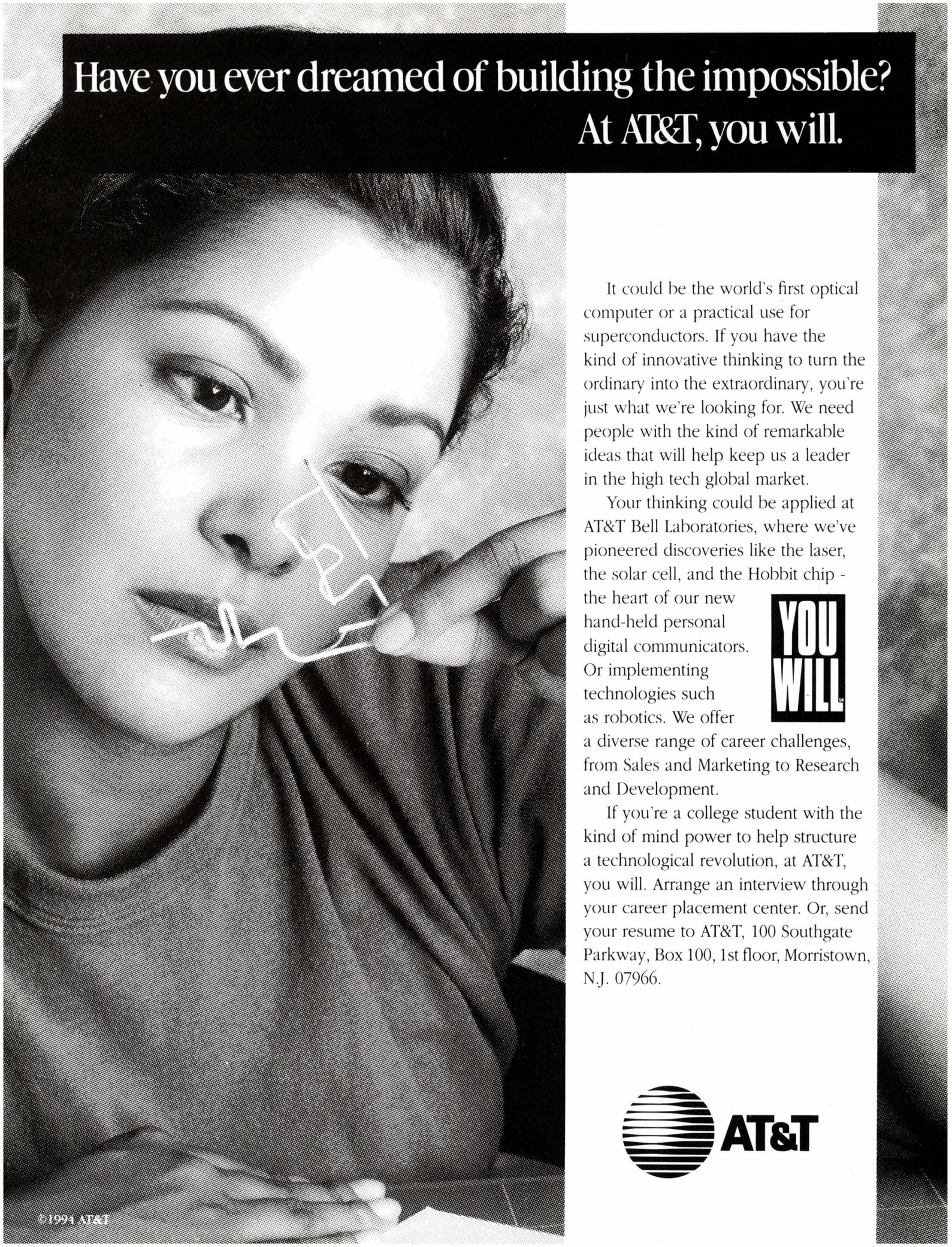
The electric motor directly drives the front wheels, getting its power from the batteries located beneath the rear seats. The propane engine kicks in to provide electricity when the batteries are below 40 percent of capacity. It is the propane engine which provides most of the energy for long trips, as the batteries are used primarily to provide power at the touch of the accelerator. Since the propane engine never physically drives the wheels of the Lumina, it can be tuned to run at maximum efficiency. Typical auto engines have to provide power at varying speeds, cutting into their efficiency drastically.

The team put the Lumina under one significant road test in the month before the FutureCar Challenge. The vehicle traveled from New York to Washington as part of this year's Tour de Sol. The 16 gallon propane tank has a range of 600 to 700 miles, well above the FutureCar Challenge's minimum requirement of a 250 mile range.

Entering the car in the Tour de Sol was "the smartest thing we've done," Randy Senger, overall team manager, told the *Richmond Times-Dispatch*. "It gave us the chance to break the car in, to find out what was going to work and what wasn't."

Next year's competition will focus more on comfort and usage aspects of these hybrid vehicles, concentrating specifically on increased luggage space and comprehensive tests of the vehicles heating and air-conditioning systems. Additonally, the minimum range of the vehicles will be increased to 350 miles.

The Tech team hopes to reduce the weight of their next effort, according to a report in the *Richmond Times-Dispatch*. This year's entry was the heaviest car in the competition. **EF**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TWIST AND SHOUT

Scientists Dissect the Tornado

BY RAY EASTERLING

A team of scientists have tracked down a severe tornado and, using portable Doppler radar, have dissected the inner workings of one of nature's most deadly phenomenons.

While it sounds like something out of a summer blockbuster movie, researchers from the University of Oklahoma at Norman accomplished this feat in reality.

On June 3, 1995, storm chasers collected images of unparalleled detail after setting up their radar 1.8 miles from the funnel of an F-3 tornado outside of Dimmit, Texas.

While the United States has the highest occurrence of tornadoes of any country in the world — about 1,000 each year — predicting where and when these storms will strike has been, and remains, a daunting task.

"Our success rate is only about 20 percent," Joshua Wurman of the University of Oklahoma at Norman told the *Washington Post*. The data collected by the team aids scientists not so much in predicting these tornodoes, but rather has given them greater insight into the inner workings of these great storms.

The data confirmed the theory that the tornado's greatest speeds occur 300 to 600 feet above ground. The research, however, did uncover some unsuspected aspects of the funnel itself. Within the center of the vortex, data suggests that there is clean (non-reflective) air dropping through the funnel at approximately 80 feet per second, which is then shunted upward again near the base of the funnel. Wurman notes this particular feature may not be applicable to all tornadoes.

"Maybe some tornadoes are one-cell vortices" with only the common, observable spiral updraft, Wurman said.

Researchers also noted, the *Washington Post* reports, there is evidence of double cylinder formation withing the funnel. The two form a centrifuge effect, Wurman said, with water droplets spinning within the inner ring, and dirt and debris caught in the outer band.

The storm chasers were hoping to find the infamous "sucker zone" formation, where air is into the base of the funnel at ground level. This is probably due to a com-bination of distance and tech-nology. First, the team was almost two miles from the F-3 twister. Second, the radar beam used by the researchers had only a 1.5 degree of separation. Combining those two factors, the radar could only dissect 200 foot wide swaths of the tornado. The inflow, or sucking, is reported to happen about 70 to 100 feet above ground.

Researchers with the Oklahoma group are hoping for better data collection soon. They are currently using a radar which has 115 foot wide resolution at two miles. Additionally, they are working with a Massachusetts team to develop radar with a much shorter wavelength, and hope to combine their efforts next year. **EF**

Fujita Wind Damage Scale

Number	Wind Speed	Damage
F-0	Up to 72 MPH	Light
F-1	73 to 112 MPH	Moderate
F-2	113 to 157 MPH	Considerable
F-3	158 to 260 MPH	Devastating
F-5	Above 261 MPH	Incredible

Continued from page 11

or environmentally sensitive areas. VDOT also addresses the potential damage to other species in the corridor. Although road-kills will occur, VDOT suggests that several of the bridges will provide safe passage for animals below the road.

According to VDOT, the Smart Road will provide some environmental improvements, at least over a standard highway. Since the Smart Road will save approximately 25,000 vehicles six miles per day, it will actually reduce carbon monoxide pollution. In addition, the technology implemented in the construction of the road may reduce the potential for accidents and hazardous materials spills. Safety enhancement will be a major issue of study during the construction of the road.

This location is, by VDOT's assertion, the best choice for the Smart Road. It is the shortest alignment for the road and disturbs the least amount of habitat. The location also avoids any unique or sensitive ecological areas and will impact fewer sensitive fish and wildlife resources than any other proposed location. VDOT states that this is the preferred route for nearly all other land-use and natural agencies consulted.

In addition to environmental concerns, the VDOT document addresses the economic and practical benefits of the Smart Road to the public. According to VDOT, the Smart Road is more economically feasible than Alternative 3A, the proposed bypass corridor that would connect the Blacksburg and Christiansburg bypasses and reduce traffic on Rt. 460. If the Smart Road is not built, 3A and the Christiansburg bypass will need to be extended to six lanes by the year 2010, at a cost of $17.2 million. Further widening to eight lanes would cost $60-70 million. According to Dan Brugh, the county resident engineer for VDOT, Alternative 3A and the Smart Road were designed to work as a team.

VDOT also insists that relocating the Smart Road, or performing the research along 3A are not feasible alternatives. The current location was chosen after ten years of study and is the only location authorized to receive $4.8 million of federal funds under the Intermodal Surface Transportation Efficiency Act. In addition, Alternative 3A would not provide a long enough test track. The road would have to be closed for days to conduct research, which would result in unacceptable levels of traffic congestion.

The document includes estimates of financial gains that would be created by the Smart Road. The Virginia Tech Center for Transportation Research (CTR) currently has more than $3.5 million worth of research directly related to road design or test bed utilization. According to Ray Pethtel, University Transportation Fellow and head of CTR, this research could include vehicle to vehicle and vehicle to road communication, drive-by-wire or "hands off" technology, traffic and accident management, and pavement technology research. The Center may also be involved in additional projects related to Intelligent Transportation Systems as a part of the National Automated Highway Consortium. Virginia Tech conservatively estimates that the Smart Road will attract over $100 million in research.

VDOT and the Center for Transportation Research hope that this research will in turn attract high-tech companies, including wireless communications, fiber optics, electronics, sensors and sensor integration, robotics, software development, computers, transportation, and defense conversion, to Montgomery County. Additionally, the construction of the Smart Road will create 300 jobs for eight years. All in all, the $100 million expenditure for the road could result in $267 million in benefits to the community. "The Smart Road will put Virginia Tech and Montgomery County on the cutting edge of transportation technology," said Pethtel.

Shirene Parsons, an area resident and president of the local chapter of the Sierra Club, does not feel that the estimated benefits warrant the construction of this road. According to Parsons and other opponents, the Smart Road is simply a bad idea. Parsons filed a lawsuit against the Federal Highway Administration, VDOT, and the U.S. Department of Transportation in May, claiming that the construction of this road is beyond the jurisdiction of federal and state transportation authorities. The Smart Road is "public money being used for private benefit," Parsons said. VDOT was later dropped from the suit, but it is still pending against the other two agencies, as is a similar lawsuit filed by the national Sierra Club, the New River Valley Greens, and the New River Valley Environmental Coalition.

When Shirene Parsons moved to Montgomery County five years ago, she was attracted by the lack of congestion and the abun-

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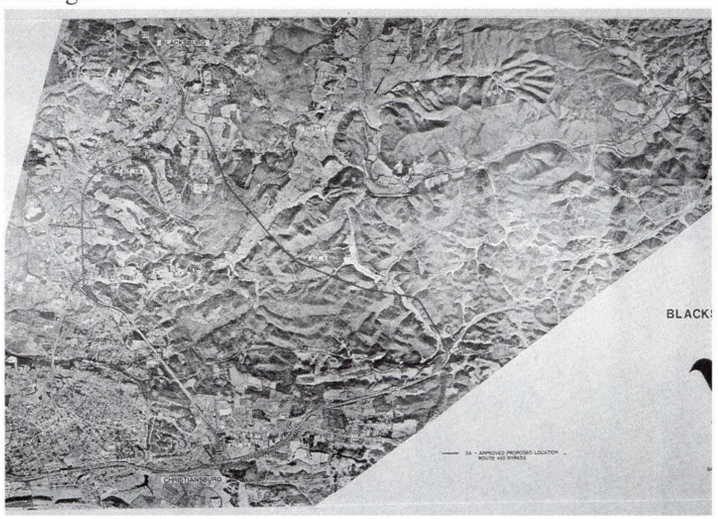
Continued from page 24

dance of natural beauty. With the advent of the Smart Road, Parsons fears that these things will change. "The Ellett Valley land is special and fragile, and it should be protected," said Parsons. She feels that the ugly companions of highway construction, noise, accidents, reduced property value, and the possibility of groundwater contamination, will harm the land on which the Smart Road is to be built. Parsons contends that the land is protected by the AFD laws because it is fragile and it should not be disturbed.



The Smart Road, or Alternate 6, is shown as the Right alignment north of Route 460. This route carries the road through the Ellett Valley to I-81.

Parsons insists that she is not opposed to transportation research and she is aware of the need for an alternate entrance to Blacksburg from Interstate 81. "The Ellett Valley location is not necessary," said Parsons, "this research could be conducted anywhere." Although VDOT has said that the chosen location is the best choice, other opponents of the road agree with Parsons. Michael Abraham, a local businessman and vocal Smart Road opponent, said the Smart Road is "not the best solution" to the needs of the area. He suggests that VDOT develop Alternate 3A to alleviate traffic congestion and that Virginia Tech use its own property for research purposes. VDOT has said that 3A and the Smart Road must work together, but opponents such as Parsons and Abraham are not convinced.

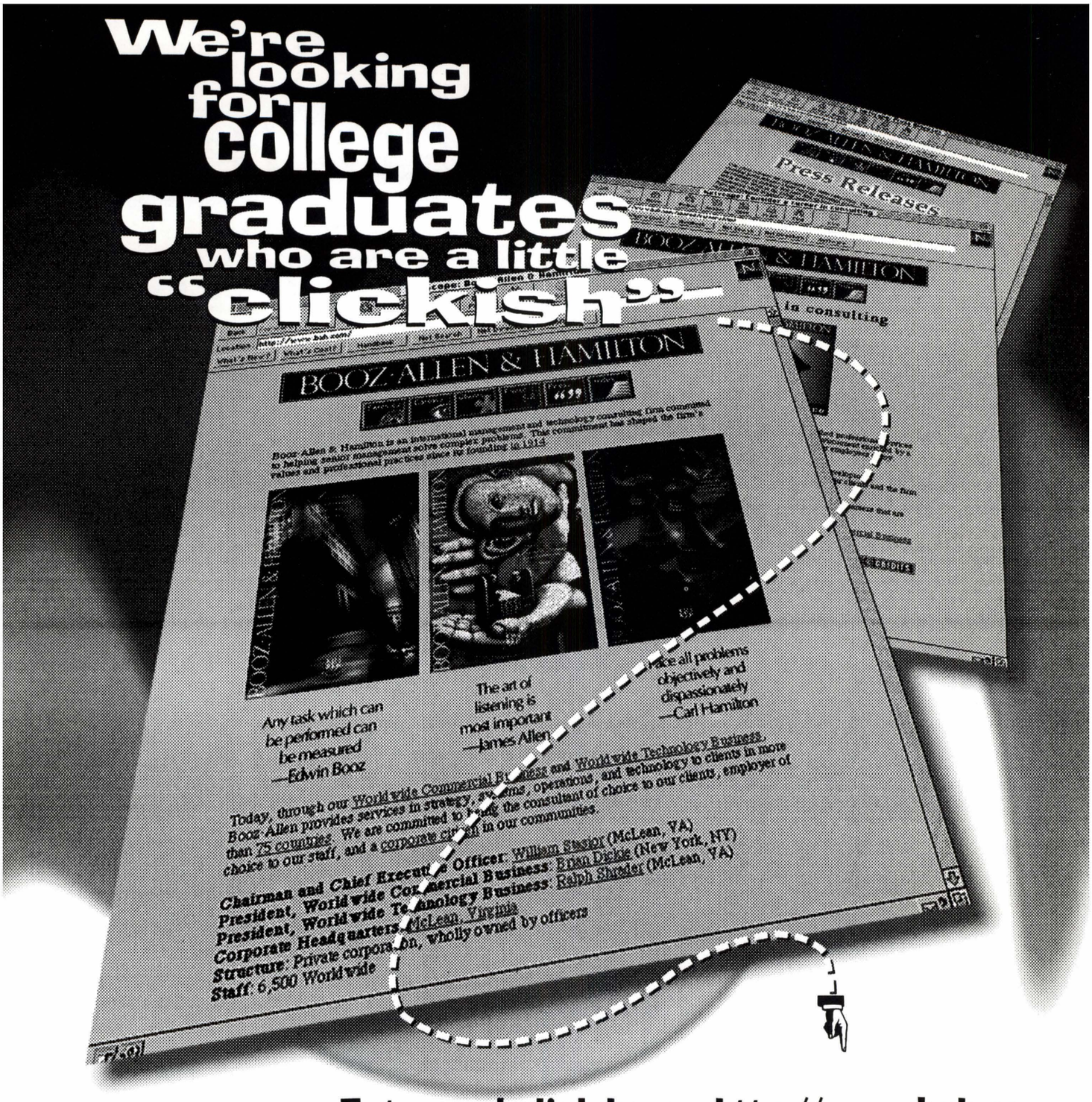
An additional concern with the Smart Road is the funding. Parsons has called this the "road to nowhere." Of the $98 million needed to build the road, only $6 million worth of funding has been approved and an additional $25 million is planned for allocation. This concerns Parsons, who worries that the road may never be completed. "Other roads could be improved with this money," said Parsons. She believes that this is the wrong way to spend taxpayer money. Michael Abraham agrees. "The taxpayers are investors in this project," he said, "but they will have no way to recoup any losses." Opponents of the Smart Road like Parsons and Abraham see the projected benefits of this road as merely projections, and they do not feel that public money should be spent for less than concrete gains.

While many see the involvement of Virginia Tech as beneficial and positive, opponents of the Smart Road disagree. "This will affect the relationship between Virginia Tech and the community," said Parsons. By pushing for a "from the ground up" test bed in the Ellett Valley, Virginia Tech has "shown a lack of integrity," she said. Abraham, a 1976 Virginia Tech graduate in Mechanical Engineering, feels that this project is poor from an engineering standpoint as well. "Engineers should provide for the needs of the public, not the other way around," he said.

On June 17, 1996, after months of discussion and a 90 minute public address session, the Montgomery County Board of Supervisors voted 4-3 to accept VDOT's request for the land in AFD-7. "The system has failed us," said Parsons in reaction to the vote. She also said that "the fight is not over." "I am confident that the lawsuits will go all the way and that we will win," she said.

Meanwhile, the Center for Transportation research has begun to discuss ground breaking. Pethtel said that the advertisement for the construction contract may be let by late March 1997. Some research, particularly in the area of pavement research, will start the day construction begins. Several more projects are in the wings and will begin once the two-mile test bed is complete.

"I am excited for Virginia," said Pethtel, "because this project will put Virginia on the cutting edge." **EF**



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