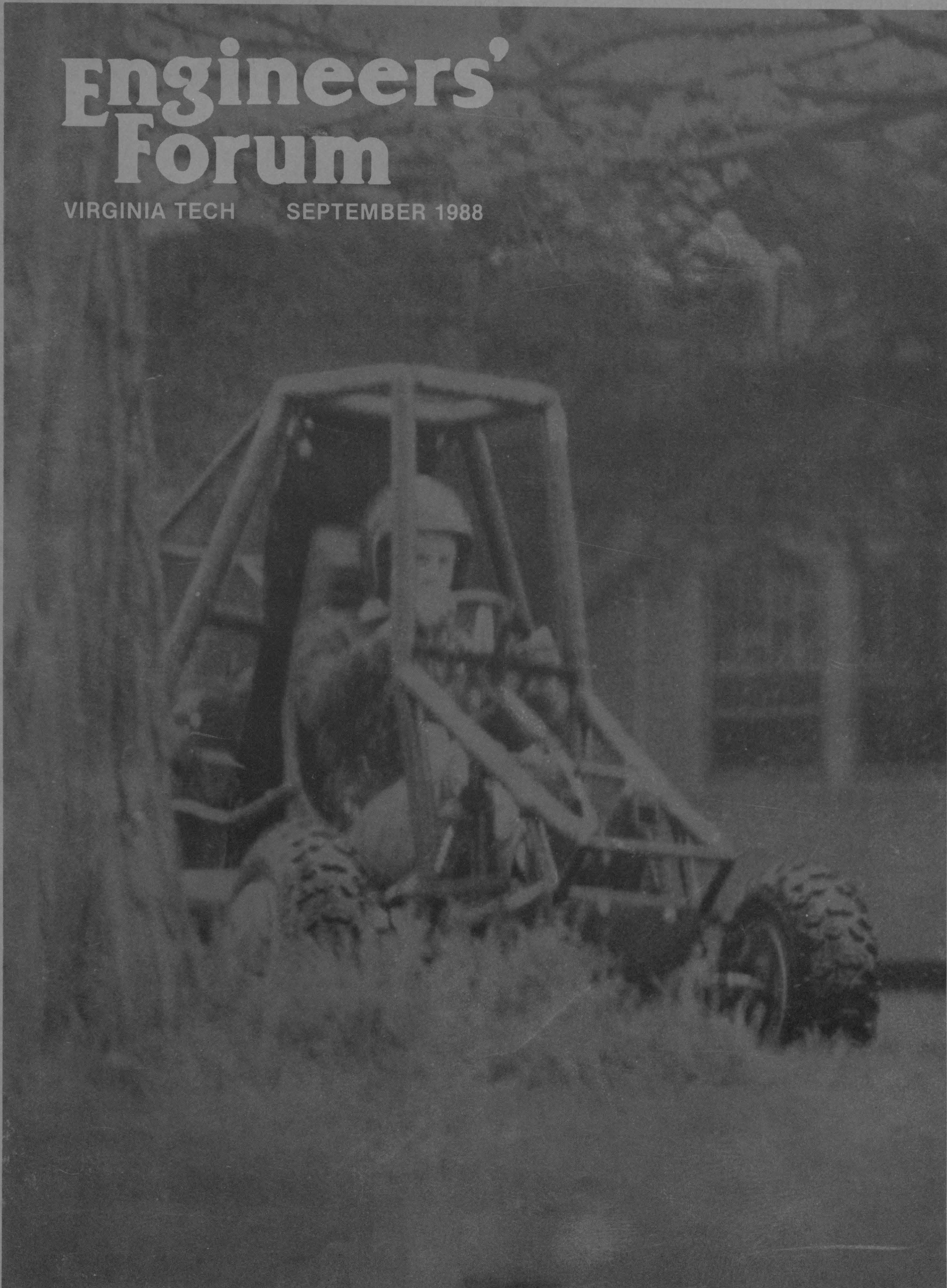
Engineers' Forum

VIRGINIA TECH SEPTEMBER 1988



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NAVY OFFICER.

"YOU ARE THE NAVY, YOU ARE TOMORROW."

On the cover: A member of Virginia Tech's ASME chapter pilots their mini-baja through a day of wet-weather testing at the duck pond last spring. Photograph by Theresa Gidley.

Volume 7, Number 1
September, 1988

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The opinions expressed in the *Engineers' Forum* do not necessarily reflect those of the administration, faculty, or student body of Virginia Tech.

In Praise of Independent Study

You're an engineering student, in your third year. Assuming you're still reasonably on schedule, you are now at the heart of your engineering education. You're done with all of the basic prerequisite courses, ready to learn about the latest developments in optical disks, supercomputer design, or whatever. But wait a minute, you think, the school doesn't offer a course on yttrium-oxide superconductors — what can I do?

Well, some kind administrator came up with an option for you ambitious undergrads. It's called independent study, and it's available in all of Virginia Tech's ten engineering departments. The beauty of the program is you are the one who decides what you will study. This allows for virtually unlimited flexibility in choice of topic and the approach to studying it.

The first step is to approach the department with which your subject is associated. They will likely provide a form for you to fill out. But before submitting the form, you must locate a professor who will oversee your studies. Once the topic is approved, the professor writes up a syllabus for the you to follow. A professor will likely allow student input on the content of the syllabus, but of course this will depend on the professor. In any case, the studying and research done on the topic will usually culminate in a technical paper of some length. The student will be evaluated (for a grade and credit; this study is not unrewarded) principally on the paper, but also on preliminary work.

Independent study is a great opportunity to study a topic of interest, and get credit for it at the same time. Also, with a well-written paper to show for your efforts, you can enter any of a number of technical writing contests (including the *Engineers' Forum's*). That can translate into cash or a published article for your resume, or both. In short, you have much to gain from pursuing your interests. Take advantage of the opportunity!

Andrew E. Stalder
Editor

Engineers At Speed: Formula SAE

by Andy Stalder

Ever wonder what it would be like to design your own race car and build it from the ground up? The culmination of this fantasy would be for the car to win the World Championship in Formula One — with you at the wheel, of course. (At this point, you lift your head from the desk and realize that you have learned zero about Thermodynamics in the past half hour.) Well, some ambitious Virginia Tech engineering students have been working on the realization of this fantasy — with their development of a Formula SAE car.

Just what is a Formula SAE car, you ask? It is an open-wheeled — i.e., no fenders covering the wheels — single-seat race car which is conceived, designed, and constructed by student engineers. The car is intended to compete in the annual Formula SAE competition, which is sanctioned by the Society of Automotive Engineers (SAE) and by the Sports Car Club of America (SCCA). The car must conform to some regulations, but much flexibility is given to designers to enhance creativity. For instance, a car must have a minimum wheelbase of 60 inches; but the car unrestricted in the areas of curb weight, track, and ground clearance. Cars from engineering schools around the country will compete this year; last year, the University of Texas at Arlington was the overall winner.

Virginia Tech's student chapter of SAE is entering the competition for the first time this year. In the initial stages of the project, the club decided it would be best to break down into design groups, responsible for different systems: engine and drivetrain, chassis and suspension, etc. Every week, these groups would meet to brainstorm about how to approach the design problems in their area. Much was accomplished in the area of planning; the next step was to carry out the tasks. Club President Rudy Consolacion drew up a design and construction schedule for the project. However, when a few weeks passed and little active work was done, it appeared that the project may have been too large an undertaking.

"When it looked like nothing was going to get done, morale started to go down, and people dropped out," says senior Mitch Wenger, Team Leader of the project. Wenger says that he and nine other Tech students — Steve Booth, Todd Bowlands, Todd Bowman, Glenn Covington, Ashley Dudding, Curtis Jacobson, S.-Rodney Raganit, Mills Robinson, and Khoi Ta — have done ninety percent of the work on the car. And at this stage, three weeks before the competition, the work is frantic. "Right now, it's basically like, if you see a job which has to be done, if someone else has already started it, you still do it," Wenger remarks.

Despite the rush to put the finishing touches on the car, the design process was very methodical. In designing the frame, the group tried to keep the size down to a minimum to conserve weight. The frame was designed to incorporate as many straight members as possible, to eliminate the stress concentrations associated with bending. Mock frames were modelled around the largest potential drivers in the group. The resulting frame is shaped much like a shoe box. The frame incorporates a tall roll bar to protect even the tallest driver in the event of a rollover.

Obviously, stresses must be considered in the design of a frame. In the case of an automobile frame, the idea is not for the chassis to support a static load (though the SAE's constructed frame will support 2000 pounds); the intention is to build up as much torsional rigidity as possible. To understand why, one must consider the aims of a race car.

In travelling around a track, an ideal race car would have all four wheels planted to the road constantly. With all four wheels planted, the car has more traction, and therefore can corner at higher speeds. Also, to make maximum use of the engine's power, all of the driving wheels must be planted firmly to the road. Of course, the car also could not steer without having the steering wheels in contact with the road.

Now enter the suspension. Very generally, the suspension acts as a vital connection between the rolling wheels and the chassis. The suspension transmits the loadings on all four tires to the chassis. But if the chassis is not sufficiently rigid, those loadings will cause the frame to twist. This twist could cause some wheels to lighten or even lift off the pavement; and the car would not accomplish the goal of continuous contact with the road. Thus, chassis rigidity is a paramount concern for the race car engineer.

With this consideration in mind, the group set out to construct the frame. Based on rough calculations and the experience of some club members, the group decided on .060" square tubing for the construction of the frame. After the group welded the frame together, a finite element analysis (FEA) was performed. Through FEA, it was revealed that for a maximum couple applied to one end of the frame (with the other end fixed), the frame would achieve 6 degrees of deflection. (The amount of deflection illustrates the rigidity; a well-designed racing chassis will achieve less than one degree of deflection). Due to this high degree of deflection, the group elected to utilize a stressed-skin chassis: thin sheets of aluminum, in this case, riveted tightly to the frame members. The aluminum sheets act just as the name implies — as stressed members. With the new chassis, the frame achieves somewhat less than 2 degrees of deflection.

The front and rear suspensions were both uniquely conceived by team members. The front suspension was designed to have a roll center 2" above the ground, and 2" of suspension travel was designed in. The big consideration here was to keep the roll center as stationary as possible. A low, stable roll center maximizes traction for the front wheels; their traction is crucial to handling and steering. The rear suspension consists of two parallel radius rod sat each corner.Long, thin radius rods provide a longer moment arm, while allowing thinner rods to be used (which translates into less weight).

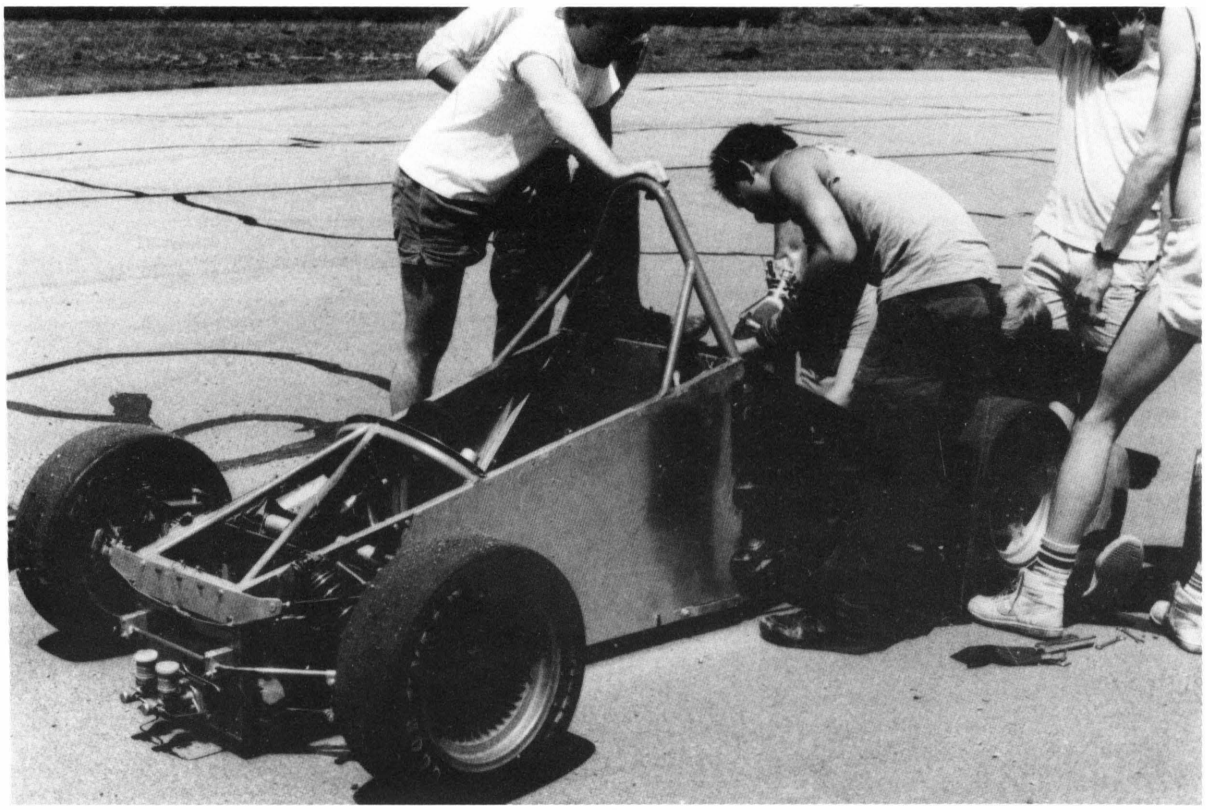
For a powerplant, the group really got lucky. Club member Khoi Ta elected to loan his spare Kawasaki Ninja 600 motor for the project. The rules stipulate engines must be four cycle and displace no more than 610 cc. Given this engine's size and its high horsepower rating (65 hp stock), it would seem that the Ninja motor is an ideal candidate. For those not familiar with the kind of performance packed into these half-liter horsepower heavyweights, here are the vital stats: the 592 cc water-cooled Ninja four has two overhead mechanical cams, four valves per cylinder (two intake, two exhaust), and an 11:1 compression ratio. Each cylinder is fed by its own carburetor; spent gases leave the engine via a four-into-one, low-restriction exhaust system. Though the engine makes peak power at 10,500 rpm, it will rev freely to 12,500 rpm. These stats seem more appropriate for the Monaco Grand Prix than for a motorcycle!

However, the rules also present another obstacle. In the interest of making the engines more equal in power, a 20 mm restrictor must be placed between the carburetor (only one carburetor is allowed) or throttle and the engine. To put this into perspective, the stock engine has four 32 mm carburetors (note that the number of carburetors here is not significant; the size of each is). Of course, simply putting the restrictor plate in place would not optimize the flow of air to the cylinders; what is needed to combat turbulence and flow separation is a gradual transition upstream and downstream of the restriction. This is accomplished with a converging-diverging nozzle (with the 20 mm restrictor at the center of the nozzle).

The group also designed an intake manifold for the application. The manifold utilizes short runners to maximize throttle response. The exhaust of the engine remains stock back to the collector; the end exhaust pipe was designed by the students.

The Kawasaki powerplant retains its six-speed integral transmission; gear changes are accomplished by depressing a clutch pedal and throwing a lever forward or reverse. The front sprocket turns a chain which runs to a rear sprocket within a modified Subaru differential. The differential's ring and pinion gears were removed; the rear sprocket (which was custom cut by a Kawasaki dealer) was mated to the planetary gear. The Subaru differential was chosen because of its small size and relatively light weight. From the differential, the power is transmitted to the rear wheels through Plymouth Horizon spindles. The difference in tire size between the car and the original bike is offset by the smaller rear sprocket utilized; hence the effective gear ratios remain the same.

Despite all the power on tap and the car's light weight (estimated around 600 lb), stopping will be an easy affair. With dual master cylinders and front and rear disks (pirated



Crew members troubleshoot an engine malady during testing weeks before the national competition.

from a Rabbit and a Horizon, respectively), the car's braking system would be sufficient for cars many times the Formula SAE's size.

Steering effort is channeled through a unique rack-and-pinion unit which allows one turn lock-to-lock. While steering effort may be heavy, having one turn lock-to-lock is a plus on the tight and twisty competition course. As one team member pointed out, you don't want to be steering hand-over-hand in a 1.5-g corner!

Inside the cockpit, the driver is kept informed with a tachometer and coolant temperature gauge, and oil pressure, power, and neutral lights. Just who will see the competition from this position will be determined in trials before the competition.

The team's first test session, held at the Virginia Tech Airport, could best be described as a learning experience for everyone involved. Since most team members had never driven anything even close to a true race car, first impressions behind the wheel were more of shock and awe than anything else. Cornering at well over 1 g has a way of causing such a reaction. After everyone was given an introduction to this performance, the team settled to some serious tuning.

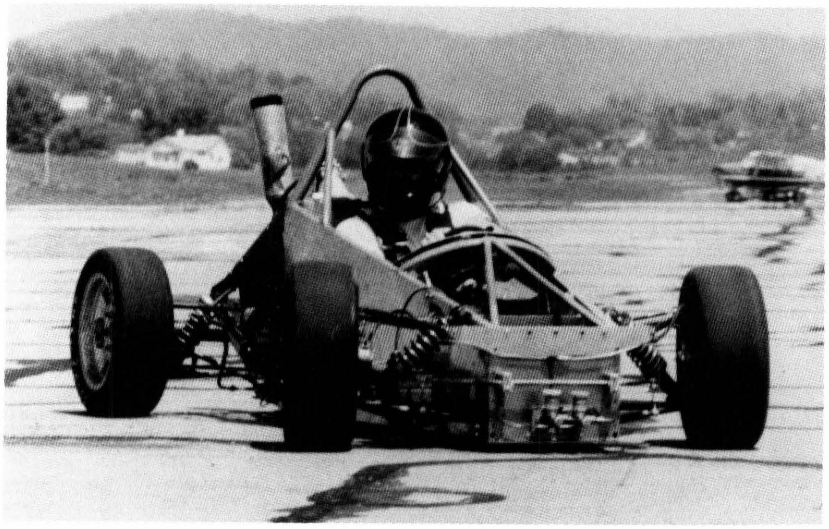
Poor carburetor performance was the first trouble encountered. Initially, the engine appeared to be flooded; but once it was brought up to operating speed and temperature, its response was still balky and uneven. Black smoke emitted from the tailpipe indicated an overly rich mixture. The plugs were inspected, and it was found that the middle two cylinders were burning an overly rich mixture, while the outer two were slightly lean. This oddity was attributed to an insufficient intake manifold design: the middle two runners were lower and straighter than the outer two, and so received a greater portion of the mixture (due to gravity and ease of flow). For the time being, though, the problem was solved through tuning the carburetor.

Suspension tuning received the most attention all afternoon. At first, under hard cornering, the inside front wheel was lifting. To combat this, the group experimented with a myriad of suspension settings. A course was laid out on the airport ground to simulate the competition situation. After hours of testing, the group settled on a setting which provided maximum on the course's tight hairpin corners.

When the car was properly 'dialed-in', some competitive lap times were taken for several drivers. Yet this did not signal that the car was ready for competition; some problems persisted. The engine ran very hot all day, causing the group to construct a makeshift airscoop for cooling. Additionally, the gearing on the car was far from ideal. Launching the car in first with the engine wound to 9 grand caused a slow ease-away that belied the car's tremendous power-to-weight ratio. Yes, much work still remains.

Tech's effort in this competition is definitely a low-budget one. For example, many of the teams — such as Georgia Tech, Texas, and Cornell — all admittedly spent over $13,000 on their efforts last year. In contrast, Tech's budget at the time of this writing was $1200. Still, the project would not have been possible without numerous donations: tires from Goodyear, synthetic oil from AmsOil, aluminum from Alcoa. Also, the club is thankful for the miscellaneous help from the ME shop next to their lab — their help was the biggest donation of all, according to one. And the project would not have been possible without the assistance of the team's faculty advisor, Assistant Professor R.J. Roby. Project SAE was a massive undertaking for the small handful of students involved. But, judging from the way students talked even as they worked, they loved every minute of it.

Editor's Note: At the competition after this issue went to press, Tech's laborious efforts were rewarded — to an extent. The team won the maneuverability portion, and had turned the second fastest lap in the endurance race before they cooked the motor. Were it not for this failure, the team would have likely had a very good shot at second place overall. As it turned out, they ended up tenth overall. Not a bad showing for a first attempt.



Theresa Gidley

A team SAE driver explores the handling characteristics of the newly-constructed car. After each brief run, small adjust ments are made to the suspension to fine-tune the car's handling.

Faculty Focus: Sporn Award Winner Don Morris

As an undergraduate engineering student, Don Morris planned to never darken the doors of a university again. But after a short stint with industry and attending graduate school part-time, he decided to make teaching his career objective.

This past 1987-88 academic year marked his tenth anniversary in the engineering classroom at Virginia Tech, and his efforts were rewarded with one of the highest honors the engineering students can bestow on a faculty member — they selected him to be the Sporn Award recipient for teaching excellence.

The obvious reaction — surprise — was registered by Morris when he was informed of his award. But he also jokingly added, "I'm nice, but not that nice."

Why was this engineering science and mechanics faculty member selected as the students' choice among the approximately 300 college faculty members?

In the selection process, the Student Engineers' Council solicits nominations from all engineering students. Ballots are collected by the SEC, and the top five professors receiving the most votes are considered to be the finalists. At a closed meeting of the SEC, students who nominated each of these five finalists speak to the entire SEC on the reasons why each faculty member was nominated. After the presentations are made, other members of the SEC speak to their knowledge of the faculty members. A secret ballot vote is then taken.

The students who spoke for Don Morris talked about his willingness to give students a second chance on tests, and his late-night help sessions when he stays until the last student under stands the material.

Commenting on these reasons, Morris smiled as he said he usually outlasted the students in the work sessions. "Most of them are worn out after about two hours."

As for the option of taking a second test, he said, "My intent is not to have a class with a low average. I want them to understand the material, and it takes a tremendous amount of effort on their part to take tests a second time."

This concern for students prompted him to devise a special formula for the grading of the two tests. "The formula I use combines the grades from the first and second test which can make the final grade better or worse, depending on how the student performs the second time," Morris explained. With this plan, most students are able to improve their grade as well as understand the material.

Morris estimates his innovative approach to grading probably costs him an additional 25 to 30 percent of his time, but the results are well worth his efforts.

"There is a tremendous burden on students today. They are required to enroll in difficult courses at a much earlier age than when I went to school. There are also more economic pressures on them."

Morris says he has also developed more sympathy for students since his daughter is a sophomore in engineering. "I see what she has to do, and I often act as her private tutor without pay," he laughs.

As an ESM faculty member, Morris teaches undergraduate courses for all engineering students, as well as some upper level classes. "I think teaching undergraduates is very important...Students today are a different breed. They seem to be more materialistic, but they also appear to be more willing to work."

The ability to be innovative in his teaching is one reason why Morris enjoys the challenge. "I taught at the United States Military Academy as a visiting professor, and although the classes were small (no more than 15 students), the teaching is structured for the professor...Here at Virginia Tech, the common thread for the different sections of the same class is the syllabus. Tests and grading styles are all different. I am able to give my classes my own very detailed objectives for the courses."

Morris believes a "stroke of luck" played a role in his selection as the Sporn Award winner, but that is not what the students believe. One student who nominated him put it simply: "He really is a great teacher."

Tech Holds First Annual Engineering Open House

by Noel Schulz

The Virginia Tech chapter of Tau Beta Pi, the engineering honor society, sponsored the First Annual College of Engineering Open House on March 22, 1988 during Engineers' Week. Between 1200 and 1500 people were able to see the instructional and research facilities in each of the different branches of engineering.

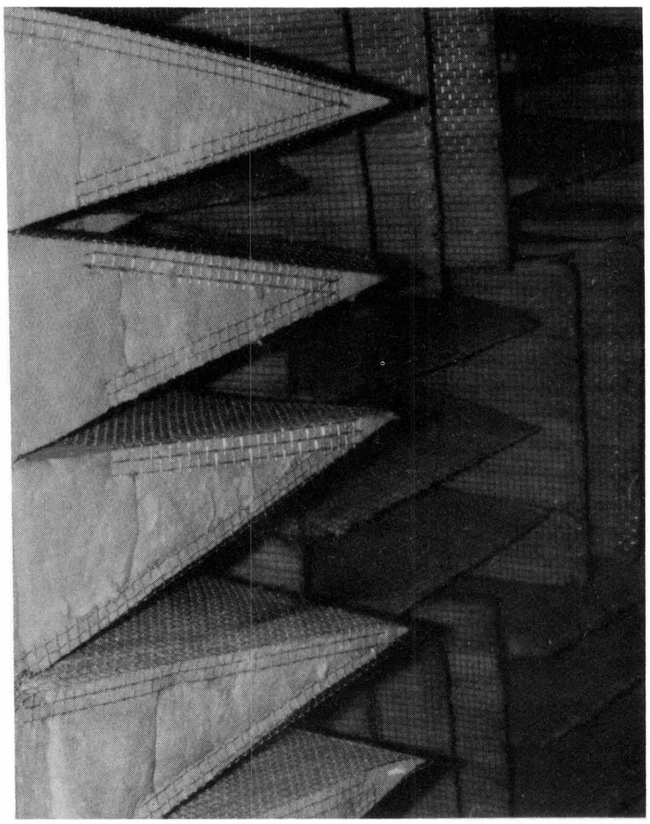
Many professors, graduate students, and undergraduate students prepared exhibits and displays. Dr. Felix Sebba of Chemical Engineering had several Touch-and-Feel displays where visitors could participate. Agricultural engineering also had a very interesting exhibit with tours, games, and prizes. Other departments held demonstrations and tours. Engineering Science and Mechanics had beam breaking demonstrations. A popular tour was the Aerospace Engineering wind tunnels.

The Open House gave visitors a chance to see what engineerings is and how Virginia Tech is teaching and researching in engineering. Visitors ranged from members of the Board of Visitors and other Alumni, to prospective freshmen and their parents, to current students, faculty, and staff, and their families. Some distinguished guests included Board of Visitors member Dr. Edwin Harrison, and Committee of 100 member Philip Compton.

Prospective freshmen were able to tour the engineering facilities as well as find out more about Virginia Tech. Dean Pamela Kurstedt held information sessions encouraging these prospective freshmen to choose Virginia Tech. Present freshmen used this event to help decide which branch of engineering to enter.

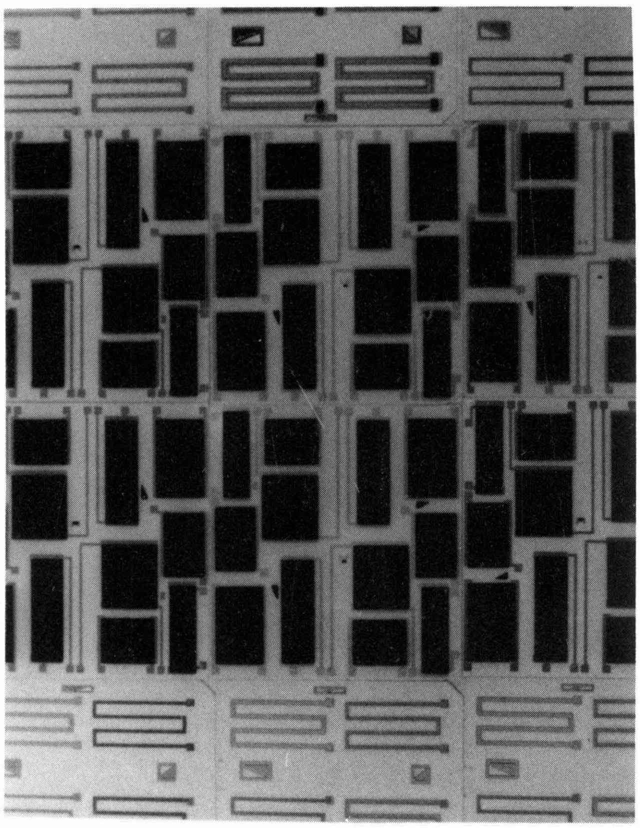
The Open House was possible through the financial support of Tau Beta Pi, Student Engineers Council, College of Engineering Dean's Office, and the Student Budget Board. Chairpersons, Ruth Bowman, Lane Hinkle, Noel Schulz, and Elizabeth Walke, would like to thank those that helped out with this large undertaking.

Overall the efforts of Tau Beta Pi, Open House organizers, engineering societies, faculty, and students proved successful and the event highlighted the College of Engineering. Tau Beta Pi is now planning the Second Annual Open House. This year's open house will be Friday, February 24, 1989. Anyone interested in helping or finding out more about Open House should call Greg Bloch (president of Tau Beta Pi).



Theresa Gidley

Inside Mechanical Engineering's anechoic sound chamber.



Theresa Gidley

A scene from the Electrical Engineering department's Hybrid Microelectronics Lab.

Smart Structures Laboratory

by Karen Koger

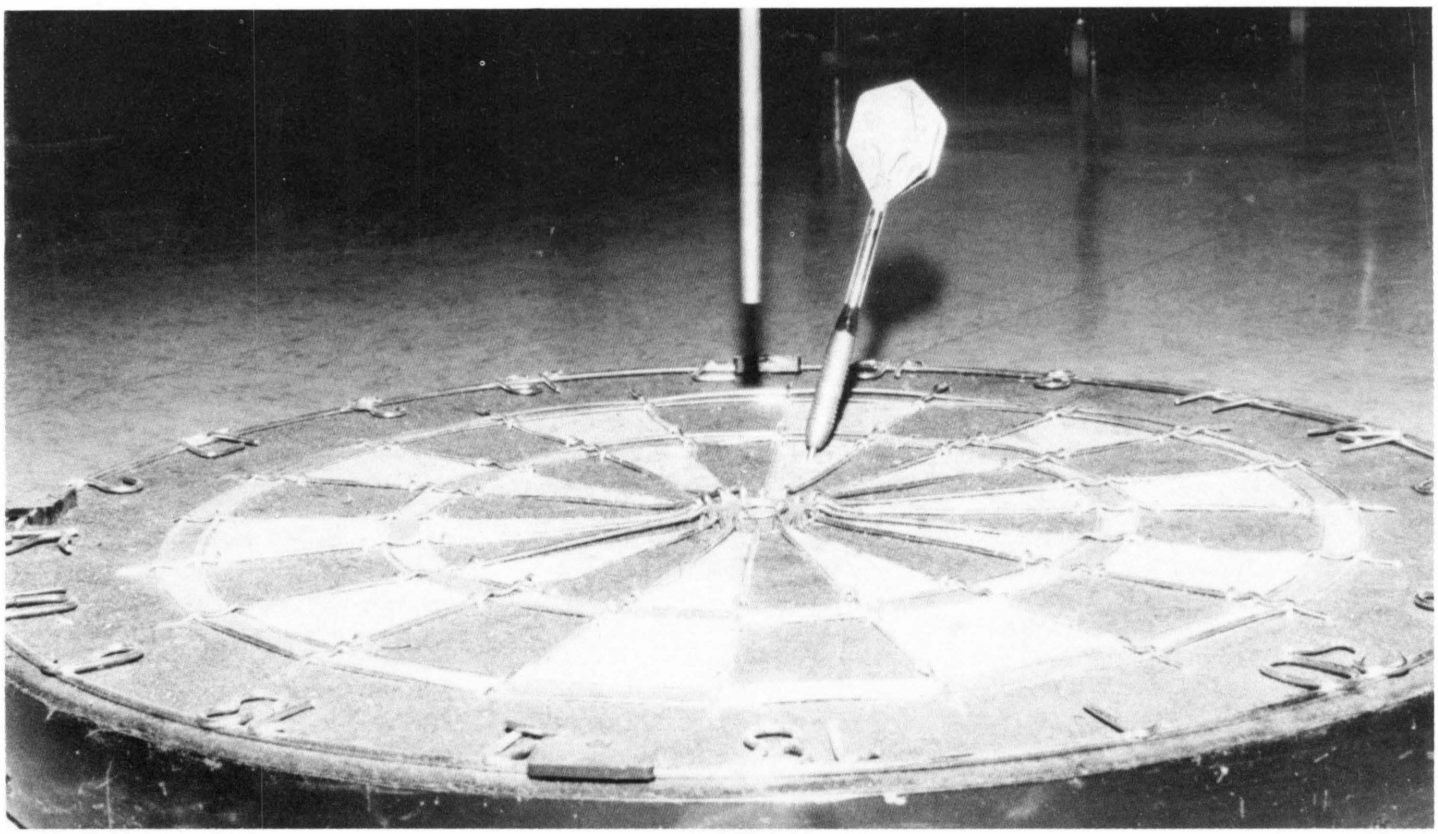
The Smart Structures Laboratory, located in the Mechanical Engineering Department in Randolph Hall, draws attention from many people because of the huge truss that hangs from the ceiling. The lab was also a popular attraction during the College of Engineering Open House because of the "magic" Nitinol wire that would uncurl itself when heated. The truss and the Nitinol may look like fun toys, but are actually being used in some very serious research on smart structures and materials, a relatively new area of technology.

A smart structure is defined as a structure that has the capability to sense the environment and/or its state within the environment, make a decision based on this information, and produce a desired response based on this decision. The major distinction of smart structures is that these capabilities are internal. Typical structures have external sensing and response, with a human operator making the decisions.

The laboratory staff is a unique mix of professors and students from three different disciplines of mechanical engineering. Dr. Charles F. Reinholtz specializes in kinematics, Dr. Harry H. Robertshaw in controls, and Dr. Craig A. Rogers in solid mechanics. Each of these professors are assisted by graduate students and the entire staff works together toward the common goal of designing and building a smart structure.

Kinematics, Dr. Reinholtz's area of research, is the study of the constrained motion of interconnected rigid links, such as those in a truss configuration. The structure currently being used in the lab is a variable geometry truss (VGT). A VGT, also called an active truss, contains some variable-length links which allow it to change shape, so the kinematics of a VGT differs from that of a static truss. VGT manipulators can be constructed using planar (2-dimensional) or spatial (3-d) configurations. A chain of VGTs can form a highly dextrous manipulator that still has the stiffness of a truss. This type of manipulator could extend and "snake" through complex passageways or around obstacles to perform robotic tasks. It could also be used as an adaptive structure to decrease vibration or control the position of a supported object. The truss currently in the Smart Structures Laboratory has two bays. Future plans include building a ten-bay VGT manipulator.

Dr. Robertshaw is working with smart structures in the area of structural vibration control. In a simulation, a VGT was shown to have a greater control over structural vibrations than more conventional methods such as proof masses. Both planar and spatial vibration reduction experiments are being performed. The planar experiments are being conducted with one plane of a tetrahedral-tetrahedral truss controlling a beam that is constrained to almost planar motion. The spatial experiments are being performed with an octahedral-octahedral truss controlling a rod. In each case, the trusses have three variable-length links actuated by machine screws driven by dc motors. The control scheme

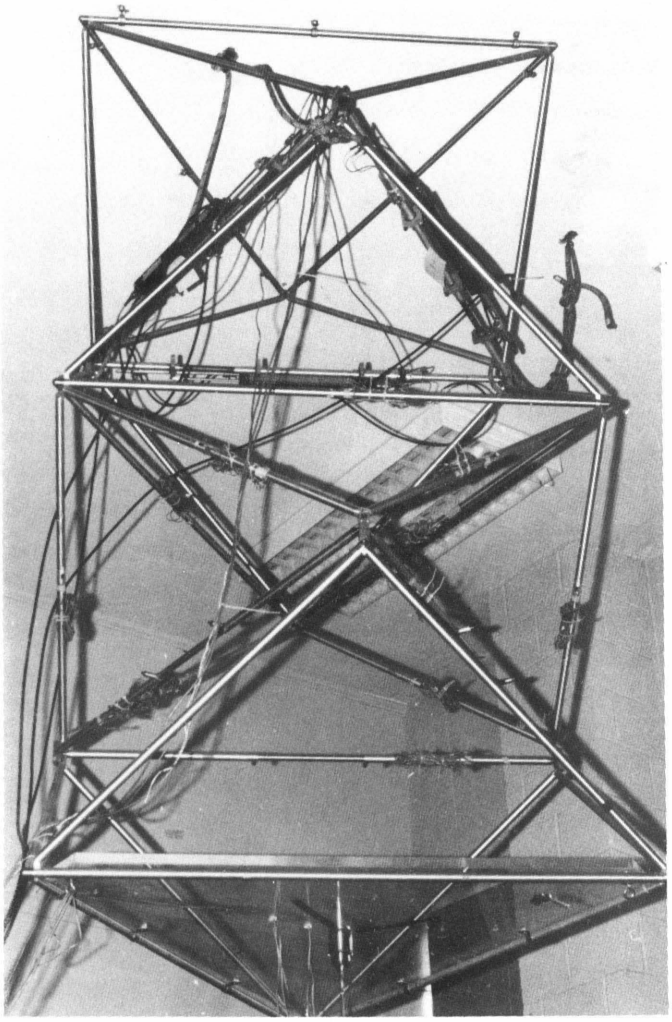


Theresa Gidley

Yes, this is part of the smart structures lab — not some teacher's method of assigning grades. The dart board helps determine the accuracy of a 'remembered' shape.

uses motors to dissipate the energy in the vibrating rod. Measurements of the rod position are sent to a computer which calculates the motor response required to oppose the vibration of the rod. Significant vibration reduction has been observed with reasonable correlation to the analyses.

The actual materials that make up smart structures are being developed by Dr. Rogers. These smart materials, or adaptive materials, utilize a shape memory alloy in a laminated, fiber-reinforced composite. Adaptive materials are able to change their physical geometry or alter their physical properties. These materials are used as actuators for force, motion, and/or variable stiffness.



Theresa Gidley

The large truss used for research in the Smart Structures Laboratory, located in Randolph Hall.

Nitinol is the shape memory alloy being used in the composite beam used for experiments in the Smart Structures Lab. The Nitinol is drawn into a wire shape (0.031 inches diameter) and annealed at a high temperature to define its "memory shape." After being plastically deformed, Nitinol can return to its "memory shape" through the addition of heat. The use of a Nitinol-reinforced composite in a VGT will eliminate the need for external motors for vibration control and other applications. The primary focus of the research is characterizing the actuator and sensing (temperature and strain) capabilities of Nitinol and producing prototypes that demonstrate motion control, vibration control, and acoustic control.

The Smart Structures Laboratory staff is collaborating on this research with the Fiber & Electro-Optics Research Center in the Electrical Engineering Department and the Center for Composite Materials and Structures. Fiber optics are being considered for use as strain sensors in smart materials and structures. Presently, strain gages are being used.

Smart structures and materials, which contain distributed actuators, sensors, and microprocessor capabilities, can be used in many applications requiring adaptability to changing external and internal conditions. External conditions may consist of environment or loads. Internal conditions may be damage or failure to portions of the material or structure. A current technological need is for structures and materials that can be left unattended for long periods of time in isolated environments, such as submarines, aircraft, or a space station, or in biomedical applications, such as an artificial heart. Smart structures and materials have the capabilities to adapt to changes in the environment or damage to the structure without input from a human operator and would be ideal for isolated environments. A structural member made of a smart material can perform many different adaptive responses to many different kinds of situations. For example, this member could compensate for deterioration in absorptivity and thermal expansion properties which cause an excessive change in length of the member, control the motion and vibration of the structure, or change load paths in the structure so the component can be replaced or repaired before causing system failure.

Applications for smart materials and structures include:

- active vibration control and acoustic suppression for submarines, robot manipulators, and propeller aircraft.
- failure detection and prevention for bridges, walkways, and phone and electrical cables.
- active control of helicopter rotor blades.
- artificial heart valves and pumps.
- thermal expansion balancing.
- robot manipulators.
- thermally activated valves, ducts, and switches.
- structural dimension adjustment and environment adaptation for antennas.

The development and production of smart structures and materials could have a great impact on technology in many different disciplines and many more applications are likely to be discovered.

For more information on smart structures, please contact Drs. Reinholtz, Robertshaw, or Rogers.

EXPO 88
A TECHNOLOGY SHOWCASE

War Memorial Gym
Monday, September 12, 1988 12:00 - 5:00
Tuesday, September 13, 1988 9:00 - 4:00

by David Ling and A. J. Gorenc

As students adjust to Virginia Tech's first semester, the Student Engineers' Council (SEC) will be busy hosting EXPO 88, its 9th annual technology showcase. Virginia Tech's EXPO 87 was the second largest technology exposition in the country with an attendance of 94 high-tech companies. EXPO 88 promises to be even more successful than last year's with an anticipated turnout of 100 companies.

This year's EXPO, normally held in Squires, will be held in War Memorial Gym due to the present construction in Squires. Each year, representatives from local, national and international corporations as well as governmental agencies set up information display booths to meet and talk with students.

EXPO provides companies exposure to a large number of tech nical as well as non-technical students. For seniors and gradu ate students, EXPO is an excellent opportunity to informally meet with company representatives to discuss various topics ranging from what type of products a company makes to the types of jobs a company has to offer. It also provides students a chance to submit resumes and personal data sheets and perhaps schedule a formal interview.

Juniors and other underclassmen can also benefit from EXPO by investigating co-op and summer internship opportunities in addition to providing a forum to discuss what engineers do in the real world.

In addition to companies and governmental agencies, all eleven engineering departments will be represented through their professional and honorary societies. They will set up booths and demonstrations to familiarize students with each of the engineering disciplines. The University Cooperative Education Program and the University Placement Services will be attending to inform students of the services and opportunities that they provide.

A.J. Gorenc, EXPO 88 chairman, began planning EXPO last February. In tackling such a large project, A. J. is directing the efforts of approximately 100 students working for various committees. Some of these committees and their committee chairpersons include Facilities by Jeff Cooper, Publicity by Christi Adams, Company Contacts by Sarah Cole, Wine and Cheese Party by Elizabeth Soong and Command Center and Registration by Diana Robertson. Their hard work has ranged from mailing information packages and calling companies to ordering t-shirts, buttons, posters, balloons and creating banners.

Some companies will be giving special thirty minute technical presentations to present in-depth views of new products, technical advances or specialized research. With the aid of computers, audio visuals, models and products, companies will provide students with a glimpse of the current trends in industry.

Previous company displays have been very impressive. General Motors brought a new Chevrolet Corvette for display while Volvo-White brought their latest semi-truck cab. General Electric brought an 8 foot, 2000 lb. power plant control panel and demonstrated its operation. Texas Instruments demonstrated high resolution 3-dimensional graphics on their latest computers.

Dean of Engineering, Dr. Paul Torgerson, will be speaking at the opening ceremony and the Highty Tighties will perform there also. Last year's EXPO was attended by about 5000 students. EXPO 88 should attract even more students than ever before with the increased company turnout and EXPO's increasing popularity.

The Student Engineers' Council extends to you a personal invitation to attend EXPO 88. EXPO 88 is the only opportunity where students can learn about such a large and diverse number of companies within such a short time period. Whether you are a freshman, graduating senior or graduate student, come see what the business world has to offer you and what you can offer it at EXPO 88.

Companies attending EXPO 88, and where they'll be:

Company	Booth Number
AAI	141
Allied-Signal, Inc. Engineered Mtls.	115
American Electric Power	147
AMP Inc.	134
Armstrong World Industries	138
BDM International	162
Bechtel	132
Bell Atlantic	117
Bellcore	133
Center for Night Vision and Electro-Optics	154
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David Ling graduated in Electrical Engineering last spring and is currently working at Allied-Signal, Inc. in Baltimore, MD.

A.J. Gorenc is a senior in Industrial Engineering and Operations Research. He is the EXPO 88 Chairman and a member of the Student Engineers' Council Executive Board.

On the Leading Edge:
Superconductor Research at Virginia Tech

By Kendall E. Giles

The scientific community today is overflowing with a passion and enthusiasm unseen for many years. The magic word is "superconductors" and solving their mysteries as well as putting their highly desirable properties to use is the prime goal of scientists all over the world. Active research is being conducted here at Virginia Tech in the area of thin film superconductors, and much progress has been made towards solving their enticing puzzles of molecular resistance and unrestrained current flow.

The idea of superconductivity has been around for a num ber of years. In 1911, a Dutch physicist named Heike Kamer lingh Onnes was performing experiments on the effects of low temperatures on metals. He found that all resistance to the flow of electricity in a sample of mercury suddenly disappeared at 4.2 K, the temperature where helium becomes a liquid. Onnes found similar results upon cooling tin and lead in succeeding experiments. A current was started in a loop of superconducting metal, kept at liquid helium temperature, removed from electric and magnetic fields, and was found to be still flowing, undiminished, a year later. Superconductivity had been discovered, but keeping the metal samples at such low temperatures was costly and impractical for very intensive research. No one understood how or why superconductors worked, and solving that puzzle daunted many scientists. Efforts were made to raise the transition temperature (the temperature at which a superconductor loses all resistance to the flow of electrical current) but progress was very slow.

In 1957, forty-six years later, three physicists, John Bardeen, Leon N. Cooper, and J. Robert Schrieffer, proposed the BCS theory, which gave a reasonable picture of what was happening inside a superconductor on the microscopic level. They said that pairs of electrons, when the temperature is lowered, appear to form bonds between themselves and become what are now known as Cooper pairs. These conduction pairs, as they travel through the crystal lattice of a metal or alloy, have a net amount of energy between them. When one electron collides with an impurity in the lattice, the second one gains the energy the first one lost, and so the net energy between the pair neither increases nor decreases. Thus, there is no resistance to the flow of electricity in the metal and it is now called a superconductor.

Though this theory helped scientists to understand the inner workings of superconductors better, it did little to help them raise the transition temperature. The breakthrough came at IBM's Zurich laboratory on January 27, 1986. A new class of superconducting material was developed with a transition temperature of 30K, much higher than any temperature previously reached. The material was a ceramic oxide of lanthanum, barium, and copper. No one had thought to look for superconductivity in a ceramic and this discovery cast the scientific community all over the world into a state of breakneck research. IBM's results were soon duplicated and confirmed by groups at the University of Tokyo, the Chinese Academy of sciences in Beijing, and the University of Houston. Efforts by other American research groups, notably American Telephone and Telegraph's Bell Labs, Stanford University, and the Argonne National Laboratory, raised the transition temperature even higher, to 52K.

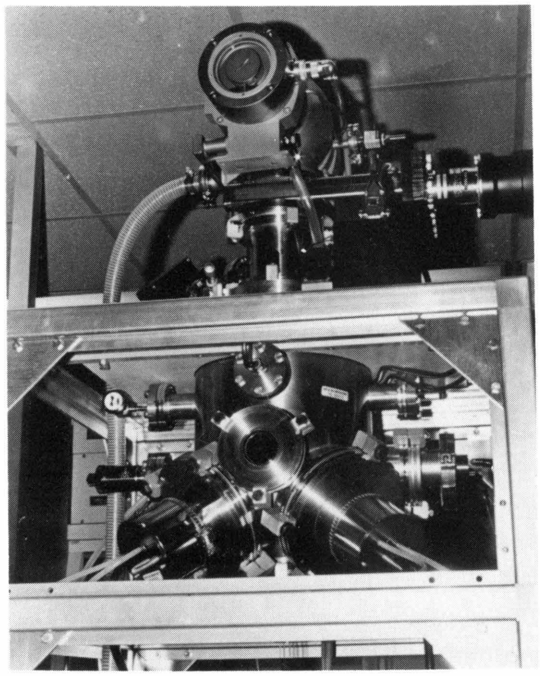
Theresa Gidley

Staff writer Ken Giles gets in over his head while studying superconductivity.

On March 2, Ching-wu Chu and his colleagues at the University of Houston reported another monumental feat, superconductivity at 94K, using a new material fashioned of an oxide of yttrium, barium, and copper. This temperature is higher than the boiling point of liquid nitrogen, which is 77K, and this accomplishment opened up an amazing number of possibilities with significant consequences. Liquid nitrogen is a much more desirable cryogen than liquid helium. It is much cheaper, much easier to handle, and does not require the added cooling apparatus that liquid helium demanded. The world of physics entered into a period of frenzy and marathon research that continues today, with scientific teams rushing to report on new developments concerning superconductor research and application.

Extensive superconductor research is currently being conducted here at Virginia Tech in the area of high-performance thin superconducting films, directed by Dr. Shinzo Onishi, Assistant Professor of Electrical Engineering. The problem with previous superconductors is the low critical current densities, which means that the superconducting materials cannot handle the necessary high amounts of current, thus severely limiting their use in practical circuits. Superconducting films, however, have the advantage of not only being small in volume, but also being able to handle higher current densities.

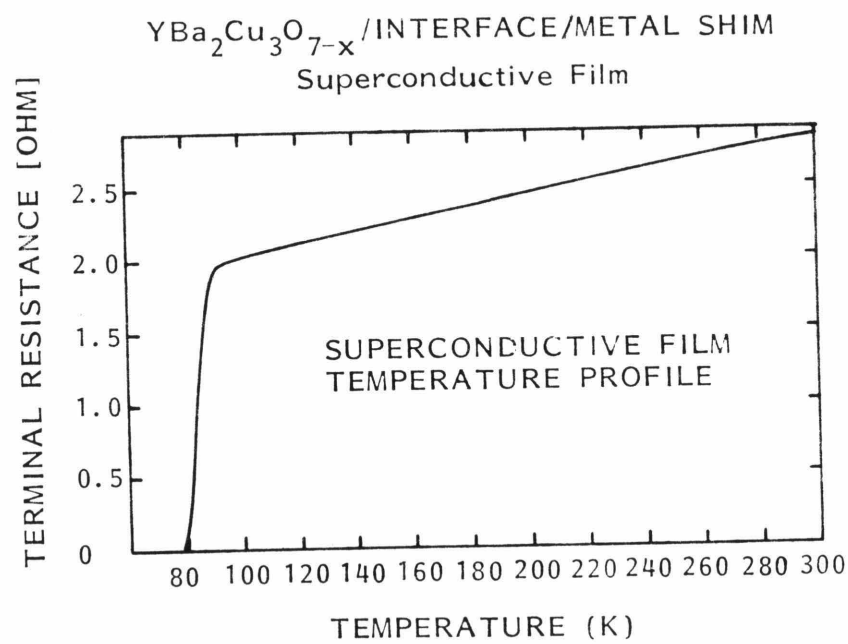
The films are made by a process called sputtering, which involves the removal of material from a solid cathode by bombardment with positive ions from a rare gas discharge. In order to get the complex oxide compounds desired for optimum superconducting properties, a very precise system is needed. But such a system with the exact operational characteristics was not in existence anywhere in the world, and so Dr. Onishi, beginning in the summer of 1987, built his own "thin-film superconductor deposition system." This system consists of a radio frequency magnetron sputtering source which is housed in a stainless steel vacuum chamber and is pumped by a turbomolecular pump. The sputtering, done in the presence of argon and oxygen gas (which help to control the properties of the deposited film), removes material from a yttrium-barium-copper oxide target and deposits this onto a metal substrate. The goal of Dr. Onishi's research is to be able to deposit a superconductor film onto any surface. According to Dr. Onishi, "such films will be used as a means to investigate electrical contacts for leads, reactions with other materials, high frequency properties, and potentially open up a new field in materials preparation."



Theresa Gidley

Some of the exotic equipment used in superconductor research at Virginia Tech.

Time and lack of proper funds are major obstacles that hamper Dr. Onishi's dedicated research efforts. Superconduc tor research is long and laborious, requiring much time, and there is strong pressure in the scientific community to be the first to publish unprecedented discoveries. This isespe cially true in the area of superconductors, where break throughs occur in very rapid succession and in a very small time span. To be the first is the goal, and since everyone is working towards the same objective, your results will be duplicated by someone else in only a matter of minutes, days, or weeks. Contractors give urgent deadlines for results, and these deadlines must be met in order to secure money, which is another barrier towards progress. Also, there are many materials which are needed for proper research efforts and accurate conclusions, and these items are rather expensive and thus are hard to acquire. However, Dr. Onishi remains very optimistic about the direction his research is leading, and would like very much for more Virginia Tech graduate and undergraduate students to be able to share in his work. There are indeed many applications to be made as a result of all this scientific querying and furor. Once a few more fundamental details can be worked out, the applications into everyday life will be almost limitless — from power lines, high speed trains, computers, motors, atom smashers, fusion power plants... the list goes on. Superconductors can fit into any area where smaller size and faster speed are desired, from medicine to scientific research to mass communication and transportation. Progress towards seeing this day when superconductors will be such an integral part of our lives is being furthered by Dr. Onishi, who says that anything can happen next. Breakthroughs can happen overnight, but breakthroughs can only happen with the dedication and hard work of scientists and researchers who are striving for benefits for people everywhere. Thus the work goes on.



ENGINEERING COLLEGE MAGAZINE ASSOCIATED
1988 NATIONAL CONVENTION

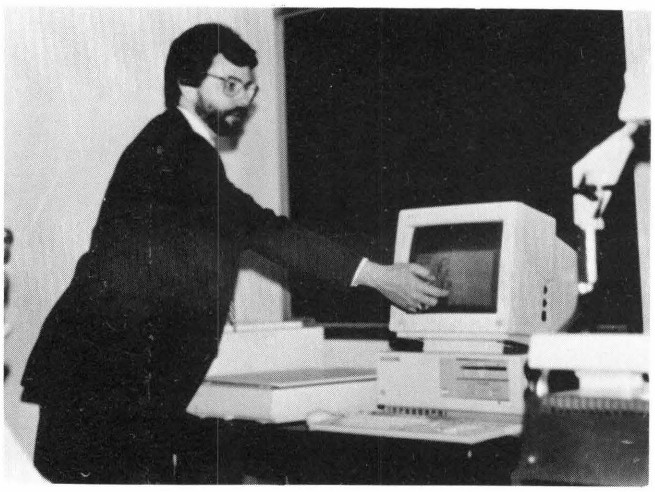
by David Ling

The *Engineers' Forum* magazine, one of a handful of self-supporting Virginia Tech publications, hosted a national engineering college magazine conference last spring. The conference took place at the Donaldson Brown Continuing Education Center (CEC) on April 14-17. The Engineering College Magazine Associated (ECMA) conference is an event hosted by a different member school each year. Through a bidding process, *Engineers' Forum* received the honor to host 1988's ECMA conference.

The conference featured speakers who were experts in all aspects of journalism and magazine publishing. They made presentations on many diverse topics including advertising, desktop publishing, and technical writing and science journalism. The convention would not have been possible without the financial assistance of Virginia Tech's College of Engineering, the Virginia Society of Professional Engineers, the American Society of Mechanical Engineers, General Electric and the *Graduating Engineer* magazine.

The first conference of what was to become the ECMA was held in Chicago in February, 1920. The convention was held to organize tentative "standards of practice" for undergraduate engineering magazines. The main goal of ECMA was to simplify solicitation and distribution of national advertising by providing a single channel for advertisers to contact the magazines with a standardized page size and level of quality. By achieving this, advertisers would be more attracted to engineering college magazines as an advertising medium. ECMA 88 marks the 68th year of the ECMA whose membership has grown substantially since the first conference.

Eighty students representing college magazines from across the country attended the four-day event, as did fifteen speakers, guests and ECMA Executive Board members. Schools that attended the conference included University of Pennsylvania, Cornell University, University of Minnesota, Ohio State University, Yale University, University of Wisconsin-Madison, Howard University, Wayne State University, University of Colorado, Rensselaer Polytechnic Institute, University of Nebraska, University of Notre Dame, Louisiana Tech, University of Wisconsin-Platteville, University of Iowa, University of California-Berkeley, Kansas State University and Virginia Tech.



Theresa Gidley

A representative from Hewlett-Packard conducts a seminar on desktop publishing at the ECMA conference.

The conference opened with Monte Carlo night, which was hosted by the Institute of Industrial Engineers (IIE) society in the University Club. Previous ECMA conferences held dances which flopped, but Monte Carlo night, IIE's annual fund raiser, proved to be extremely successful. Guests were each given $5,000 in play money to gamble in 'Vegas' type casino games in quest of high stakes. Numerous games were available such as Black Jack, Acey-Ducey, High-Low, Roulette and Craps. At the end of the evening, prizes donated by local businesses were auctioned to the highest bidder. A set of shot glasses sold for $75,000 and a Virginia Tech sweatshirt sold for $150,000! A buffet dinner and beer were also provided with the financial assistance of General Electric.

The next day of the conference consisted of breakfast in the CEC and five morning workshops. The first workshop dealt with the importance of communicating technology. The workshop was presented by Dr. Michael Furey, a Virginia Tech mechanical engineering professor who is an expert on the complexities associated with technology and society. In the second workshop, Arthur Fisher, the keynote speaker and the Science and Technology editor of *Popular Science,* discussed effective methods of editing a college magazine as well as his personal experiences with *Popular Science.* In the third workshop, representatives from Hewlett Packard demonstrated desktop publishing equipment and addressed questions concerning the integration of equipment and software into a production cycle. For the fourth workshop, Bruce Matzner, Publisher of *Experienced Engineer, Engineering Horizons, and MS/Ph.D.* magazines, explained how to package magazines as a usable resource. In the fifth workshop, Dr. J. Thomas Head, Assistant Director for Audio Visual Services at Virginia Tech, illustrated how to integrate computer graphics into a publication layout.

After the workshops, Arthur Fisher gave a keynote address at a luncheon also held in the CEC. The remainder of the afternoon consisted of a workshop on advertising presented by Littell, Murray, Barnhill Advertising, Cass Advertising and Thompson Advertising. The workshop cleared the air on several controversial national advertising policies which had been financially damaging the revenues of several ECMA magazines. In an additional work shop, Ms. Jane Asche, an Extension Specialist from Virginia Tech's Center for Volunteer Development, presented several methods to motivate and manage a volunteer staff.

The morning of the third day of the conference consisted of committee meetings which reviewed the ECMA finances, the ECMA constitution, convention activities, and rules concerning probation and awards. The afternoon involved a general session held in the CEC auditorium.

Finally, the conference concluded with the awards banquet, which was held in the CEC dining room that evening. At the banquet, Dr. Gary Downey, from the Virginia Tech Center for the Study of Science in Society, spoke about the importance of both the technological and societal effects of engineering. He stressed the engineer's responsibility to society to preserve the environment and maintain safety.

Afterwards, the long awaited ECMA awards were presented by Howard Schwebke, ECMA Executive Secretary, Lynn Nystrom, ECMA Chairperson and Lee Atchison, ECMA Vice-Chairperson. Awards are given to magazines in categories such as best technical article, best non-technical article, best overall magazine, best cover, best editorial and best overall magazine. Virginia Tech's *Engineers' Forum* won four awards in the categories of best pure technical article, best cover (single issue), best cover (four issues) and best editorial.

Planning for the April conference began in October, 1987 and was co-chaired by Christina Van Balen, *Engineers' Forum* Production Manager, and David Ling, *Engineers' Forum* Business Manager. Lynn Nystrom, the faculty advisor for *Engineers' Forum,* provided extensive guidance to Christina and David, without which the conference would not have been successful.

The conference provided students with information and ideas for the coming year. They learned much from the workshops and guest speakers; but they also learned much from each other, through informal discussions and conversations. Every school attending gained from the conference, not just the ones that won awards.

David Ling is a class of '88 electrical engineering graduate, the Business Manager of the *Engineers' Forum* and was co-chairperson for the 1988 Engineering College Magazine Associated conference.

Christina Van Balen is a senior in Industrial Engineering and Operations Research, the Production Editor of the *Engineers' Forum* and was co-chairperson for the 1988 Engineering College Magazine Associated conference.

Computers, Phones, and MTV: The CNS System

By Martin Gendell

There's a new phone company at Virginia Tech. Nope, it's not C&P or AT&T, or even MCI. It's Virginia Tech. More specifically, the Communications Networks Services Department. CNS is a branch of the university supervised by the office of the Vice President for Information Systems.

By now, most of you are at least somewhat familiar with the system. This ambitious, multi-year telecommunications project is designed to "significantly improve the learning environment on campus." The system is divided into three services: phone, video, and data. Before examining each of these services, let's look at some general information on the system.

GENERAL INFORMATION

This project is the largest single endeavor attempted by the university. The $13.5 million price tag is fully funded by bonds, so no state funds, grants, or departmental funds will be used. When fully completed, the system will have:

- 1,000 miles of fiber optic cable
- 9,000 miles of twisted pair copper wiring
- 118 buildings served
- 10,000 phones

Every facet of university life will be affected by the system. Perhaps the biggest change will occur in the area of campus phone numbers. The 961-xxxx phone numbers will be replaced with two new exchanges: 231-xxxx for faculty/staff and 232-xxxx for students.

The hub of the phone and data services is an IBM communications system. The installation here at Tech is one of the largest in the country. The new phone and data services are scheduled to begin service in August 1988 for the residence halls. Academic and administrative facilities will switch over to the new system by the beginning of 1989.

Providing the video services involves using some of the existing facilities, including the 9-meter dish (visible from Route 460) near the airport. In addition, an improved campus video distribution system and a cable TV system capable of carry ing 60 channels is planned.

PHONE SERVICE

The system combines both the voice and data services. Every residence hall room will come with a digital IBM ROLMphone. This is a special unit capable of handling both phone and data duties. Because the system is entirely digital, only the ROLMphone will work on this system. This means that personally owned phones and related equipment (e.g., answering machines) will not work on the new system.

Several features of the new telephone system will make campus life easier. Busy signals can be handled two ways. First, the caller can request that the system call both parties back when both lines are free. The second option is to remain on the line for a C&P-like call-waiting. A feature called consultation allows callers to retain two independent calls and toggle between the two at the press of a button. For $1.50 per month, speed calling is available. Students can also purchase a feature called Phone Mail. PhoneMail is a voice message system with all the features of an answering machine and more. The monthly charge for Phone Mail is $10.

PhoneMail is a unique service which deserves some special attention. PhoneMail is an electronic answering machine. Instead of recording messages on tapes, however, both incoming and outgoing messages are recorded digitally on a computer. A light on the phone signals that a message has come in. To hear messages, you simply dial a four digit extension, and enter a personal code. A female voice answers and tells how many mes sages were received, and what keys to press to listen to or delete the message. Once familiar with the operation, you don't need to wait for the voice to give all the options. Fortunately, she (the voice) doesn't mind being cut-off, so you can press the keys as fast as you want.

DATA SERVICES

Currently there are more personal computers at Tech than telephones. As a result, Tech ranks as one of the top three universities for the number of PCs. To meet current and future demands, every residence hall room will be equipped with a data connection.

All you need on your computer to use this service is a serial (RS-232) port, and a standard serial cable. The cable connects the computer's serial port directly to the back of the ROLMphone. With the data connection, users can access the university's mainframe computers, other students, and soon library data bases, local networks, and various bulletin boards.

VIDEO SERVICE

Gone are the days of tin foil on the antenna or a whole hall of people crammed into one room because it's the only one that receives channel 13. Thanks to the new video system, each room will receive 38 cable-clear channels.

A wide variety of programs are available with the system. Yes, MTV is included, but the pay movie channels like HBO and Showtime are not. Emphasis, however, will be placed on foreign language channels. Aimed at international students, students of foreign languages, the foreign language faculty, and librarians, three foreign language channels will be available: CBC — Canadian Broadcasting Company, a French Canadian language station; Univision — A Spanish language station; and SCOLA — Satellite Communications for Learning, a multi-lingual, multi-national news and information station. Also, there are plans to have campus help sessions broadcast over the cable system. Using the integrated phone system, students can call up the help session and ask questions.

Like everything else, you don't get something for nothing. There will be an increase in students' housing fees starting this fall. It's not all bad news, however. The monthly service bills from C&P will be eliminated, and CNS estimates that long distance rates will be slightly lower with the new system than with C&P. The amount of the housing increase used to support the telecommunications systems is only $216 per student per year. With an estimated average long distance charge of $225, the student will pay a total of $441 per year. This is only $91 per year more than the estimated $350 per year for phone service from C&P ($100 for basic phone service plus $250 for long distance service). So, for only an additional $91, students get improved telephone service, a data connection, and 38 entertainment, instructional, and news channels.

If all goes as planned, the entire telecommunications system will be in place and fully functional by early 1989. The system brings vast and far-reaching changes that will certainly make campus life more enjoyable. Now, if only someone would do some thing about that dining hall food ...

The author would like to thank Susan Bright of CNS for her invaluable assistance with this article.

The Concrete Canoe Race: Tech Heads For the Nationals

by Barbara Raymond

On June 18, 1988, eighteen regional finalists converged on Lansing, Michigan for the first national concrete canoe race. Sponsored by Master Builders, Inc., a Cleveland-based construction products manufacturer, the event is the culmination of six months of planning and construction for 231 student chapters of the American Society of Civil Engineers (ASCE). The event marks the first time that regional winners from around the United States will compete in a national competition.

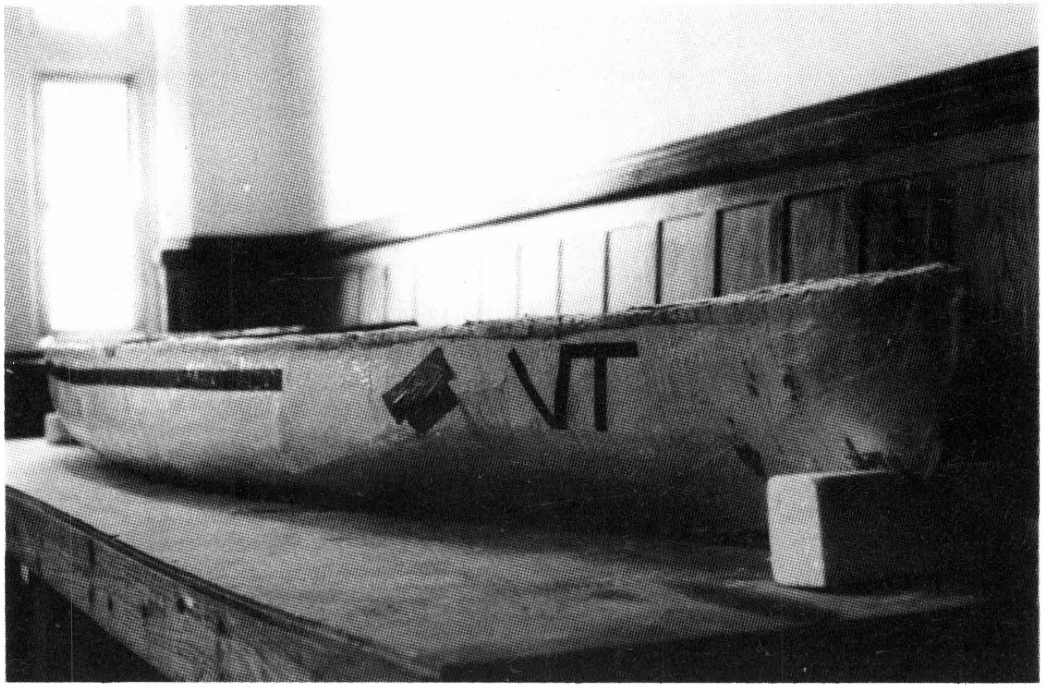
Racing concrete canoes has been a regional tradition for civil engineering students for two decades. Each participating student chapter is required to build a new canoe each year. The ASCE provides the guidelines for design, materials, and construction of the concrete and wire-reinforce hull of the canoe, as well as a few rules for the races.

Work on the project begins in early fall to meet the April race deadline. The students first select and test various hull designs and materials. Next, forms are constructed over which or into which the reinforcing is carefully laid and sewn into place. Finally the concrete is mixed and smoothed over the reinforcing and allowed to cure. Before heading to their regional races, each team paints and tests their canoe for flotation, and prepares the required design paper.

Tech's concrete canoe team was invited to compete in regional races sponsored by the University of Maryland, held at Seneca State Park. The team included undergraduates for the men's and women's relays, and a graduate student and a professor for the grad student/teacher race.

This year's team named their entry "The Minnow" in memory of last year's canoe, which sank to the bottom of a lake in Pennsylvania during racing and was never recovered. This year's canoe lived up to its name and sank to the bottom five minutes after it was launched. Hasty repairs were made, and the Minnow was relaunched with greater success.

The Minnow proved to be fast and maneuverable, thanks to her thin, light hull and deep vee entry tapering back gradually to a wide beam. The canoe survived many collisions with other canoes, requiring only a minimum of duct tape to keep her afloat. The Tech team placed consistently high in all the races. For this reason, the team was selected from among the eleven schools and twenty-one canoes entered at the Maryland regional races to represent the region at the nationals. The national finals competition will benefit participating civil engineering schools in several ways. Winning teams' schools will be awarded $9,000 in scholarships. While canoes are improved every year, so is the competition. For example, a toll-free number for help in canoe design and construction is currently being established. Also, lodging and travel expenses for regional finalists in the national competition are donated by Master Builders. Virginia Tech's concrete canoe hopes to continue its winning tradition this year. Interested students should contact the Tech chapter of the ASCE.



Theresa Gidley

The concrete canoe on display in Patton Hall. This most recent canoe proved to be the Tech ASCE's best hull ever.

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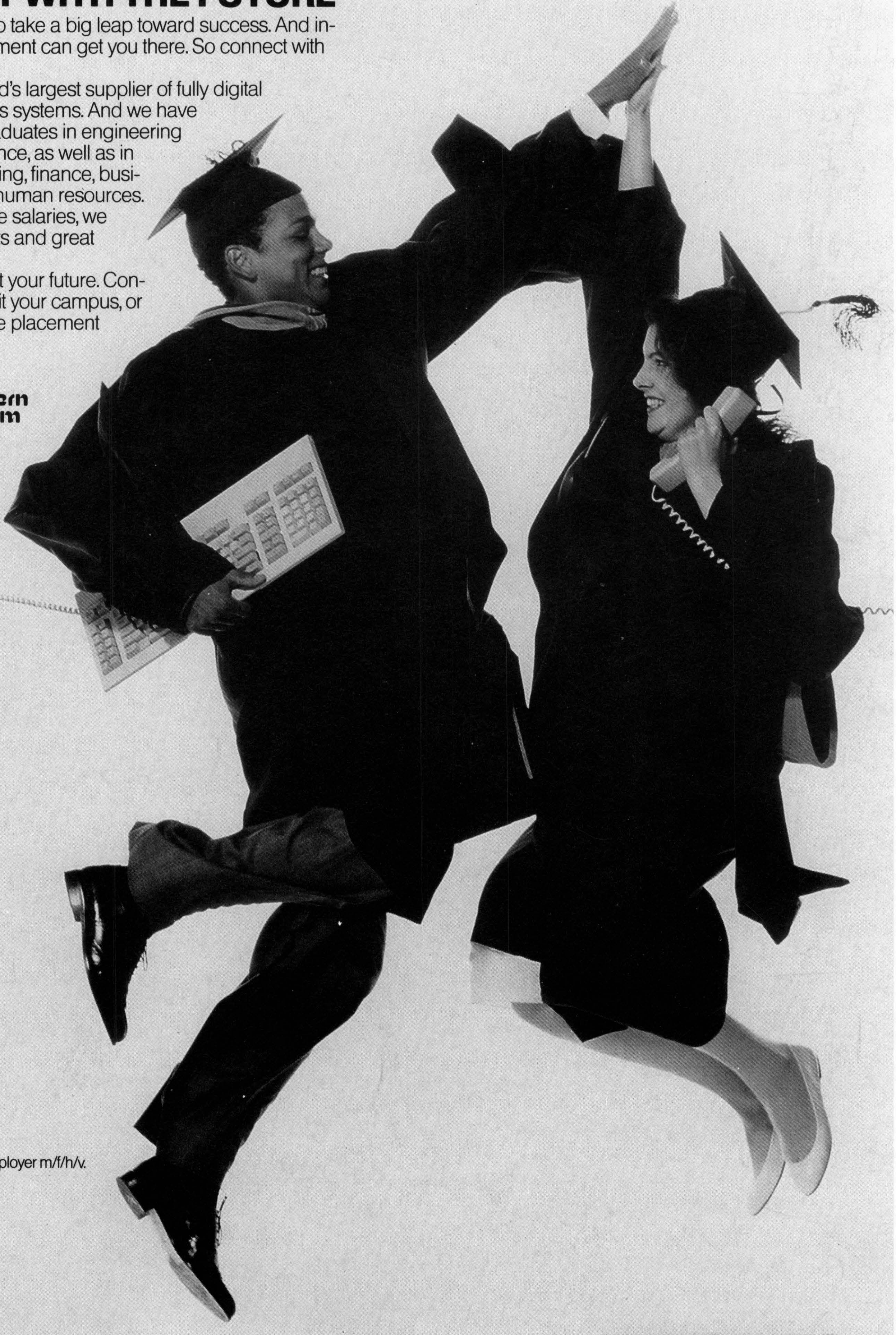

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