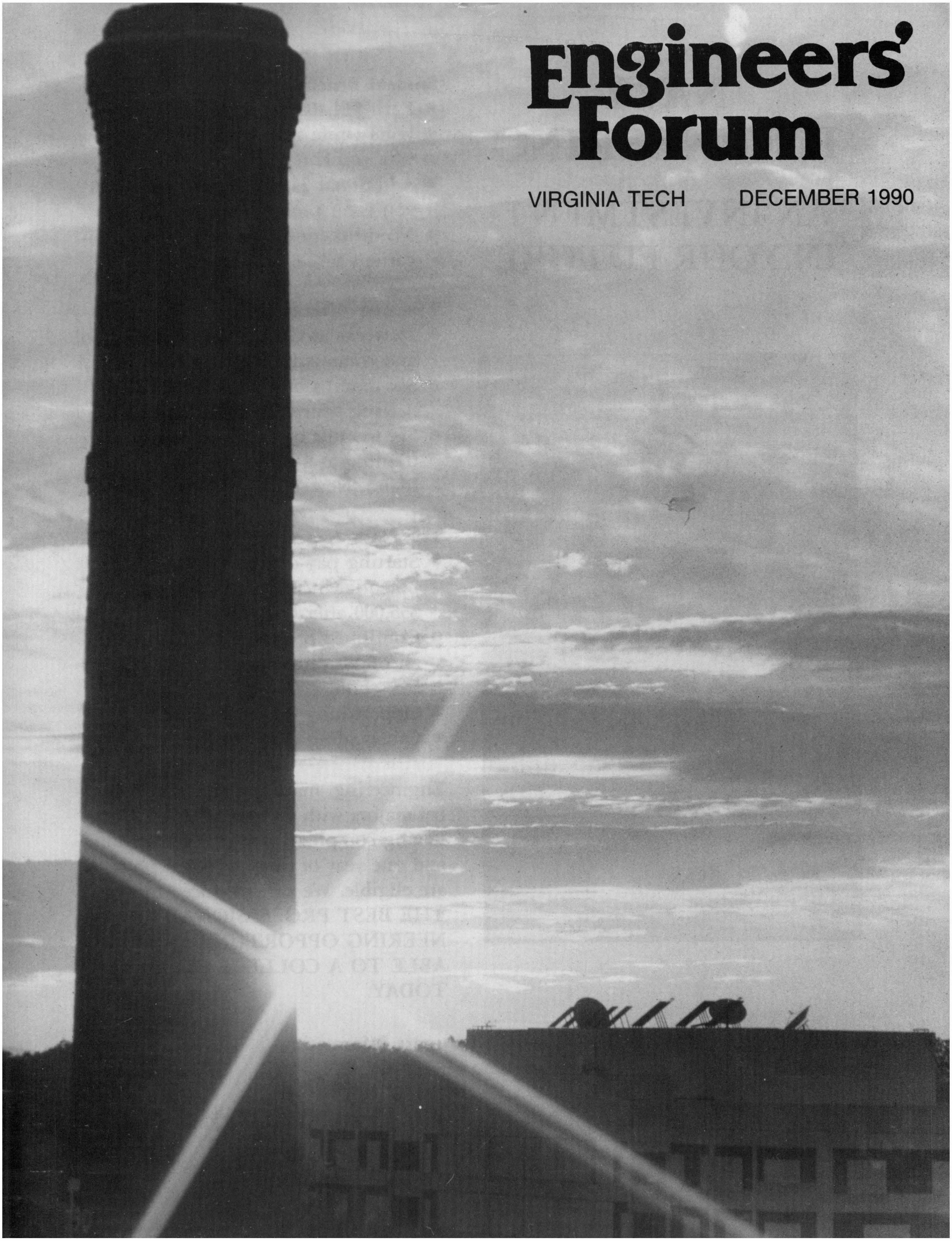
Engineers' Forum

VIRGINIA TECH DECEMBER 1990



NAVY ENGINEERING

AN INVESTMENT IN YOUR FUTURE

Student Benefits
- Earn $14,400 a year for up to two years while still a student to use any way you choose
- Additional $4,000 bonus paid when you enter program
- No drills, uniforms or summer obligations while in school

Training After College
- 16 weeks at Officer Candidate School and commissioning as a Navy officer
- Six months of graduate level engineering education in Orlando, Florida
- Six months of hands-on engineering training at a prototype trainer in Idaho, New York or Connecticut

The Navy Engineer
- Starting pay of up to $27,000 with potential increases to more than $55,000 after five years
- Continued professional growth and an opportunity for Navy paid graduate school
- Opportunity for world travel
- Outstanding marketability

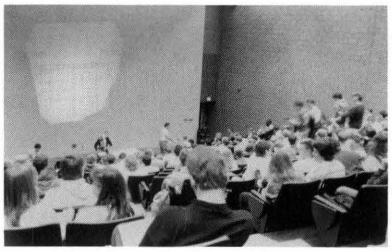
Engineering, math, physics and chemistry majors with at least a 3.0 GPA and having completed one year of calculus and one year of calculus-based physics are eligible. We are convinced this is THE BEST PROFESSIONAL ENGINEERING OPPORTUNITY AVAILABLE TO A COLLEGE STUDENT TODAY.

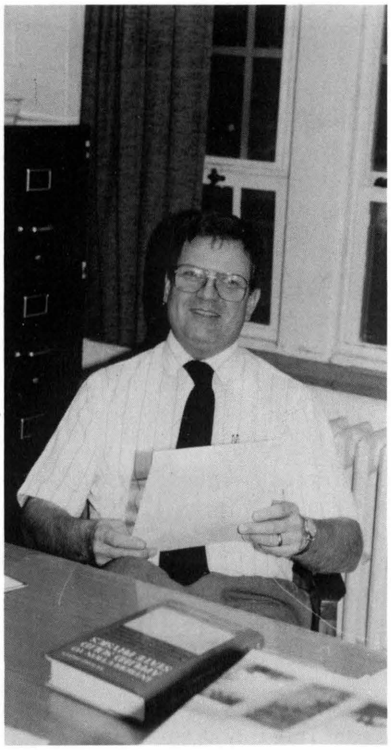
Call 1-800-533-1657 for more information.
There's no obligation.

NAVY OFFICER **You and the Navy. Full Speed Ahead.**

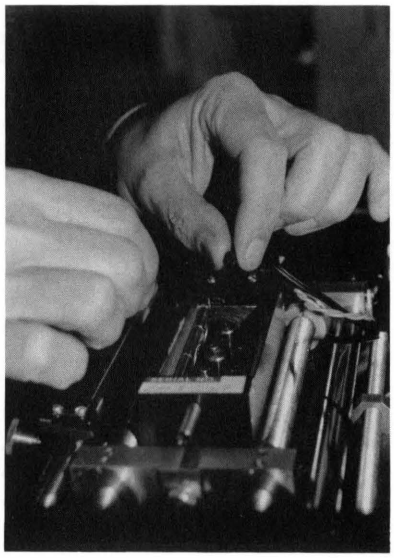
CONTENTS

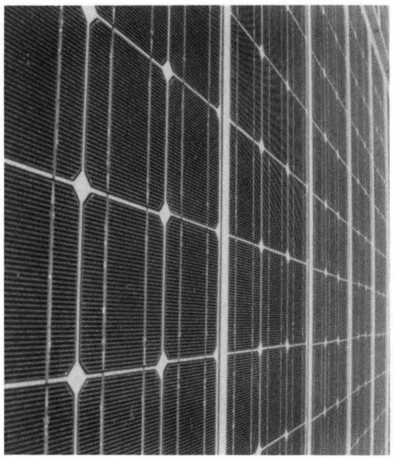
VOLUME 9 NUMBER 2 DECEMBER 1990

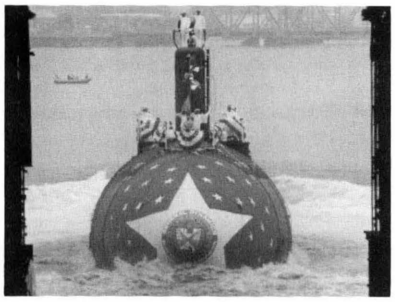


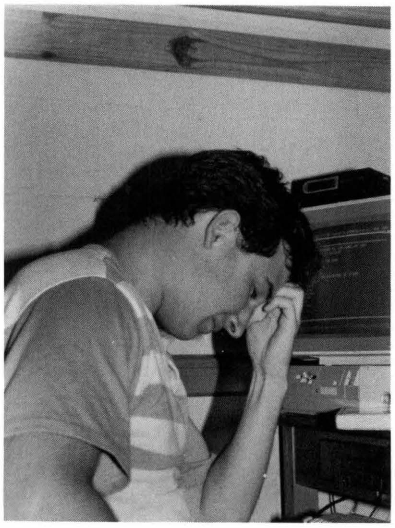


ON THE COVER: Photographer Mark Cherbaka captures the old and new dormant smoke stacks and the new solar cells as seen from Thomas Hall.









Engineers' Forum

Editor-in-Chief
Jonathan Hess

Assistant Editors
Tony Giunta
Grady Koch

Business and Advertising Manager
Howard Kash

Staff
Collin Bruce
John Cole
Robin Elder
Stephen Payne
Mike Reese

Photographer
Mark Cherbaka

Editorial Advisory Committee:
Lynn A. Nystrom
Head; Director of News and External Relations for the College of Engineering.

Gary Downey
Assistant Professor, Center for the Study of Science in Society.

Richard Goff
Engineering Consultant.

Ed Henneke
Professor of Engineering Science and Mechanics.

Sam Riley
Professor of Communications Studies.

Design/Typesetting Consultant:
David Simpkins
Phototypesetting Specialist, College of Engineering

Engineers' Forum is Virginia Tech's student engineering magazine. *Engineers' Forum* magazine is published four times during the academic year. The editorial and business office is located at 112 Femoyer Hall, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. Phone (703) 231-7738. Member of Engineering College Magazines Associated, Lee Edson, Chairperson.

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

Copyright 1990, *Engineers' Forum*

Darkroom facilities donated by Virginia Tech Communications Department.

EDITOR'S PAGE

"Study Geeks" :

At first I thought it would be appropriate to discuss the budget cuts that the College of Engineering is currently facing, but my colleague Tony Giunta has written a story on this subject. After that, I thought the Persian Gulf crisis merited some discussion, but this can be found on the front page of almost every newspaper. Finally, I decided to discuss a topic that has raised some interest to me in the past few weeks — the classification of engineers as "Study-Geeks."

The other night, I was up late finishing a lab for a class titled Work Measurement and Methods Engineering, when my roommate came in from a fun-filled evening out on the town. Upon entry into the room, his exact words were "Man, I can't believe you are still studying. You engineers are some real Study-Geeks." At first, this offended me, but then I decided to step back and explore the real meaning of these two words combined obviously to elicit some form of response.

> *Study Geek: 'A carnival performer whose act usually consists of biting the head off a live chicken or snake while pursuing knowledge through reading, observation, or research.'*

Consulting *The American Heritage Dictionary*, the term "Study-Geek" would most likely consist of some combination of the definitions for "Study" and "Geek." If the term were included in this dictionary, it would probably read something like: 'A carnival performer whose act usually consists of biting the head off a live chicken or snake while pursuing knowledge through reading, observations, or research.' Certainly, this is not what my roommate thinks engineers are, but I thought I would humor him by telling him this definition. Just like an engineer, right?

So what did he really mean when he referred to engineers as "Study-Geeks?" An accurate description might be the following: It is 3:01 a.m. on a Wednesday morning and the engineer is sitting at his or her desk, with books ranging from "Computational Aerodynamics" to "The Handbook of Mechanical Properties of Materials" spread across the desk and the floor beside. Central to this scene is the trademark of the true "Study-Geek," the Hewlett-Packard Calculator glistening under the light from the desk lamp, while fingers

hope for the future?

frantically punch away at the small electronic device to figure out the results to a complex Weissinger approximation.

Now that a picture of the engineering "Study-Geek" has been painted, we can seriously analyze exactly what makes an engineer behave in such a manner that he or she is dubbed a "Study-Geek."

Perhaps part of this description is a result of the intense workload given by professors, which is commonplace in every department of engineering. Obviously, professors do not assign the large amounts of work that they do for the hell of it. And yes, despite what you may think, they are aware that you have other classes, as they too were in your shoes at one point in their life. So, why do they assign so much work?

If students would view the amount of work required of them in college as preparation for what is to come after they have been handed their diploma, maybe their view would change. Contrary to the belief of many, the workload you will encounter as a practicing engineer will most likely be much more intense than that which you are experiencing now. The 40-hour-a-week engineering job is almost nonexistent anymore. On the other hand the 60-hour-plus week including work on Saturdays has become the standard. In other words, get used to the work load now, so you can learn to budget your time in a way that permits the enjoyment of lifes leisure activities by the time graduation comes.

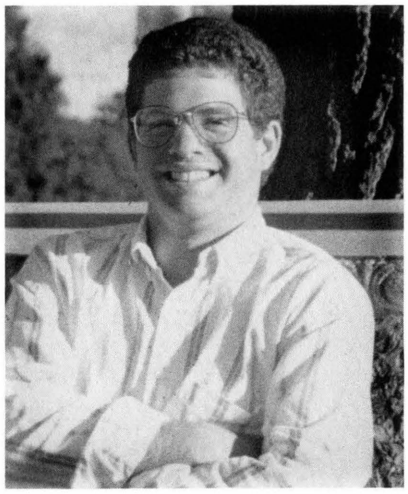
The above topic leads into something even more critical — making sure you love what you do. So many times I hear fellow engineers saying things like "I hate this stuff," or "Why do I need to learn this?" In any profession, I believe that the only way you can truly succeed depends on whether you really love what you are doing. Sounds like something your mother would say, doesn't it? Well I am not trying to be anyone's mother, but it is true.

At the end of last year I was faced with a question of this sort because I was an Electrical Engineering student who had no interest in the EE courses I was taking. At that point I started to question whether I could see myself doing this for the rest of my life, and the answer was no. Anyway, to make a long story short, I am still an engineer, but in a discipline in which I have a noticeable interest in the material being taught.

Anyway, the point I am trying to make is maybe the classification of engineers as "Study-Geeks" is not so bad. Possibly it means engineering students are spending so much time on their subjects because they have a genuine interest in them, and not just because it is an assignment due tomorrow. If this is true, then I am confident that the engineers of tomorrow could be the answer to the problems of today.

Jonathan S. Hess

Jonathan Hess,
Editor



FORUM FOCUS

Jonathan Hess *is the esteemed editor of* Engineers' Forum *and a junior in ISE. He can also drive a mean golf ball.*

BUDGET

Dr. James Marchman, Dean of Academic Affairs, commented, "If the choice is, do we teach half a dozen students who want a nuclear course or do we teach 50 students in a class of thermodynamics — we will teach the thermodynamics."

by Tony Giunta

Unless you have been doing so much homework that you have lost all contact with the outside world, then you have heard about the budget cuts Virginia Tech is currently facing. Less money for the university means much more than just longer lines at the dining halls and a tuition surcharge. It could affect, and it some cases has already affected, the quality of education at this institution.

The budget for the school is determined on a biennium, with a target amount to be reached each year in the two year block. For the College of Engineering, this budget reduction goal has been set at about 1.36 million dollars for both 1990-91 and 1991-92. This is the amount which the College must return to the University.

The three divisions in the engineering department are instructional, research, and extension. In order to reach the prescribed totals, each of these three divisions will absorb some cuts. The largest amount of money is being taken away from the instructional section, which will see 1.24 million dollars trimmed from its budget by the end of the fiscal year. However, this goal has been approximately two-thirds reached, without any forced reductions in faculty or staff positions.

The money which has so far been removed from the instructional section's budget has come from the normal number of people who resign or retire from their university positions. This occurrence can be compared to the "half-filled/half-empty glass of water" analogy. Yes, the engineering department has not been forced to lay off any faculty or staff, but the vacated positions cannot been filled either.

Regardless of how it appears, there are still some vacancies which will remain open. As of mid-October, there were a total of about 25 openings in the combined areas of faculty, graduate assistantships, and staff. Mr. Jack Osborne, Associate Dean of Engineering for Administration, estimated that approximately eight additional positions in the instructional division would need to become free in order to meet the budget. However, if the target is not reached, the remaining amount may be transferred to the following year. "After that," remarked Dean Osborne, "the dean will have to decide...how to redistribute the remaining resources among the departments."

What do these initial budget cutbacks mean to students? The answer is that there may be some noticeable changes in the future. Depending on your department, the cutbacks will seem more or less severe. If a faculty member who has developed a special course decides to retire or resign, there might not be money available to find another professor to fill the position. Additionally, certain less popular electives may have fewer sections or may not be offered at

CRUNCH

all. In reference to this, Dean of Academic Affairs, Dr. James Marchman commented, "If the choice is, do we teach half a dozen students who want a nuclear course or do we teach 50 students in a class of thermodynamics — we will teach the thermodynamics."

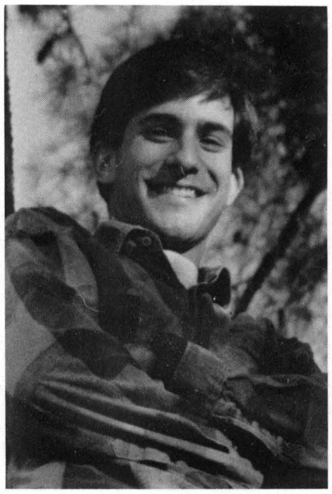
Possible solutions to the loss of faculty positions may not have very desirable effects. In classes such as Engineering Fundamentals there could be an increase of a few more students per section.

To counter more severe cuts that may occur the future, some thought has been directed towards decreasing yearly enrollment in the College of Engineering. This would drop from the current level of about 1200 students to 1100 or perhaps 1000 freshmen. However, this would be an extreme measure to undertake, and at the time of this writing, no such cutback has been put into effect.

The two big question marks that appear whenever budget cuts are mentioned concern accreditation and building construction. Tech received its most recent accreditation review in 1989. Although some departments will come

See Crunch, page 20

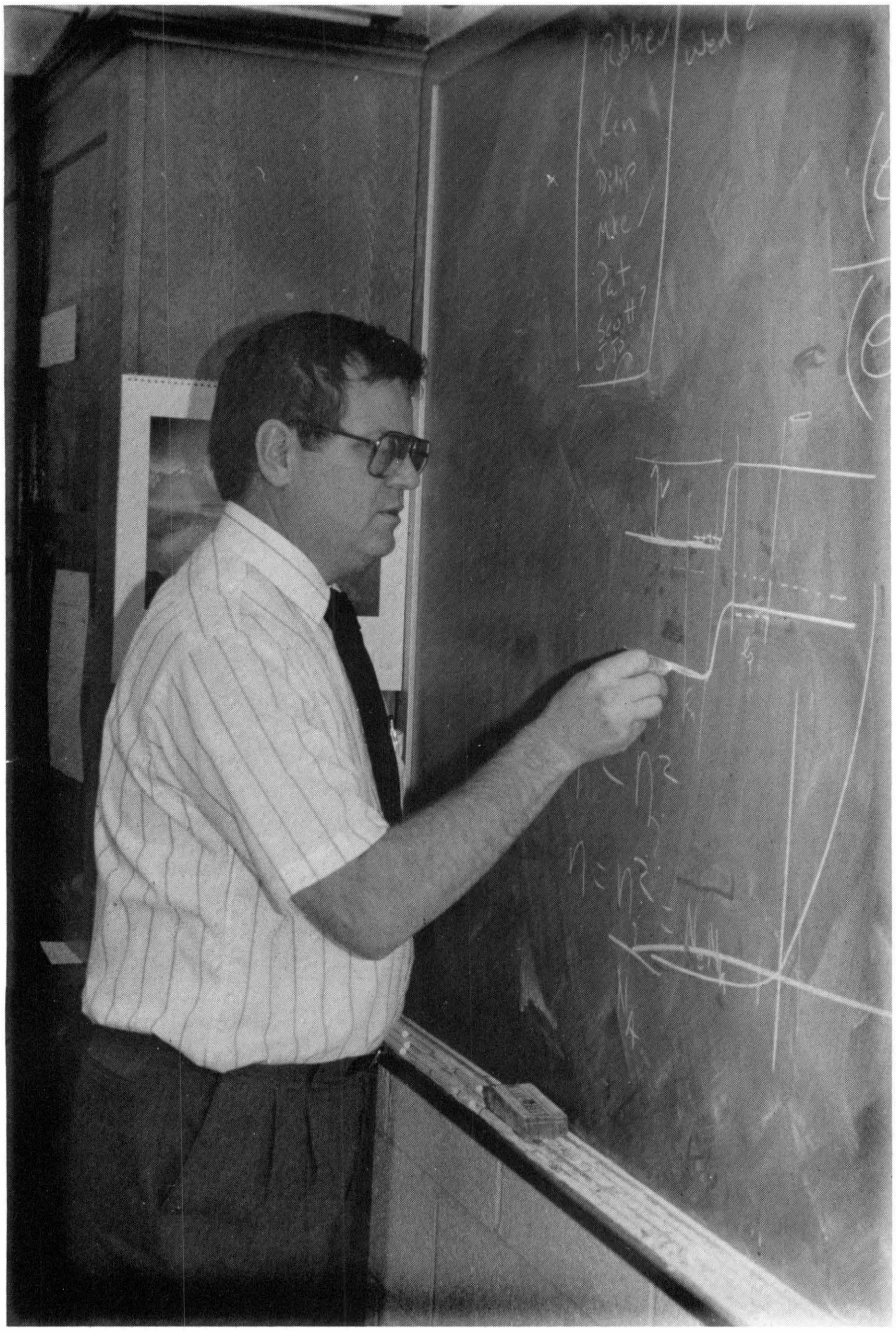
This is the area designated for the new $25 million Engineering/Architecture building. All funds for construction are presently frozen due to the Virginia state budget cuts.



FORUM FOCUS

Tony Giunta *is a junior in Aerospace Engineering. In his spare time, he enjoys listening to classical music and telling jaguar stories.*

Professorship Profile:



Dr. Robert Hendricks teaches five undergraduate courses.

Most engineering students complain about the amount of work that needs to be done. The excessive workload always keeps them busy, leaving no time for fun. Dr. Robert Hendricks, a professor in the Materials Engineering (MatE) department at Virginia Tech, is always busy, but thoroughly enjoys his job and manages to make time for leisure activities.

Dr. Robert Hendricks

by Collin Bruce

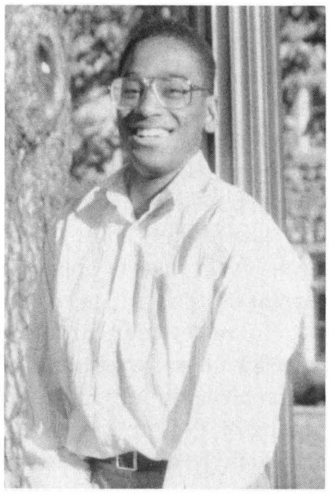
Dr. Hendricks teaches five courses. Two of them, MatE 4214, Electronic Material for Electrical Engineering (EE) and Physics 4124, Solid State Physics for EE, have enrollments as high as 170 students. The other three courses have smaller enrollments: MatE 3154, Solid State for Materials Engineers, MatE 4234, an elective course in electronic materials and MatE 5244, a graduate course in residual stresses. He also occasionally teaches MatE 2034, Elements of Materials, which is taken by most engineering students not majoring in Materials Engineering.

Dr. Hendricks is also involved in numerous research experiments. His primary research area is residual stresses, where he studies the relationship between residual stresses, mechanical properties, and environmental properties in both ceramics and metals. He is also currently performing joint work with EE Professor A. Elshabini-Riad on stresses in thick film hybrid circuits. Stress corrosion cracking and heat affected zones of welded stainless steel pipe are other areas Dr. Hendricks has spent much time researching.

Dr. Hendricks has been married for 32 years to his wife, Delores, and has two children, Jim, a graduate student majoring in Aerospace Engineering at Cornell University and Karen, a sophomore at Blacksburg High School.

At Cornell University in 1959, Dr. Hendricks received his Bachelors degree in Metallurgical Engineering. Five years later, in 1964, he received his Ph.D in material science at Cornell. He then went to work at Oak Ridge National Laboratory where he did basic research on metals, ceramics, polymers and superconductors. In 1981 he left Oak Ridge to become a product manager at Technology for Energy Corporation, a company devoted to products and services for the nuclear industry. This experience was valuable for his teaching career. He came to Virginia Tech in 1986.

Dr. Hendricks takes pleasure in gardening, reading, listening to music and loves traveling with his family. He also enjoys working with students. "I enjoy the classroom but I especially want to work with students on a one-to-one basis. The close interaction is what I value the most."



FORUM FOCUS

Collin Bruce *is a junior in ISE whose hobbies include reading, listening to music, playing racquetball, and, in his own words, "Just taking it easy.".*

Materials Engineering to diversify

The Materials Engineering Department is in the midst of change. A new program has been initiated in which MatE faculty and other faculty members throughout the university are jointly appointed. Dr. Gerald Gibbs, a University Distinguished Professor in Geology, is the first person to participate in this program. He will spend half of his time in the Geology department and half in the Materials Engineering department. Plans are also underway to change the department's name to the "Department of Materials Science and Engineering." The joint appointment program and the new department title will emphasize the interdisciplinary scope of Materials Engineering.

The Need for Alternate Energy

by Grady J. Koch

The cost of energy is a major factor in the United States' economy. This fact is sorely being felt from the crisis in the Persian Gulf. In addition to the strain of high-priced foreign petroleum, concerns about the environment have forced new legislation (The Clean Air Act) to have been recently revised. Clearly, to preserve the health of the American economy, the United States must find cheap, clean energy that is not reliant on foreign oil.

To understand how this may come about, it is interesting to study the problems of the past and the conditions of the present. This is addressed in the rest of this article. Also in this issue is a reprint from the *Virginia Tech Engineer,* the predecessor of the *Engineers' Forum,* titled "Adoption of the Diesel for Automotive Use." This reprint, which first appeared 50 years ago, explains the technology that developed the benefits of the Diesel engine for automobile use.

"Alternate Energy Research at Virginia Tech," also in this issue, explains efforts in solar energy, biomass energy, and efficient wood combustion. The unfortunate fate of Virginia Tech's nuclear engineering program is told in Stephen Payne's article, "No More Nukes (At Virginia Tech)."

The Middle East October War of 1973 severely damaged the world's oil supply. A crucial pipeline in Syria was destroyed by Israeli bombardments; oil production was cut by about 800,000 barrels per day. Also in October, 1973, Arab Oil Ministers initiated a production cutback in protest of Israeli occupation of disputed territory. This caused a shortage of petroleum in the U.S. that prompted long lines at gas stations. The Oil Embargo was lifted in about six months, but the shortage was long enough to realize the dependence of the American economy on foreign oil.

Many programs were initiated in response to this realization. The U.S. built a reserve of oil; there is enough reserve today to keep the U.S. running at a current consumption rate for 34 days. More importantly, interest in energy efficiency and alternate energy increased. The government dedicated more money to alternate energy research. Fuel efficiency of cars increased; today's cars average 7 more miles per gallon than a car made in 1973. American consumers also got into the act by using more insulation in homes, caulking around windows and doors, and turning off unnecessary lights.

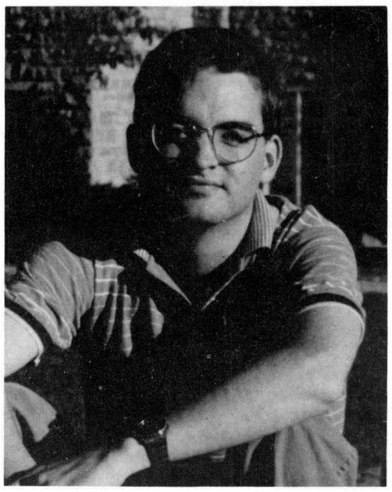
Despite this interest in energy efficiency and independence, the U.S. is still perilously reliant on foreign oil. According to 1989 Department of Energy statistics, petroleum accounts for 42% of U.S. total energy consumption. 41% of this oil is imported.

The U.S. is in the midst of another unpleasant reminder of the danger of foreign oil dependence. In August, 1990, Iraqi forces invaded Kuwait. Only four days after the invasion, the price for a gallon of unleaded gas rose an average of 7.1 cents; prices have continued to rise since then. Predictions for the price of oil in the event of a war in the Persian Gulf vary, but one thing is certain: the U.S. economy will painfully suffer.

If the world is fortunate there will be no war and the U.S. should take heed of an important lesson — energy resources must be further diversified. If there is a war, the U.S. will have this lesson forced upon it.

The U.S. is fortunately paying attention to another problem — that of the preservation of our environment. Congress recently passed a revision of the Clean Air Act of 1970, calling for tighter restrictions on auto emissions and requiring cleaner burning gasoline. Acid rain, airborne toxins, and ozone-eating chemicals are all targeted for serious reduction. The cost for industry to implement the Clean Air Act is estimated at $25 billion a year. This high price tag will certainly heighten interest in energy economy and cleaner, alternate sources of energy.

With the challenge of reducing dependence on foreign oil and implementing the Clean Air Act, the U.S. has serious work to do in the coming years. The American consumer is a important factor in facing this challenge. We must understand that change is going to come; our comfortable lifestyles may by altered. I'm doing my part by not driving to campus anymore.



FORUM FOCUS

Multi-talented EE senior ***Grady Koch,*** *father figure to the* Engineers' Forum *staff, calmly contemplates life after graduation.*

EDITOR'S NOTE: The following article was published in the November 1940 issue of The Virginia Tech Engineer, the *Engineers' Forum* of its day. The first page has been designed to approximate the look of the original article. The following pages return to a more modern format.

THE VIRGINIA TECH ENGINEER
VIRGINIA POLYTECHNIC INSTITUTE

VOLUME XVI NOVEMBER, 1940 NUMBER 1

Adoption of the Diesel for Automotive Use

New Improvements That Have Made the Diesel Practical for use as an Automotive Power Plant

J. L. LANKFORD '42

Contrary to general opinion, the Diesel or compression ignition engine is older than the gasoline engine. The increased use of this engine in automotive power plants is due to a number of basic improvements which have enabled this type to perform duties of a faster and more flexible nature than was heretofore possible.

The Diesel has advantages which advocate its use as a source of power for automobile vehicles.

1. An advantage which is of more importance in some other countries than in the United States is the fact that Diesel fuel is more readily obtainable than gasoline.

2. The Diesel is much more economical in fuel consumption than a gasoline engine of comparable size.

3. The exhaust gases of the Diesel are less obnoxious than those of the gasoline engine.

The fact that the fuel of the Diesel engine is less volatile than gasoline and therefore presents less fire hazard may be advantageous for marine and aircraft use, but does not make a notable difference in highway vehicles.

Of course the Diesel has disadvantages which make it less desirable in some instances.

1. Even with the new improvements it is difficult to equal the flexibility of the gasoline engine.

2. Because of the higher working pressures, the construction of a Diesel is necessarily heavier.

3. Although the injection system on modern Diesels is positive and accurate, they are rather delicate in some ways and require expert adjustment.

Before a discussion of the innovations and developments that have given us the modern Diesel, let us consider some of the basic differences between this type and the gasoline or spark ignition engine.

In the gasoline engine the explosive mixture of gaseous fuel and air is mixed in an external chamber before it is introduced into the cylinder. After this mixture has been compressed in the cylinder to a pressure of approximately 100-115 p.s.i., an electric spark from the spark plug ignites the mixture. In the Diesel, however, we find a slightly different principal. In this engine pure air is drawn into the cylinder and compressed to about 500 p.s.i. or more. At this pressure the air obtains a temperature of close to 1000 degrees Fahrenheit, and will ignite the finely atomized spray of fuel that is introduced at this time through the ignition nozzle.

The air-to-fuel ratio of the average gasoline engine is about 14 parts of air to 1 of fuel by weight. In the Diesel the air-to-fuel ratio will vary from 20 to 1 at full load to around 100 to 1 at idling.

The compression ratio of an engine is the ratio of the volume of the cylinder displaced by the piston on its upstroke to the volume of chamber which is above the piston at the end of its upstroke. In the gasoline engine this ratio is in the neighborhood of 6:1, in a Diesel it may be as high as 16:1 in the automotive type.

A well-known trouble with gasoline engines is their tendency to detonate under certain conditions of fuel, load, and compression. This is due to the too-rapid burning of the mixture in the cylinder. Since compression has an effect on the rate at

Continued from previous page
which ignition progresses, it can be seen that in the gasoline engine compression is somewhat limited. In the Diesel, however, a rapid burning fuel is desired since compression is performed before any fuel is injected.

These are the more salient differences in the two engines. Of course, there are many other minor differences in auxiliary equipment and details of construction, but mechanically these engines are rather similar.

One of the most difficult problems confronting the designers of automotive Diesels was that of pressure rise. It is evident that this engine would subject its parts to a greater strain due to the much higher pressures with which it operated. It was not the high pressure as such that presented the problem, however; the engine could easily stand higher pressures than it would ever encounter under operating conditions. The difficulty in changing from the massive, slow-speed, large-bore engines of the past to the lighter, small-bore, high-speed engine which was necessary for the required horsepower per unit weight, was in the rate of pressure rise. In the gasoline engine the rate of pressure rise will vary from 15 to 20 pounds per degree of crankshaft rotation. The maximum in this engine is about 450 pounds for 30 degrees of travel. In the Diesel, this rate is often 50 pounds per degree reaching a maximum of 1500 pounds. The detriment to bearings and working parts would not be excessive if this pressure were applied gradually, but when the application of such pressure comes suddenly, no machine can hold up long.

In the older engines the combustion chamber was of the "open" type, or merely an extension of the cylinder. In order that the fuel should properly mix with the air in this type, a multiple orifice spray nozzle was employed with a number of openings of about .005 inch about its circumference. To overcome the resistance offered by these holes an injection pressure of approximately 20,000 pounds was needed. Although this type of chamber is simple and economical of fuel, it requires excessive injection pressure, higher air compression, and most of all it brings about a high rate of pressure rise.

Various types of chambers were tried by engineers to overcome these difficulties. They were: The pre-combustion chamber type in which the spray was introduced into a small auxiliary chamber, the air-cell type in which an extra supply of air to prolong combustion and decrease rapid pressure changes was held in an opening in the piston or combustion chamber, the ante-chamber type which was similar to the pre-combustion chamber type. All of these types had distinct advantages over the old open type, but they were possessors of disadvantages which caused designers to seek still better systems. Two typical and recent types are the turbulence-chamber type and the energy-cell type. Both of these have found use on modern trucks and other vehicles. I shall attempt a brief explanation of the principle of their construction.

The turbulence-chamber type sought to remedy the defects of former types and to effect a slower rate of pressure rise. In this type the combustion chamber proper is removed from the main cylinder by a restricted passage. These chambers, which are designed to accommodate 80 percent of the compressed volume, are roughly spherical in shape and are disposed tangentially in relation to the communicating passage. Air forced into this chamber on compression is given a rapid and accelerated swirling or turbulent motion. The fuel is injected into the turbulence chamber and due to the motion of the air it is intimately mixed with the air. Combustion takes place rapidly in the chamber, but due to the restricted passage the pressure on the piston is steady and gradual. This type works at a considerably lower injection pressure and a single-orifice pintle type nozzle can be used.

One of the most successful types used is the Lanova system which is used on the Mack-Lanova Diesel. In this type, employing the energy cell, the main volume of the air remains in the main combustion chamber thus avoiding the scavenging, cooling and air pumping difficulties encountered by the other types. The system consists of an 8-shaped combustion chamber in the top of the cylinder situated centrally over that piston. In one of the lobes of this arrangement is the cell, which is one chamber inside another; the other lobe is the injection nozzle. The smaller inner chamber of cell opens into the throat between the lobes of the combustion chamber by a venturi tube, the smaller and larger chambers are in turn connected by a venturi. In operation about 10 percent of the air goes into the energy cell while the rest whirls around in the figure 8 of the upper chamber. The fuel is sprayed in from the nozzle and most of this enters the throat of the energy cell, although some of it starts a week combustion in the space outside. Most of the fuel enters the inner chamber where rapid combustion occurs. This explosion and its accompanying pressure rise blows the remainder out of the inner chamber into the main combustion chamber where it swirls around in continual turbulence as it burns. The turbulence and the restriction of the two venturis cause a smooth and gradual burning and pressure relative to older types. Thus the designer's aims are realized. Here is a type with low pumping losses, high turbulence, low rate of pressure rise, possessing a simple injection nozzle with low injection pressures and being singularly respondent to variable operating conditions.

One of the greatest obstacles was thus overcome in the development of modern engines. A method had been found to secure higher rotative speeds with smaller bores without encounter-

Continued from previous page
ing excessive vibration, strain, and lack of flexibility.

After the problem of the rate of pressure rise had been solved by the use of energy cells and similar devices, engineers turned their efforts toward the perfection of some type of fuel injection and distribution system that would satisfactorily serve the needs of the modern engine. The injection systems on modern engines may be divided into two type, the multiple unit injection system and the individual unit injection system.

The importance of the present Diesel injection system to its operation can not be over-emphasized. Since the power and ignition in the Diesel are dependent upon the time, pressure, and quantity of the fuel injected, it is obvious that a very accurate and dependable means must be found to accomplish these things. The injection system on a modern Diesel must be made with the accuracy of the finest watch, and yet must be constructed to withstand tremendous hydraulic pressures.

In all systems some type of low pressure pump is used to pump the fuel from the tank to the injection pumps which force the fuel through the nozzles into the engines cylinders.

In the individual unit type, each cylinder is fitted with its own pressure pump and nozzle which are operated by mechanical means such as a push rod and rocker arm. In the multiple unit type, the high pressure pumps for each cylinder are contained in a separate unit driven by gears from the engine and supplying the nozzles through high pressure tubing lines.

The advantages of the simple, compact multiple unit system over the involved, relatively trouble-some individual unit system are numerous. The individual system is compulsory for use on engines having high injection pressures, however. This is true because of the inadvisability of sending fluid under such high pressures through feed tubings to each cylinder. The individual type must necessarily be placed out of adjustment every time any work is done on the cylinder or nozzles. The presence of mechanical linkages in this system offers added opportunity for mechanical inaccuracy in operation and for improper adjustment and setting by inexperienced mechanics.

The multiple units are compact and definite and have shown excellent results on low pressure injection engines. These highly accurate precision instruments are manufactured by specialists who work with tolerances of one-millionth of an inch. The units are often sealed at the factory, and if any adjustments or repairs are needed after installation they are made by a trained mechanic employed by a world-wide service organization maintained by the manufacturers of the injection equipment.

Since this article is intended only as a general discussion of principles —the improvements of recent development — a complete description of all auxiliary equipment would by superfluous. For that reason the treatment of metering and injection nozzles shall be brief.

It is necessary in the modern engine that the fuel delivered at each injection be varied from a minute droplet the size of the end of pin to a drop of a reasonable size. The amount going to each cylinder at any one time can vary only within very close limits. This metering of fuel is accomplished in different ways of modern Diesels, but the principle is essentially the same in all cases. This consists of varying the output of the high pressure pump by some means. A slotted or grooved pump piston with accompanying relief ports or a system of relief valves is generally employed to perform this duty.

Nozzles were formerly of the multiple-orifice type when used with the open type combustion chamber engine. This type contained a number of very minute orifices which required tremendous pressures for proper injection. These tiny openings rapidly filled with soot and residue and caused faulty operation. The modern, low pressure injection, turbulence type engine employs a single-jet nozzle as a rule. This type has one relatively large opening which will keep itself clear of residue and foreign matter. Of the single-jet type, the pintle nozzle is most generally used. This is a hydraulically operated nozzle working at pressures of approximately 1700 p.s.i. A needle valve with a "pintle" or extension is employed to seat in and through the orifice. This valve will open quickly at the desired pressure and close easily and firmly after the desired amount of pressure drop. Another type of valve is the "closed type." This is very similar to the pintle valve except that it does not contain the extension on its needle.

In this article the following improvements, which have been responsible for the modern Diesel as found in trucks and tractors, are discussed:

Improvements and changes in combustion chambers — Pre-combustion chamber, Air-cell, Antechamber, Turbulence chamber, Energy cell; Fuel injection systems — Multiple unit system, Individual unit system; Metering methods; Injection nozzles.

There are other auxiliaries and fixtures on the present day engine that have undergone radical changes in the last few years. These improvements have been of a more general nature. The improvements discussed, with perhaps a few exceptions, are the ones that are considered by most engineers as those responsible for the present use and adoption of the Diesel in automotive capacities.

List of references and sources of quotation and material. —*Diesel Handbook,* Rosbloom; *Understanding the Automotive Diesel,* Mack Trucks, Inc.; *Mechanical Engineering,* feature articles and notes of recent improvements.

Tech leads in solar

Already home to the most extensive solar energy research program in the country, Virginia Tech has also made great strides in bio-based materials research and wood combustion research.

by Grady J. Koch

SOLAR ENERGY

Dr. Saifur Rahman, Professor of Electrical Engineering, is the director of the Alternate Energy Laboratory. This lab is the home of the most extensive university solar energy research program in the United States.

Dr. Rahman's work is internationally known; he has travelled to over 25 countries to share his expertise. He also consulted with Virginia Tech students in the design of VT Solaray, a solar powered car.

The roof of Whittemore Hall is adorned with glistening solar panels. These panels are generating a significant amount of power — 3 kilowatts in optimum conditions. DC electricity is converted into AC and directly helps supply the building's electrical demand.

The Alternate Energy Lab also studies how meteorologic conditions affect the amount of power that can be generated. A solar tracker, also on the roof of Whittemore, points directly at the sun to measure the strength of direct solar radiation; global radiation, wind speed, and temperature are also monitored. These studies allow prediction of the amount of power the solar cells can accommodate. A power generating station may use these predictions to estimate how much non-solar power is necessary.

Dr. Rahman has travelled to many developing countries, including South Korea, Ethiopia, Indonesia, Pakistan, and China, to assist in their power generating needs. Solar power is often used in remote areas of these countries to provide lighting and water. Dr. Rahman has also set up university training curricula and computation links to larger countries for energy system modelling.

Dr. Rahman sees a global environmental problem with power generation, especially coal burning. Coal burning is a primary source of large scale power generation. While solar energy can't be a primary source, his research has shown that the demand for energy from coal can be reduced by using localized solar power, such as the system used in Whittemore Hall. The amount of electrical load that can be handled by localized solar power can be precisely predicted.

In addition to solar energy, the Alternate Energy Lab is concerned with wind, thermal, and nuclear power. Dr. Rahman worked on restoring a small hydroelectric plant in Virginia. These small scale power plants were common in the early part of the century, but became too expensive to operate when central station electricity reached remote areas. These plants are profitable once again because of government sponsored economic incentives.

energy research

BIOBASED ENERGY

Dr. Wolfgang Glasser, Professor of Wood Chemistry, is the director of the Biobased Materials Research Center in the College of Agriculture and Life Sciences. Dr. Glasser's research has involved many groups including the College of Engineering, the College of Human Resources, and industry.

Biomass is organic material such as wood and agricultural residues, corn stalks, peanut shells, sorghum bagasse, etc. A wide range of useful products can be processed from biomass: plastics, motor fuel, pharmaceuticals, and textiles. Many of these materials are today processed from petroleum.

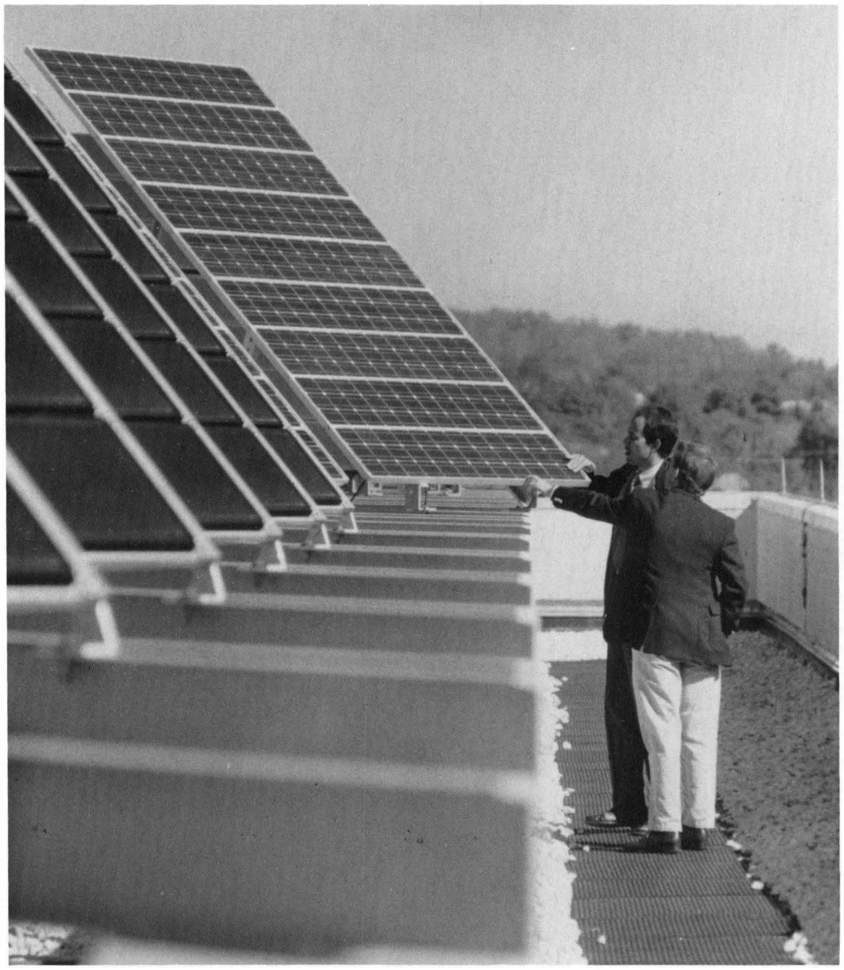
A large part of biomass processing is dedicated to woody biomass because woody plants are the most abundant renewable organic material produced by photosynthesis. The exact chemical makeup depends on the type of woody biomass, but it is all a combination of three natural polymers: cellulose, hemicellulose, and lignin.

Many chemicals are derived from these components of wood, usually by fermentation or hydrolysis. Some of these chemicals include cellulose, charcoal, ethyl alcohol, fatty acids, pine oil, rayons, rosin, sugars, turpentine, and vanillin.

Of particular interest to alternate energy is the use of woody biomass to produce chemicals now made from petroleum. Ethanol, a motor fuel, is produced by the fermentation of glucose; glucose is made by the hydrolysis of cellulose.

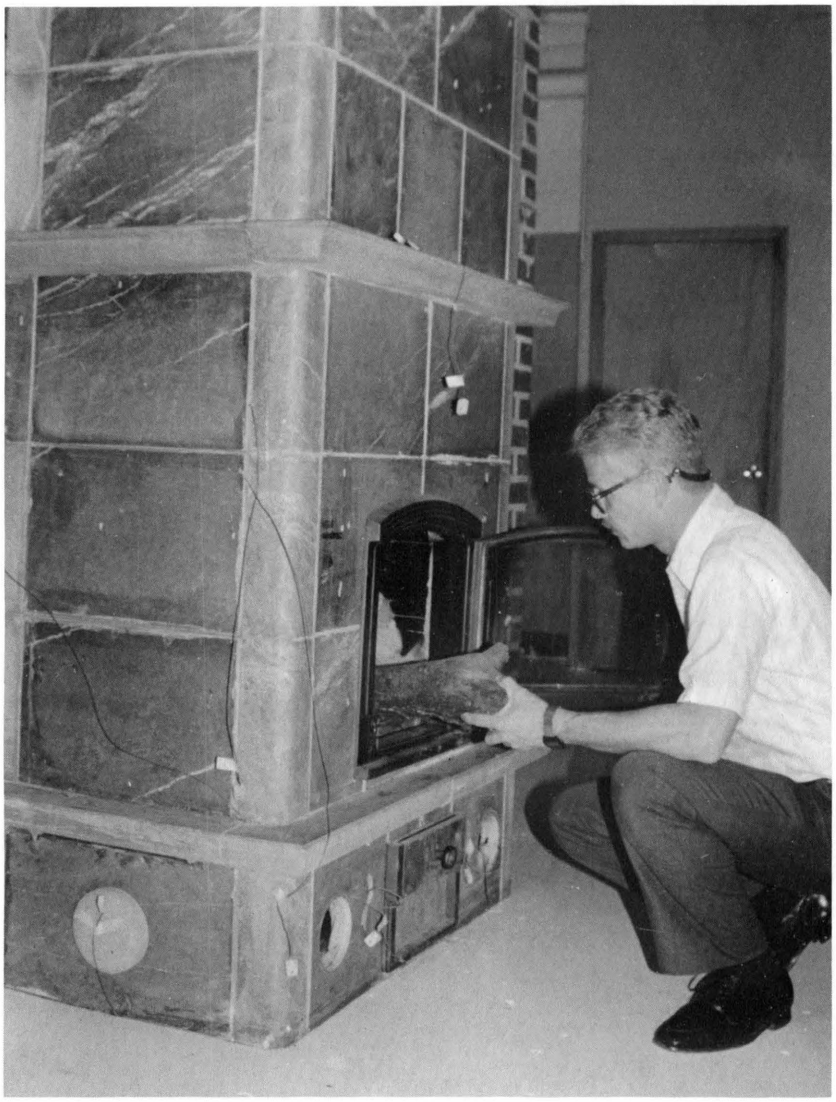
The Biobased Materials Center

Continued on next page



Grady Koch, electrical engineering senior, and Dr. Saifur Rahman, director of the Alternate Energy Laboratory at Virginia Tech, inspect the solar panels located on the roof of Whittemore Hall.

"...the demand for energy from coal can be reduced by using localized solar power..."



Dr. Dennis Jaasma, professor of mechanical engineering, adds wood to a fireplace involved in wood energy research.

Continued from page 13
is currently working on making biodegradable plastics from wood chemicals. Lignin is being used to make rigid polyurethane, a high efficiency insulator.

The Biobased Materials Center is also involved in a cooperative effort with a company in Floyd, VA, to study processing of woody biomass.

"Of particular interest to alternate energy is the use of wood biomass to produce chemicals now made from petroleum."

Processing involves the use of a machine called the Stake-Tech Digester. The Stake-Tech Digester hydrolizes woody biomass with high pressure steam and allows for the easy separation of cellulose and lignin. This easier separation allows for quicker and cheaper processing of biomass produced chemicals. The Stake-Tech Digester is the only one of its kind operating in the United States. Current research is on recycling and processing of telephone books.

Dr. Glasser has confidence in the ability of biomass to handle the task of producing chemicals now made from petroleum. Processing of biomass today isn't cost effective, but the elevating cost of oil may change this. For example, Brazil, where 80% of motor fuel is ethanol, has found biomass to be cheaper than importing oil.

"...wood combustion will play a larger role in energy production of the future..."

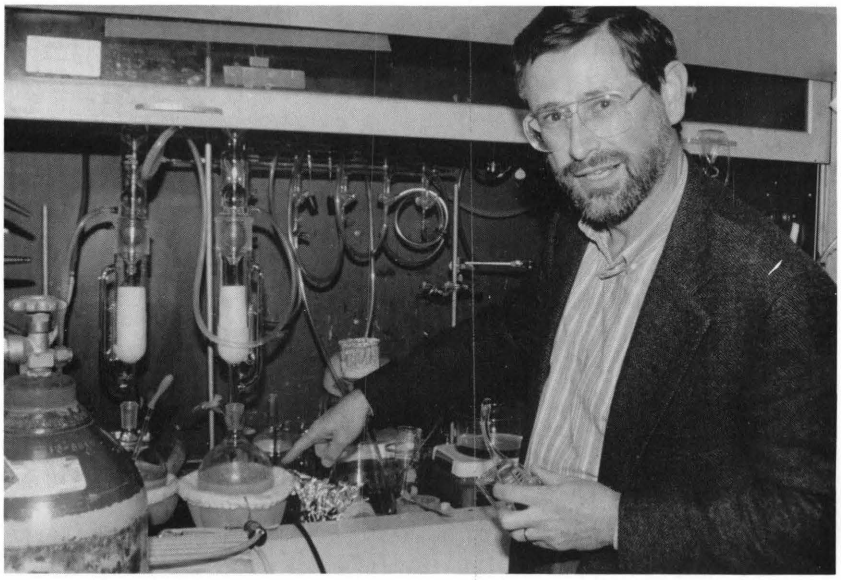
WOOD COMBUSTION

Dr. Dennis Jaasma, Professor of Mechanical Engineering, studies wood burning — wood stoves and fireplaces. Many residential homes are heated by wood stoves; about 300,000 of them are sold every year. Dr. Jaasma is studying the emission of wood stoves as well as their combustion efficiency.

Pollution from wood stoves, seen as smoke, is of concern for several reasons. Smoke contains chemicals that are potentially noisome to the environment such as carbon monoxide and hydrocarbons. A particular group of these hydrocarbons, known as polynuclear aromatic hydrocarbons, can be carcinogenic.

When Dr. Jaasma began research at Virginia Tech 12 years ago, very little was known about wood stove emissions. One method he developed, known as the Dilution Tunnel Method, for measuring emissions has been adopted by the Environmental Protection Agency (EPA). The EPA uses this method to test commercial wood stoves.

As of 1988, wood stoves were required to meet EPA standards. Their requirements have been made stricter in 1990. The Dilution Tunnel Method works by collecting exhaust from the stove in a hood. A sample from this collection is drawn through a series of filters. Gravimetric analysis of the filtered material tells how much particulate matter is present. Calculations can then be made to determine the emissions from the stove.



Dr. Wolfgang Glasser, director of the Biobased Materials Research Center at Virginia Tech demonstrates ethanol research equipment.

Some of the materials in smoke are chemicals that could have undergone combustion — wasted energy. Dr. Jaasma has developed accurate methods for measuring stove efficiency. The Department of Energy funded this research to find the best method for measurement of stove efficiency. Recent research includes field studies of wood stoves. A low-cost sampler for emissions was developed at Virginia Tech. For the past two winters this sampler has been used at a town in Colorado.

Laboratory facilities at Virginia Tech include several dilution tunnels for wood stoves and fireplaces. A state-of-the-art room calorimeter is also available to measure heat output of stoves and fireplaces, necessary for efficiency calculations.

The room calorimeter is a well-insulated compartment into which the appliance under test is placed. Air is blown through the room at a known rate, and the temperature rise of the air is recorded to obtain a direct measurement of heat output. This calorimetry room is sensitive enough to detect the heat output from a human body.

Dr. Jaasma feels that wood combustion and biomass will play a larger role is energy production of the future. He also sees localities regulating wood stoves more strictly. Localities may also start to regulate fireplaces; the EPA does not yet regulate them. Research is currently under way to measure fireplace emission.

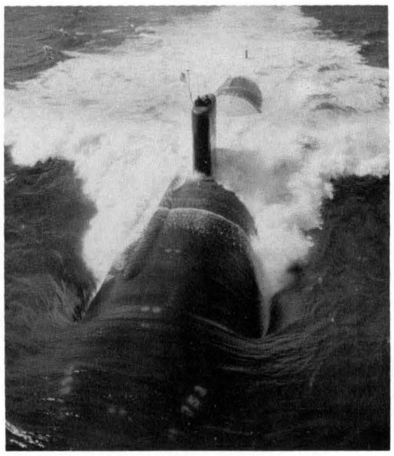
NO MORE NUKES at Virginia Tech

by Stephen Payne

It seems that the Virginia state budget cut has affected Virginia Tech in another way. Due mainly to a permanent reduction in the base budget for the 1990-1991 academic year, students can no longer obtain the "Nuclear Engineering Option," a specialization in the nuclear sciences in addition to a student's regular course of study.

The nuclear option was here last year, and all of a sudden it's gone. Following some sort of 'trend,' the nuclear engineering program was cut off totally, and it will affect more than just a few students.

The nuclear engineering option in general consists of 11 semester credits worth of specialized engineering courses. During the sophomore or even the freshman year, a student will take both of the one-credit introductory-level courses. These courses are mainly informative, with topics of discussion ranging from radiation and the operation of the modern nuclear power plant, to waste disposal, safety, and the practical applications of nuclear science. In particular, these courses have always had a significant proportion of non-engineering majors as well as engineering majors because it is a basic, short course in nuclear energy that serves more or less as a 'Nuke 101.'



U.S.S. Albany (SSN753)
Los Angeles-Class
Attack Submarine
Photo courtesy Newport News Shipbuilding

During the junior year of study, a student takes a three-credit 3000 level class called "Fundamentals Of Nuclear Power Generation" that deals with the basic design and physics of a nuclear reactor. Finally, during the senior year, the option is fulfilled by successfully completing two separate three-credit 4000 level courses, which consist of lessons in reactor physics and heat transfer, as well as a thorough examination of the nuclear fuel cycle.

Since all of the three credit courses can be used as credit for technical electives in most engineering disciplines, enrollment is not restricted only to those participating in the option. After fulfilling the 11-credit requirement, the candidate's transcript indicates that the Nuclear Engineering Option has been completed.

In order to understand why the option was discontinued, you must first understand how the system is set up. The nuclear engineering classes at Virginia Tech are taught within the Mechanical Engineering Department. Mostly Mechanical Engineering and Engineering Science and Mechanics majors pursue the option, along with a few others. However, due to the five percent reduction in state funding this year, the M.E. department's budget was cut by about $100,000. Because of this reduction, M.E. Department Head Dr. Robert Comparin was forced to eliminate something. Apparently, every effort was made in order to do the "least amount of damage" to any part of the university by reducing the number of personnel and reducing the number of classes offered. For instance, instead of hiring temporary faculty, professors already at the university are teaching other courses, which kept the hiring of new personnel to a minimum.

The M.E. department's budget cut was only part of the tens of millions of dollars of annual losses faced by the university as a whole. Fixed cost increases for things like utilities, insurance, and fuel, resulted in a combined $14 million in reductions of funds for the university. Although the operating budget for non-personnel services has remained relatively constant for the past ten years, the costs of providing a standard higher education have risen since then by nearly 75 percent.

The controversy began in the spring semester of this year when the painful reality of Virginia's budget cuts were beginning to become more noticeable. At an M.E. department faculty meeting it was made apparent that the nuclear program was in danger. Once these budget cuts came through, the decision was finalized. Students were not even involved in this decision; they were not even asked. In fact, students were not made aware that the program had been dropped until their arrival here this August, when their class ticket told them the classes had been withdrawn. Much to their surprise, it was the whole program, and not just separate classes, that had been dropped.

One reason for the dropping of the nuke program to alleviate some of the budget reductions was the program's steady decline in enrollment over the past few years. In fact, last year's enrollment was approximately 50 percent of what it was four or five years ago.

The nuclear option was here last year, and all of a sudden it's gone. Following some sort of 'trend,' the nuclear engineering program was cut off totally, and it will affect more than just a few students.

Even though the bulk of students in the nuclear engineering classes are mechanical engineers, there are always a number of other majors who will now not be afforded the opportunity of a nuclear engineering education. For those who specifically came to Virginia Tech for the Nuclear Engineering option, the outlook is grim. As for other students taking these courses but not pursuing the option, this just means that more technical electives will not be offered and that some other courses will have to take their place. And even for non-engineering majors, the introductory classes unfortunately no longer exist.

Of course, the closest thing now is the University of Virginia, where a full-fledged undergraduate degree is offered in Nuclear Engineering. There are also a small number of graduate schools throughout the country with programs in Nuclear Engineering.

One common concern of many is the fairness of this cut to the students. It was proposed to continue the program for at least one more year, so that those currently in the middle of the option could complete their studies by the end of this academic year. It was also proposed to continue the introductory courses on nuclear energy for as long as possible, due to their popularity and informative nature. Yet another proposal consisted of the possibility of getting a televised course or two from the nuclear engineering program at the University of Virginia. But as it turned out, the exact courses needed could not be obtained and this also would have been very expensive — not exactly a plus in our present budget situation.

And just as the nuclear engineering program was so suddenly dismissed, the biomedical engineering program, another option to a degree offered by the mechanical engineer-

Continued on page 18

Continued from page 17
ing department, is now being "phased out" over the next few years. "Even though the enrollment in the biomedical engineering program is not red hot, it is still more popular than the nuclear engineering program," Comparin said.

Perhaps one of the biggest proponents of keeping the program alive at Virginia Tech was Dr. Thomas Parkinson, a professor in the mechanical engineering department who taught all of the nuclear courses. (Parkinson has recently retired.) His main concern with discontinuing the nuclear program was centered on the students. First, what would happen to the students who were caught in the middle of completing the option, and would they be offered a chance to finish it? Also, what would happen to the one-credit introductory nuclear courses? These courses were very important to Parkinson because they seemed to provide much needed information about nuclear energy to the uninformed.

Parkinson was also faculty advisor for the student chapter of the American Nuclear Society here at Virginia Tech. Dr. Gerhard Beyer, a professor in the chemical engineering department and former instructor of some nuclear courses has taken over as faculty advisor of the society, a group of 20 students. Despite the current situation, the group continues to meet approximately once a month, makes numerous plant trips, and still tries to stay active.

What does this sudden cut mean outside of Virginia Tech? Are there specific companies looking for nuclear engineering students from Virginia Tech or elsewhere these days? Diane Topping, an employment representative from Babcock & Wilcox's Naval Nuclear Fuel Division, makes the point that they "don't necessarily hire many nuclear engineers [and that] most of [their] new hires tend to be primarily MEs and EEs. Also, most of B & W's new engineers tend to be involved in the safety aspect of the nuclear industry." She says, though, that there is a shortage of NEs.

Stephen Blickenstaff, manager of employment and relocation at B & W, added that he is "always disappointed to hear about the cancellation of a nuclear program." He maintains that they "do still want Virginia Tech MEs and EEs, and that [they] always try to strengthen relations with the university community."

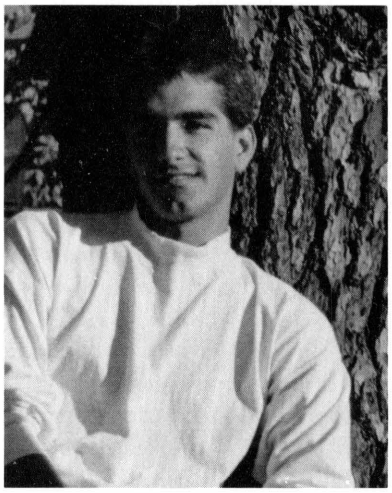
Dr. Gary Downey, an Assistant Professor of Science and Technical Studies at the Center for the Study of Science In Society, has done extensive research on the organization of public controversy, including an intensive study of the debates on the development of nuclear power and on nuclear waste disposal. He believes that "in the future the nuclear engineering option will likely return, since it is a highly efficient method of generating electricity."

Dr. Robert Comparin stressed dealing with the budget cuts so that the least amount of damage would be done. Comparin remains firmly convinced that a five percent reduction in funds will not hurt the department severely, if properly accommodated, and that he is doing what he believes will affect the least amount of students. He also stressed that the decline of nuclear energy bothers him, citing that it is an essential and efficient alternate energy source.

Comparin made the point that nuclear energy was first developed in this country but that our technology and nuclear energy's popularity has been championed by other countries, particularly Japan and France, where the use of nuclear energy provides at least 50 percent of their power.

In a letter last May to all Virginia Tech students, President James D. McComas stated that "budget realities will mean reduced class offerings" and that "the impact of this...is significant to our programs and to our mission." He explains the importance of higher education, and holds adamantly that the university is proud of its students, faculty and staff and that it will make every effort to maintain its quality during this period of budget reductions.

Since the mailing of this letter, a new dean of engineering, Dr. Wayne Clough, has taken office, replacing 20-year Dean of Engineering, Paul Torgersen. The new dean has already had to deal with even more budget cuts and more bitterness from the students about these cuts. With still more budget cuts likely, it remains to be seen if the College of Engineering will be able to maintain its mission without anymore significant program changes.



FORUM FOCUS

Steve Payne, *a senior in mechanical engineering and a future* GQ *model, is seen here sporting the latest in full fashion.*

The Freshman NIGHTMARE

by Mike Reese & John Cole

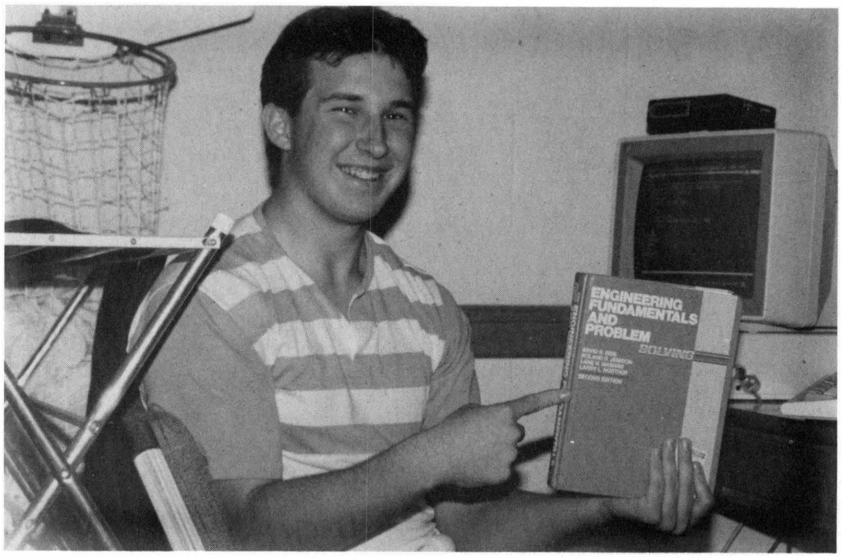
After their first few months of their college education, many freshman engineering students are left with a dumbfounded look on their face. Memories of high school teachers' warnings of the workload to come race through their fatigued minds. These students — who months ago were big-shot graduates relaxing in the sun thinking of the four party years ahead of them —have been struck with reality.

The nightmares have come true: endless homework, multiple tests on a single day, and computers that continually print out errors. Not all, but most students find themselves panicking in the late hours of the night over homework they thought would only take five minutes to complete.

On top of all of the pressure added by engineering studies, many of these undergraduates are, for the first time, struggling through life on their own. They are trying to differentiate the sin8(tan(4x2 + 3,494,565)) while in the back of their heads they are trying to figure out which clothes go in hot or cold water. Their minds are battered after reading highly-technological literature, such as "Introductory FORTRAN" and "Your ATM Bank Card and You."

No one is there to remind them as they awaken that they must be at class in ten minutes, as the alarm clock bids them to arise into the Siberian like morning air.

But not every freshman in the Engineering program is at this point. "Due to A.P. credit, this semester hasn't been as challenging as I expected, but I dread the second semester load," said Tony Aquino. Jay Rineer added, "The College of Engineering is damn challenging, but it is preparing us for our future which makes it worth it."



Kevin Stephenson, a freshman in General Engineering, shows off a textbook while FORTRAN encompasses the computer screen behind him.

The main subject that trips students up is five-hour Calculus. Almost a third of all the students failed the course last year. Most students describe the course as difficult, hard, and painful. Bob McClelland, who awakens each morning to face his instructor at eight o'clock, added this description: "Early." Five-hour Calculus in itself is a challenge, but at eight o'clock it is a courageous feat.

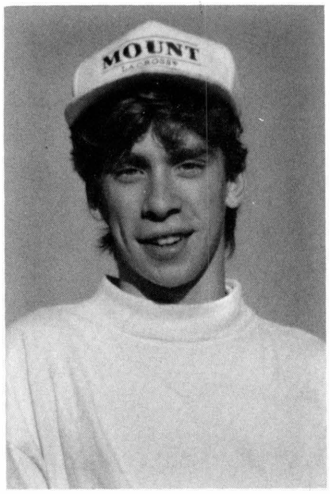
Another difficult class is Engineering Fundamentals. While some think the class is easy, others believe the class is overbearing. Most say the problem is that irrelevant subjects take up too much time. For example, the movies on the different engineering fields "don't give us an actual feeling of what happens in the workforce, and they are also outdated," according to Mike Hane.

Others, however, feel that the class is helpful in teaching different aspects of engineering. Mike Lee says, "I didn't really understand my computer for the first month, but once I got through that and the class centered on programming it really started coming to me."

Besides having problems with the curriculum of Engineering Fundamentals, the workload of the class comes as a shock to most students. Bob McClelland expressed a common sentiment when he said, "Every time I go to class I get four assignments. E.F. sure piles work on you."

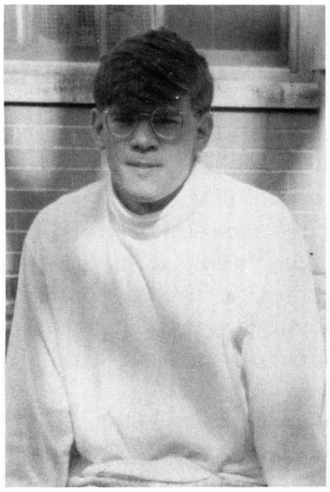
In addition to the workload in Engineering Fundamentals and other required engineering classes, students taking other electives can be

Continued on page 20



Forum Focus

***Mike Reese** is a freshman in general engineering who believes the true meaning of life can be found through the continuous viewing of Monty Python movies.*



Forum Focus

*When **John Cole** gets time away from his hectic freshman engineer's schedule, he enjoys playing soccer and listening to the tunes of Sting and Johnny Mathis.*

Continued from page 19

faced with an overwhelming workload. "I didn't have enough time to spend on my psychology class because of all the homework in engineering," said Glenn Keay.

Many students agreed they were hoping the average amount of work would be similar to high school, and are realizing that their grades might depend on spending more time on homework. "Personally, I don't have any complaints about the College of Engineering; I'm just having trouble adjusting to the increased workload and amount of studying required," explained Chris Schwarzen.

The one event that the students agree on as giving them the most trouble was the first test taken in the Engineering Fundamentals class. The average grade for classes ranged from the 80s to the low 50s. "The Engineering Fundamentals Department is being hypocritical, because the exams were standardized but the grading and material covered by Professors wasn't standardized," expressed Jen Frazier. Mike Lee disagreed with the questions asked because "if you need to know a DOS command you can look it up in the manual. We haven't used or talked about a majority of the questions since the test." The test is viewed by many freshman as being used solely to "weed out" students whom the College of Engineering doesn't want, and many students disagree with this method.

Even after their first year here at Virginia Tech, some students do make it. They become knowledgeable in studying, laundry, and, hopefully, engineering. Edgardo Colon, a senior in Chemical Engineering said, "Tech was tough, challenging, but definitely worth my time. If I had to do it all over I would pick the same major again." Perhaps the freshman engineers will be able to say the same thing in a few years when they are handed their diplomas.

Crunch

Continued from page 5

under another assessment in three years, Dean Marchman believes that the budget cuts are not going to place any of the programs in jeopardy. In reference to building construction, the planned 25 million dollar engineering /architecture project to be constructed behind Cowgill is presently on hold. Although the planning money has been approved, the state has currently frozen its use. When the funding is once again available, the project should begin to progress.

Outside of the College of Engineering, other departments have also had their budgets restricted. Apparently in response to the cutbacks, the math department has increased the size of its differential equations classes from about 30 students to over 70 in a section. And Bill Jackson, a sophomore in general engineering, said, "My physics professor was forced to take on an additional class...because they [the physics department] didn't have the money to hire another professor." With the increased workload and demands placed on the faculty due to the budget cuts, there will likely be a drop-off in the quality of instruction for many students.

The current budget restrictions are not that harsh when compared to what lies ahead. If a third round of cutbacks is ordered, the College of Engineering may find itself forced into the uncomfortable position of deciding between the needs of the students, faculty, and staff. In that situation, the course of action of the engineering department and the university would be determined by the severity of the restraints. Hopefully, the Commonwealth of Virginia will not find it necessary to impose any further budgetary reductions on our institution.

SEC News

by Timothy Baker,
SEC President

What's happening in the Student Engineers' Council? As usual, we are always looking to improve and expand any of the events that we sponsor. The following activities are being planned or have already taken place.

EXPO'90 was a big success again this year. We had 110 companies and there were 18 student organization booths. The engineering student resume book turned out well and was very successful so look for it again in 1991. Next year's EXPO will hopefully return to Squires Student Center if it is open by the latest planned grand opening. We are currently planning other improvements that will make EXPO '91 an even better experience for you and the company representatives.

We would like to thank everyone who helped with EXPO'90 and remind you we are looking for next years chairperson. If you are going to be in Blacksburg this summer and you like rewarding experiences, stop by the SEC office or give us a call. We need your support!

Recently, six SEC representatives attended the National Student Engineers' Conference at North Carolina State University. At this writing the details of the conference were not available. Look for the conference highlights in the next issue of *Engineers' Forum.*

On November 10 we held an engineering seminar entitled, 'WHAT'S NEXT: How To Become A Successful Engineer.' The topics included innovation, resume tips, corporate etiquette, interviewing techniques, plant trip preparation, job search suggestions, selling yourself and other related issues. We would like to thank Dr. Timothy Greene, Assistant Dean Pamela Kursted, Dr. Harold Kursted, Exxon Representative Roff Smith, and Placement Services Representative Ernest E. Andrews for taking time to share their knowledge with the students who attended. Also, thanks to everyone who attended, we hope your futures are filled with success!

Our next big project is Engineers' Week, which is held in mid-February. We are currently planning a week full of fun and interesting events. The tentative list includes the SEC Olympics, a dance, Engineer's Choice, lab tours, an exciting social, and several society sponsored competitions. This event will give you the chance to have some fun and prove that engineers are more than 'study-animals,' so look for E-week calendars and get involved!

If you have any questions or concerns about the College of Engineering, get involved with the Dean's Committee. Current topics of interest include transfer policies, undergraduate research opportunities, and course scheduling. Please talk with an SEC representative or officer for more details or watch for dates and times on the SEC showcase located in the tunnel of Norris.

We would like to remind you that the SEC is open to all students. We strongly encourage you to get involved with us or some engineering professional society that interests you. If you have any questions, please stop by the office in 110 Femoyer or call Tim at 231-6036.

Human Factors Society News

Human Factors is an interdisciplinary field combining engineering, psychology, anatomy, and physiology. The goals of the profession are to make products easier, safer, and more enjoyable to use, and to improve conditions in the workplace.

The Human Factors Department at Virginia Tech is a graduate program in the Industrial and Systems Engineering (ISE, formerly IEOR) Department. Several areas of human factors are studied in this department including the following: rehabilitation engineering, vehicle analysis and design, auditory systems, human-computer interaction, environmental and safety, displays and controls, and industrial ergonomics.

The Human Factors Society had their annual conference in Orlando, Florida. The conference, which ran from October 8-12, featured speakers in all major areas of human factors research, as well as workshops and day trips. Approximately 15 graduate students and 10 faculty members from the Virginia Tech chapter of the Human Factors Society attended the conference.

Students interested in learning more about the Human Factors Society (which consists of graduate and undergraduate students) or Human Factors Engineering should ask for information in 271 Whittemore Hall, or contact one of the following people:

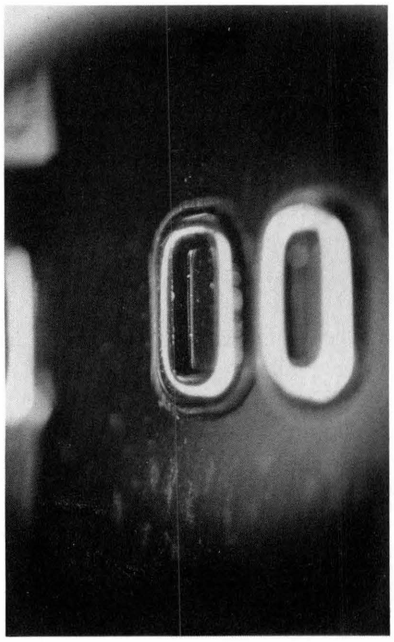
Jana Moore
(HFS President) 552-3745

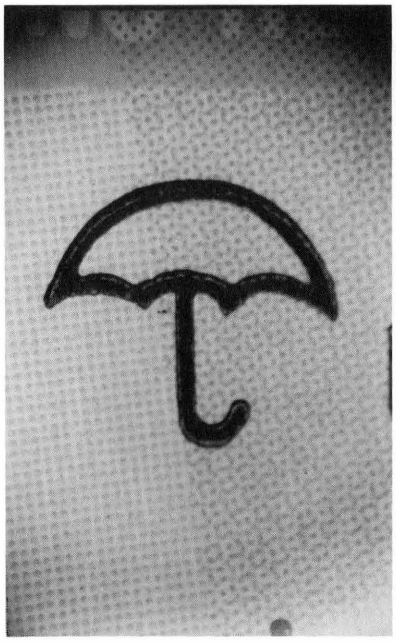
Jim Sayer
(HFS Treasurer) 951-2996

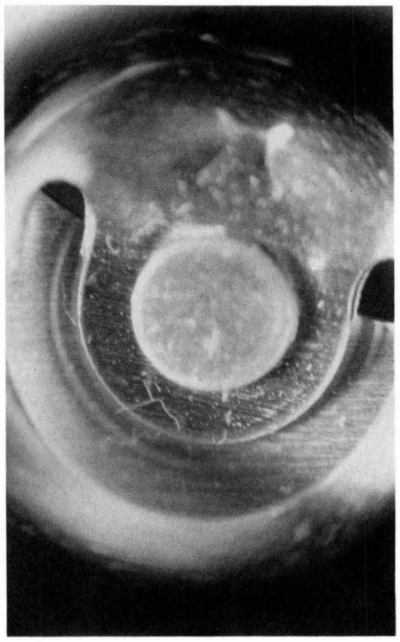
Angie Sebok
(HFS/SEC Representative)
951-3378

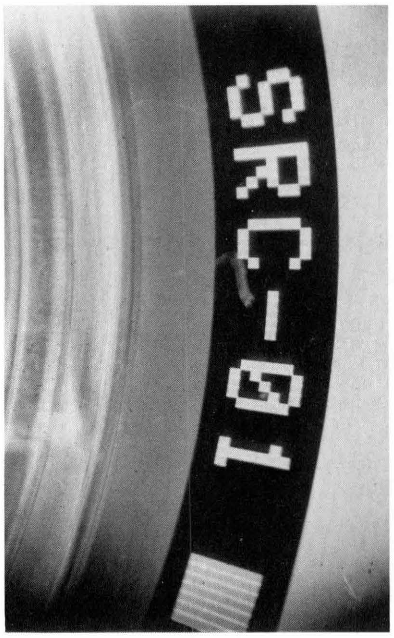
PICTURE QUIZ

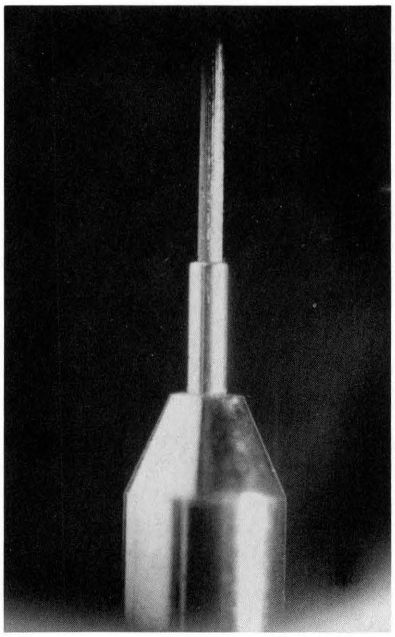
Photographer Mark Cherbaka captures some common objects in a somewhat uncommon light. Can you recognize these images?

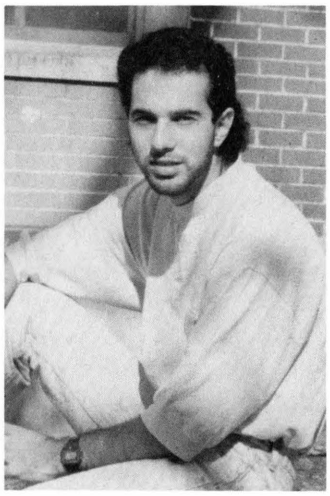












FORUM FOCUS

Rarely in front of the camera, ***Mark Cherbaka,*** *our photographer, is a sophomore in engineering science and mechanics by day and a dark room vampire by night.*

ANSWERS: *Top left:* Numbers on a credit card; *Top center:* VT football ticket; *Top right:* Beer can tab; *Bottom left:* Code numbers on a CD; *Bottom center:* End of a mechanical pencil.

Engineers with communications skills
are in high demand
in today's industry.

HAVE THE ADVANTAGE.
MEET THE CHALLENGE.

As a member of the

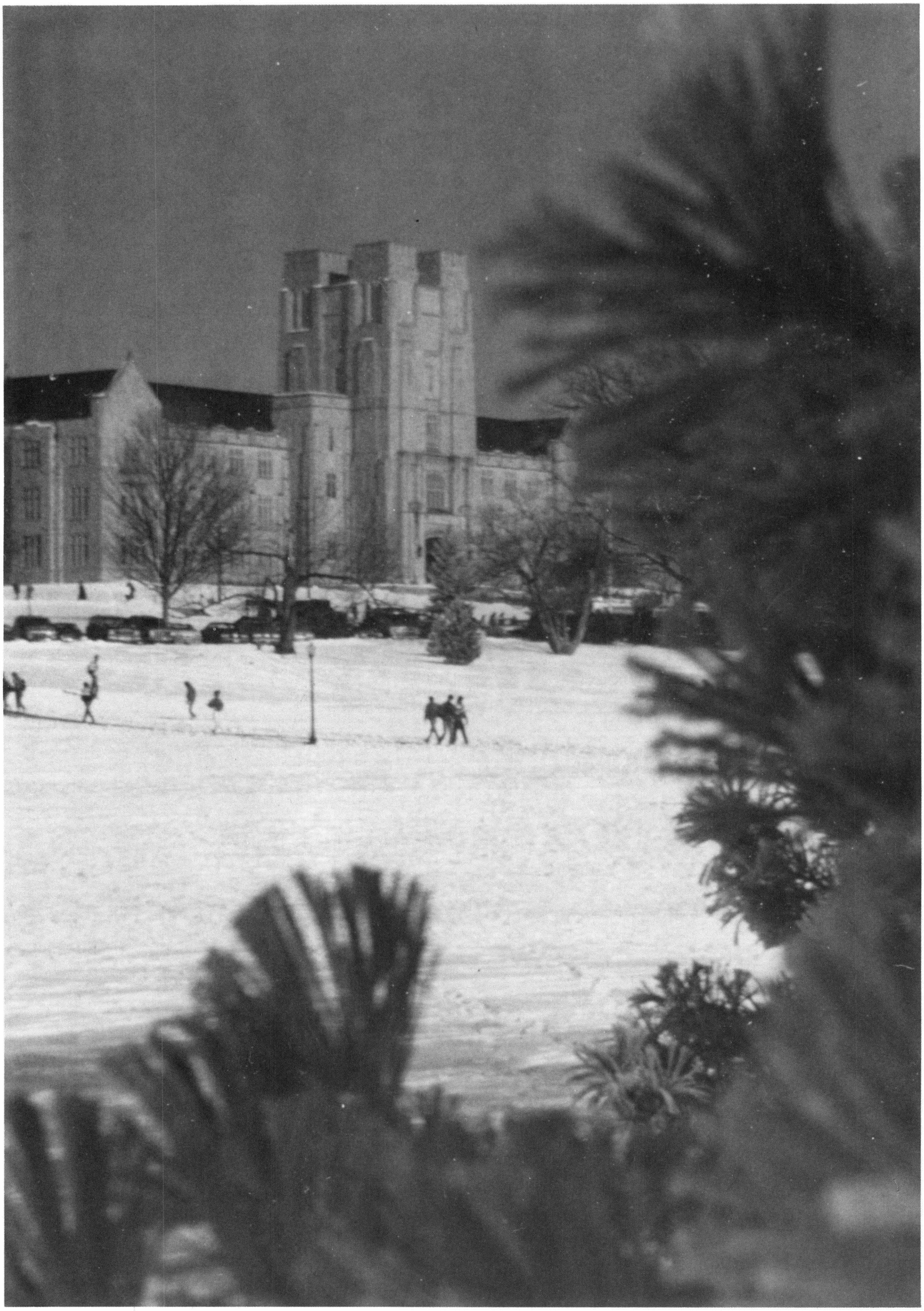
Engineers' Forum

you can gain these valuable skills.

Positions available include:

- Writing
- Production
- Photography
- Business
- Graphics

For more information, call ***231-7738***
or contact ***Jonathan Hess, Editor-in-Chief***



E N G I N E E R S

It might be a nuclear sub or a billion dollar aircraft carrier, at the Norfolk Naval Shipyard you can provide engineering support for the maintenance and testing of the most sophisticated technology in the world. Hands-on experience will challenge your personal creativity, stimulate and enhance your engineering knowledge, and accord you a good measure of responsibility on important projects.

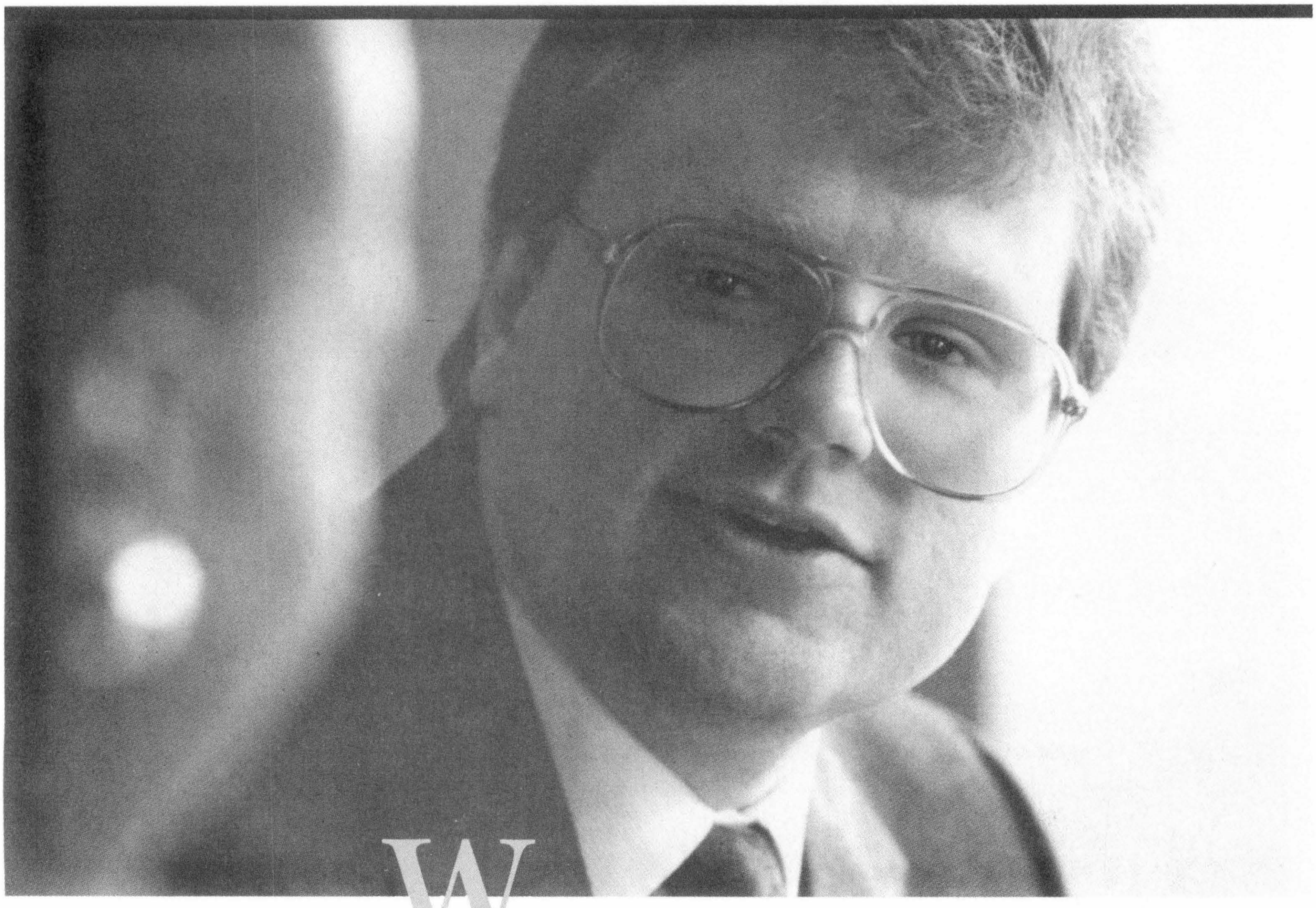
Located in the Tidewater Virginia area, the shipyard is surrounded by a vast array of recreational and cultural activities. Just minutes away, the resort city of Virginia Beach hosts water activities of all types and descriptions. Also, the shipyard is just a short drive from the Blue Ridge mountains with their spectacular fall foliage and numerous winter ski resorts.

U. S. CITIZENSHIP REQUIRED
AN EQUAL OPPORTUNITY EMPLOYER

YOUR FUTURE'S WITH U.S.

NORFOLK NAVAL SHIPYARD
ENGINEER RECRUITMENT (N)
INDUSTRIAL RELATIONS OFFICE
PORTSMOUTH, VA 23709-5000
(804) 396-4052

Don Wellnitz leads a team with global connections.



When Don Wellnitz joined GE as an Edison Engineer, he wasn't expecting to become team leader on a major international project. But the opportunity came up fast.

It started when Don went to England to help develop new technology for GE Medical Systems. He got in on the ground floor of a new imaging modality, and became the resident expert. That, combined with his ease at cross-cultural teamwork, earned him his Team Leader spot.

Now Don's helping to develop a joint project with Japan. His colleagues include English, Danish, and Russian engineers. He's plugged in to a highly respected international technical community.

At GE, the more challenges you can handle, the more you get. We give you the room to grow, so that we'll grow with you.

It's that simple. And that exciting.

World of opportunity.

An equal opportunity employer.