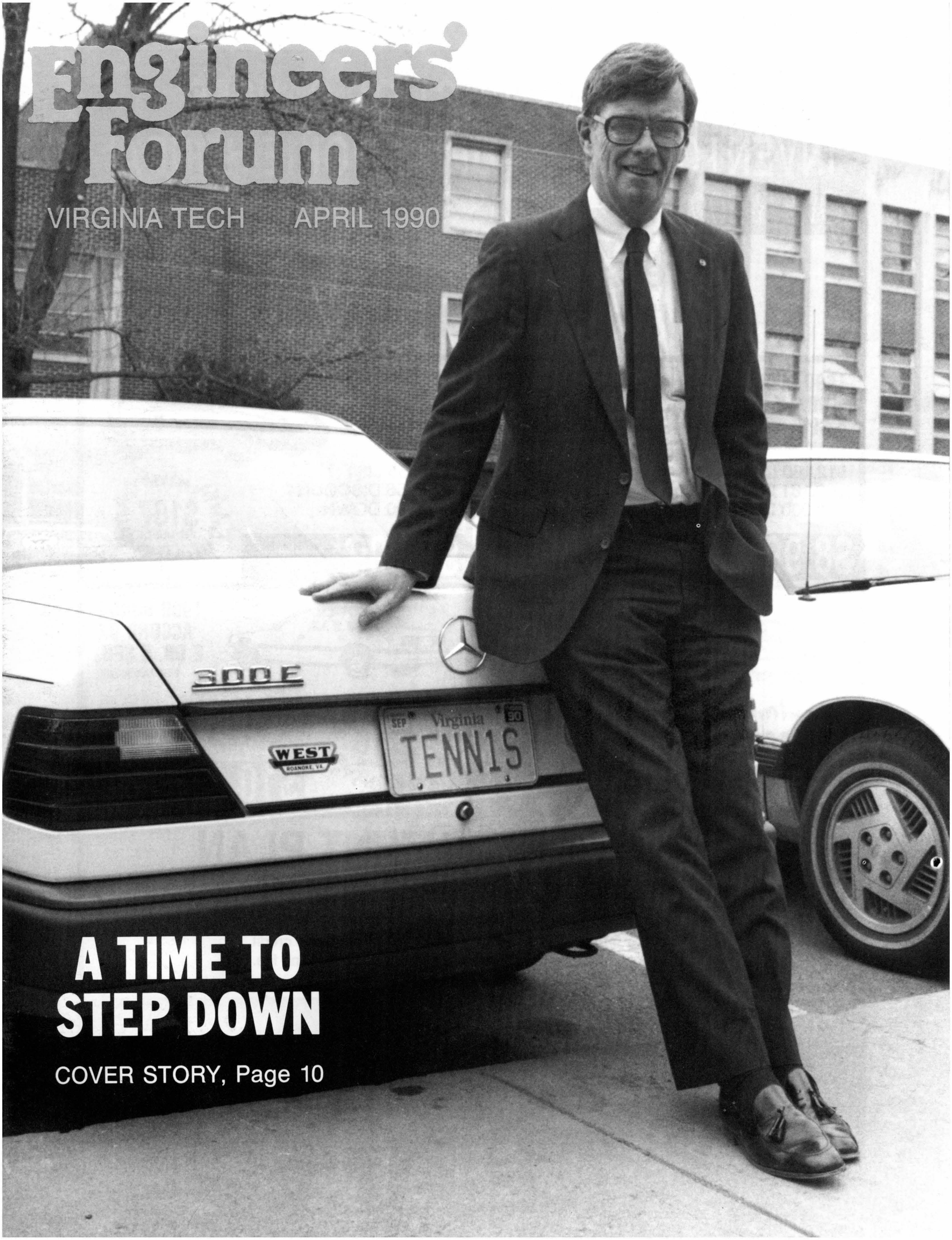
Engineers' Forum

VIRGINIA TECH APRIL 1990



A TIME TO STEP DOWN

COVER STORY, Page 10

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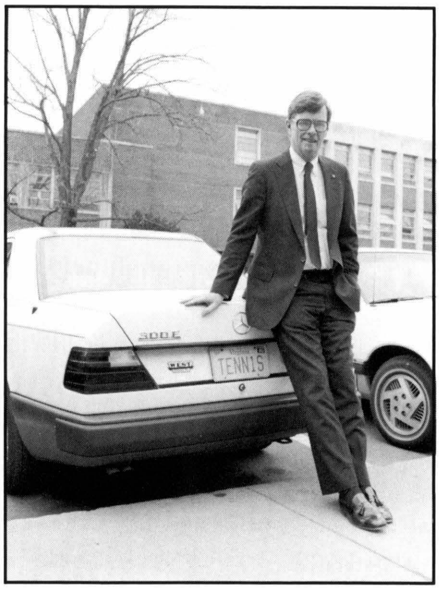

ON THE COVER

Paul E. Torgersen displays the style and professionalism that has contributed to his eminent success as dean of the College of Engineering for the past 20 years.

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EDITOR'S PAGE

Future Portends Well for College of Engineering

Tech civil engineering department head G. Wayne Clough will step into the role of dean of the College of Engineering on July 1, his appointment the conclusion of a Provost-led search for Paul E. Torgersen's successor. Torgersen is returning to teach industrial engineering full-time after a 20-year tenure as dean, a tenure in which the College experienced substantial growth — in quality of instruction as well as in size.

Indeed, Dean Torgersen can be directly credited with making Virginia Tech the recognized topnotch engineering school that it is today. This fact leads some to question what the years ahead hold for the College, and if anyone can maintain the positive growth experienced in the past two decades.

If past performance and stated plans are any indication, the appointment of Clough as Dean leaves no doubt as to the direction of Tech's future. The question is not if there will be positive growth, but how much and how soon. Clough's illustrious background and his thoughtful comments on future directions indicate that growth will continue as in the past, onward and upward and with no lost time.

Clough will enter the position of dean after seven years as head of the civil engineering department, and during this time the department grew in quantity and quality. Graduate student enrollment increased by nearly 50 percent, while at the same time student test scores increased. Fifteen faculty members were recruited, and four on the faculty were named to endowed professorships. Additionally, the department secured a $5 million endowment from Roanoke philanthropist Marion Via. These department successes can be directly or indirectly attributed to the leadership of Clough.

Clough's personal successes are equally impressive, and indicative of his leadership. A specialist in geotechnical engineering, Clough serves as a consultant to over 50 geotechnical firms and government agencies on various projects. He is currently directing a National Science Foundation-sponsored study of the earthquake that struck San Francisco last October. In February Clough was elected to the National Academy of Engineering, one of the highest professional distinctions accorded an engineer. He is a Fellow in the American Society of Civil Engineers, and has received numerous awards from the society, including the Collingwood Prize, the Huber Research Prize, and the Norman Medal.

Clough has stated that he plans to increase efforts in improving Tech's graduate engineering education, but by no means at the expense of past gains made in undergraduate education. Clough's plans are certainly in step with the times, for while Tech's undergraduate engineering program is rated by several sources as solidly among the top ten in the nation, a recent U.S. News and World Report survey rated the graduate program 22nd in the country. The same survey indicated the College ranked 32nd in resources. Accordingly, Clough intends to enhance graduate education by emphasizing gains in resources.

Clough has remarked that he desires to increase research funding. Such funding can provide an improvement in two ways: in the new programs that are implemented, and in the faculty they attract. Faculty growth and increased classroom and laboratory space are two additional goals the dean-elect hopes to achieve. Clough plans to continue pressure to build the planned $25 million architecture/engineering complex. Through efforts to increase the resources mentioned, gains will no doubt be seen in both the graduate and undergraduate programs.

G. Wayne Clough approaches his appointment with attitudes and background that assure the continued success of the College of Engineering. Filling Paul Torgersen's shoes is a tall order, but if Clough adheres to his principles, nothing but positive results can occur. Tech's future looks very bright indeed.

Andrew E. Stalder, Editor

Stalder to graduate; editorship changes hands

Thanks, Andy!

by LYNN NYSTROM

As the end of another era for the *Engineers' Forum* approaches, the magazine staff and I bid farewell to a man who has shaped and refined this publication as editor-in-chief for the past two years. This man's name is Andy Stalder.

Andy came into my office this week, as he often does, to tell me about a concern he had about the magazine. I happened to notice that he was in one of the best moods I have seen in his two-year tenure as editor. I think the reason was a sense of relief that he has successfully published the magazine three or four times a year, and is now handing the reigns over to his protege Jonathan Hess.

Few students and even fewer faculty realize what it takes to produce this magazine. For instance, did you know that the *Engineers' Forum* is entirely self-supporting through advertising dollars? Engineering departments at other Universities such as Howard University, Rennsalear, and Cornell contribute a great deal of financial support to their student publications. In some cases, the grants might be several thousands of dollars per issue.

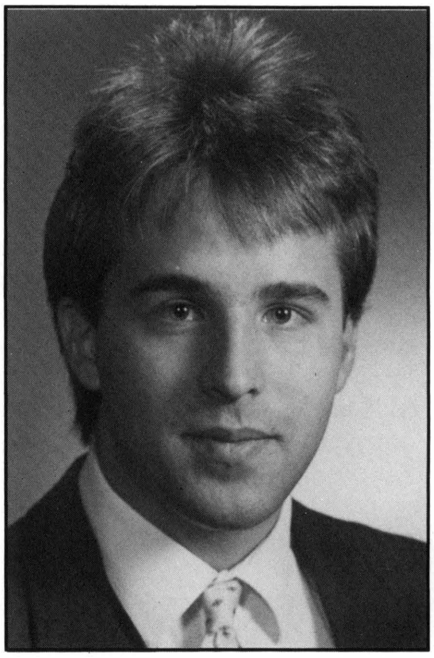
At Virginia Tech, we feel that the students learn a great deal more from their experience on the magazine if it is operated as a true business. This means Andy cannot take the magazine to press unless there is enough money from advertising to cover the cost of each issue. The total budget of producing four black and white magazines is a little under $8,000. That's a lot of money to raise for a student organization. And for two years, Andy has kept the magazine in the black (with only one threat of a lawsuit for not paying a bill on time). I'd say that was a pretty good feat.

In addition, Andy has kept a staff together, learned how to do layout and design work, and struggled to enforce deadlines on a volunteer staff. He's written some excellent editorials and performed miracles editing *Forum* magazine articles.

Outside the *Forum's* office, Andy has proven himself as a fine mechanical engineer. Although editor of the *Engineers' Forum* is a very demanding position, Andy has still found time to become involved with other student organizations in his field like American Society of Mechanical Engineers and Society of Automotive Engineers (SAE). His involvement with SAE has been particularly extensive as he has participated in the SAE formula car project for two years.

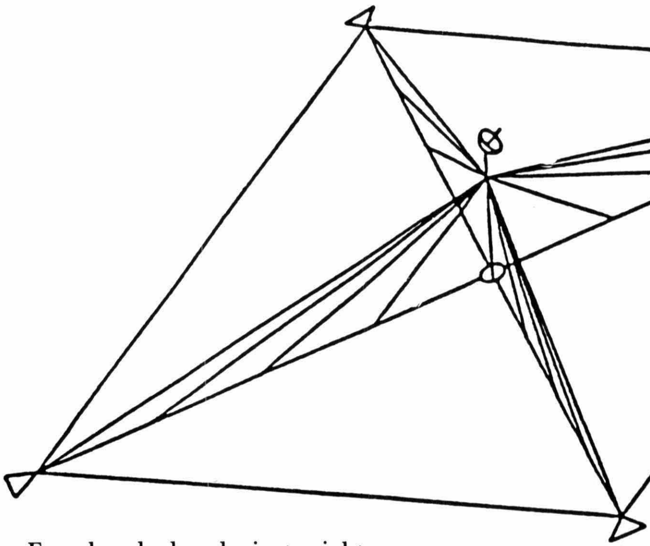
Somehow, while accomplishing all of this, he is still managing to graduate. Jealous?

The magazine staff and I will miss


PAUL TORGERSEN

Andy Stalder

editor-in-chief Andy Stalder, as he has inspired the success of this student publication for some time. Good luck with all of your future endeavors Andy, and may all of your aspirations be fulfilled. Just remember one thing when you get out into the working world and are making all that money. The *Engineers' Forum* gladly accepts donations from alumni, especially past editors!



STUDENTS ENTER SPACE RACE

by COLLIN BRUCE

Four hundred and ninety-eight years ago, a Portuguese sailor named Christopher Columbus attempted to find an alternate way to India by sailing west across the Atlantic Ocean. Instead he discovered the Americas. To commemorate his discovery, the Columbus 500 Space Sail Cup Competition is sponsored by the American Institute of Aeronautics and Astronautics. The competition involves a race to the moon and Mars using a solar sail as the sole means of propulsion for the spacecraft.

Light rays are a stream of particle-like photons travelling at extremely high rates of speed approaching 300 million meters every second. Millions of photons can cross an area as small as a square inch. Since light is emitted continuously from the sun, an object which can use this energy would have a limitless supply of power.

One problem, however, is that the intensity of light varies according to the distance from the light source — the sun in this case. As an object gets closer to the sun, the intensity of the light increases —as it gets farther away, the intensity decreases.

A solar sail spacecraft is a unique space vehicle which uses huge sails to reflect sunlight in order to produce propulsive forces. The photons continuously impacting on the sail's surface create pressure on the sail resulting in a propulsive effect. The surface of the sail needs to be covered with a material, like aluminum, which will reflect light, so that the photons bounce directly off the sail's surface, increasing momentum transfer.

The spacecraft will accelerate as long as the sun is visible. If there is an eclipse of the sun, caused by the spacecraft passing behind an object, the vehicle will continue at the same velocity unless it is acted on by another object's gravitational field.

Near Earth's orbit the pressure on the sail is about one ten billionth of atmospheric pressure on earth at sea level. In order for a solar sail spacecraft to be able to navigate when its distance from the sun changes, the sail orientation must be continuously adjusted. A spiraling motion is required to escape from the gravitational pull of the Earth.

A trip to the moon would not be an easy thing to accomplish. Under the rules of the competition, the spacecraft would be launched as a secondary payload and would have to deploy itself. After deployment the spacecraft would fly from a high earth orbit to the moon. The spacecraft could have no other propulsion systems aboard other than the solar sail and the entire structure has to weigh less than 500 kilograms (approximately 1100 pounds).

The competition is divided into three stages: stage one was the preliminary design of the spacecraft and the mission profile; stage two will be a detailed design followed by the building of the spacecraft; stage three will be the actual race itself. The race is scheduled to start in 1992, five hundred years after Columbus discovered the Americas.

Twenty-two Virginia Tech aerospace seniors advised by Dr. A. Jakubowski entered the competition. They were divided into three teams in 1988 and began work on stage one of the competition. The results were impressive. The teams won the first, second and third places, making a clean sweep.

"The hardest problems were designing the spacecraft to deploy itself and navigating the spacecraft by adjusting the sails," said Dr. Jakubowski.

The spacecraft would be boosted to an orbit high enough (approximately 1000 kilometers) to avoid drag and to enable the spacecraft to accelerate. Motion of the craft would begin immediately after the sails have been fully extended, accelerating the space vehicle one or two millimeters a second every second.

Until it gained enough speed to escape earth's gravity, the vessel would orbit around the earth, performing its spirals. Then, orienting its sails so that the sunlight is always striking them at the proper angle to achieve maximum momentum, the spacecraft then attempts to stay an average distance away from the sun, while at the same time travelling toward its destination.

If it approaches too close to the sun, it will accelerate too fast — if it strays away from the sun, its acceleration rate will decrease. When it reaches the vicinity of the moon, it will begin to orbit using the moon's gravitation along with its sail orientation completing its journey.

Virginia Tech's first place solar sail spacecraft design, the Heliogyro Sail, was designed by eight students: team leader Dale MacMurdy (currently at Pratt and Whitney), David Baker (working at NASA Goddard Space Flight Center), Joseph Empert (at Pratt and Whitney), Deborah Furey, Lee Hart, Craig Martell (all three are at Virginia Tech pursuing graduate degrees), Scott Ragon (working at General Dynamics) and Tom Vollmar (working with the Navy).

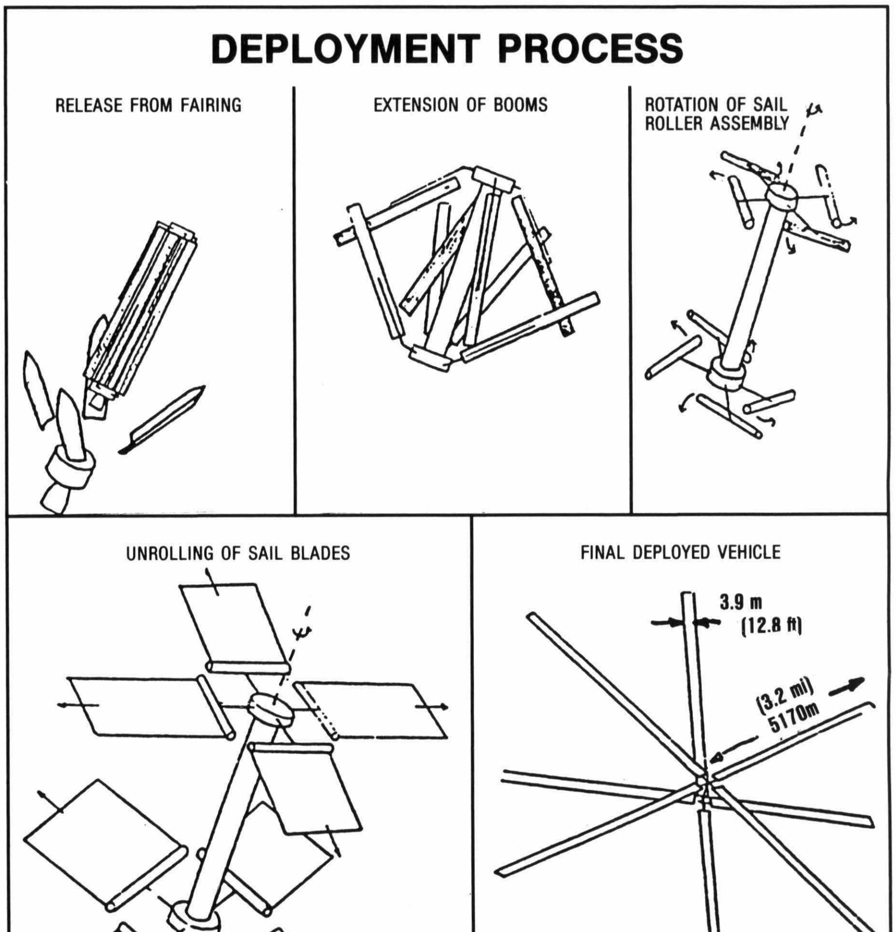
This solar sail vessel uses eight sails made of a very thin film called polyimide manufactured by Dupont. The sails each measure 5,170 meters long (3.2 miles) by 3.9 meters and are 1 to 3 microns thick. They are covered with a very thin layer of aluminum on one side for reflective purposes and a thin layer of chromium on the other side to reject heat.

The second place solar sail spacecraft, the Lunar Schooner designed by a team of seven students led by Darron Beyer, uses two circular sails which spin around the center of the spacecraft. One large sail has a radius of 360 meters and is used for propulsion. The second smaller sail rotates in the opposite direction to provide stability for the spacecraft.

The Terrapin Project, the third place solar sail spacecraft designed by a team of seven led by Keith McGhee, is a square sail 294 meters on a side. At each of the four corners, small veins work together to orient the sail whenever necessary.

The next stage of the Columbus 500 Space Sail Cup Competition will involve a detailed design and the actual building and testing of the solar sail spacecraft. Since the groups have just completed stage one and received word of their victories, there has not been enough time to begin a comprehensive effort toward stage two activities.

The teams now need to find corporate sponsors and reorganize themselves since most of the members left Tech after graduation. However Dr. Jakubowski added, "We hope to be able to continue. We definitely have the potential."



Problem of Global Warming Requires an International Solution

by ROBIN ELDER

The last ice age, when the average Earth temperatures dropped about eight degrees Celsius, our ancestors were forced to "develop tools and technology, science and civilization," explained Carl Sagan. "Certainly, skills in hunting, skinning, tanning, building shelters and refurbishing caves must owe much to the terrors of the deep ice age."

Eight degrees also is believed to have caused the extinction of many species of animals, the rearrangement of plant life, and the covering of what is now North America with ice a mile thick.

Presently, many environmentalists say by the year 2050, the average temperatures on our planet will have risen anywhere from a couple of degrees to a possible 8 degrees Celsius.

As a result, Central America could be parched in summer, and higher latitudes could become warmer. The temperature change may melt the West Antarctic Ice sheet, raising sea levels by some 20 feet, eventually inundating all of the coastal areas on this planet. So much for Spring breaks in Florida.

These scientists attribute the possible near future changes in climate to what is called global warming, also referred to as the greenhouse effect. More specifically, global warming is a hypothetical change in the climate of the Earth due to an increase of "greenhouse gases": Carbon Dioxide (CO_2), water vapor and, in smaller quantities, chlorofluorocarbons, and methane.

When sunlight strikes the Earth, part is reflected back into the sky; much of the rest is absorbed by the ground and heats it. The ground radiates infrared radiation back into the air which is then trapped by the greenhouse gases. The heat remains near to the surface, providing an infrared blanket for the world. Too much blanket, or too little and the Earth's surface could be in for a big change.

The Earth took a couple billion years to develop an atmosphere conducive to life as we know it. As explained by Stephen Schneider of the National Center of Atmospheric Research, "If not for the CO_2, methane, and clouds (made of tiny condensed water droplets) in the air," the Earth's temperature would be about 20 degrees Celsius below the freezing point of water.

The temperature change may melt the West Antarctic Ice Sheet... eventually inundating all of the coastal areas on this planet. So much for Spring Break in Florida.

Recently, data from the British Meteorology Office indicates that temperatures on the globe were .23 degrees Celsius warmer in 1989 than during the period from 1951 to 1980. In fact, six of the ten hottest years on record fell in the 1980s, making the decade the warmest in the past century.

According to the supporters of the "greenhouse theory" a corresponding well documented increase in the amount of CO_2 in the air can be attributed to human activity — like cutting down the trees which absorb the CO_2, burning carbon rich "fossil fuels" like coal and gasoline which release CO_2, and polluting the air with an excess of cars.

There are several viewpoints concerning future climatic conditions. Schneider, being part of the group of scientists who support the greenhouse theory, is opposed by scientists such as William A. Nierenberg.

"Summing up the abundant uncertainties that surround greenhouse models and predictions, we believe it is too soon to take any actions to reduce greenhouse gases."

Nierenberg and his group have been studying C_{14} traces in tree rings, which indicate a decrease in solar activity in the next century, leading to a mini ice age which will offset any greenhouse warming.

"The warming trend of the past century was probably caused by increased solar activity and not an accumulation of greenhouse gases. The greenhouse warming in the next century will be small — perhaps one degree Celsius," explained Nierenberg.

Schneider and his group strongly oppose this viewpoint. "Since no one really knows what the sun was doing 100 years back, (our theory) is just as likely as theirs. If the Earth warms up 2-4 degrees Celsius it will swamp anything the sun has done in the last 100 years."

In response to the lack of consensus, the administration has limited its activities to doing more research and planting a billion trees per year over a ten year period.

A major source of CO_2, the burning of fossil fuels by factories and cars, is being overlooked. At the beginning of this month the president declared, "Global Warming is still too unproven and its forecast too much like a shot in the dark to justify action yet."

"There's no need to spend billions of dollars reducing greenhouse gases mostly by weaning the nation of its fossil fuel dependency based on predictions that might not come true." he said.

William Nordhaus, economist at Yale University, said "The cost of cutting CO_2 might far exceed the damage from a warmer climate."

Although environmentalists agree that research and tree planting are good efforts, many believe "the president's decision to invest in the greenhouse effect now and act later to control it" is misguided, and are ready with solutions.

"The real schedule for answering all the questions is more like 10-50 years, so it makes no sense to wait for more information," said Schneider.

He further explained that scientific research alone would not be able to justify that the warming will occur. "Science doesn't prove anything. Science works by people constantly trying to disprove."

"It's the rates of change that have me most worried," expressed Schneider, speaking for many of the environmentalists. "What we want to do is slow it down. This can only happen if the committees (in Congress) talk to each other. The solution isn't a single thing but a lot of things. If we don't do them all we're not going to get anywhere."

As a possible means of reducing CO_2 output by cars, Paul Ehrlich, a professor of population studies at Stanford University, feels that "We should put taxes on gasoline to run the price up very rapidly to two, three bucks a gallon. If you start depressing gasoline prices" a wider range of effects can be had in addition to decreasing global warming.

Some of the benefits mentioned by Ehrlich are longer lasting roads, less parking problems, and decreased air pollution.

Switching to a lower carbon fuel would seem to be one of the easiest solutions. Arthur Squires, a Chemical Engineering professor of Meritus at Virginia Tech, said however, that "There is not enough natural gas, or it can't be produced quickly enough, to allow us to convert from coal, or oil even, to natural gas."

"Although the research and development effort is broad none of the nonfossil energy sources are ready to be substituted completely for fossil fuel at the scale necessary to reduce emissions," explains William Fulkerson in *Science* magazine.

In response to the lack of consensus, the (U.S.) administration has limited its activities to doing more research and planting a billion trees per year over a ten-year period.

Regardless of the methods used, environmentalists and climate experts are calling for a necessary reduction of 20% in CO_2 emissions by the year 2000.

Some say that it might even be necessary to reduce emissions by as much as 90% to reverse warming and restore the climate to that of preindustrial times, before man made CO_2 began to accumulate.

The consensus of many was expressed when Paul Ehrlich said, "This is an international problem that can only be solved by a global effort. If the US halted its CO_2 emissions at its current level, projected coal burning by China alone would more than make up the difference."

"We have to make high technology available at a decent price," said Schneider. "Virginia should be shipping smokeless solid fuels to Third world countries where women now cook with charcoal. We can make the fuels from our state's wonderful low sulfur-coals. Manufacturing the fuels, transporting them abroad,

Continued on page 8

Said the President at the beginning of this month, "Global Warming is still too unproven and its forecast too much like a shot in the dark to justify action yet. ...There's no need to spend billions of dollars reducing greenhouse gases mostly by weaning the nation of its fossil fuel dependency based on predictions that might not come true."

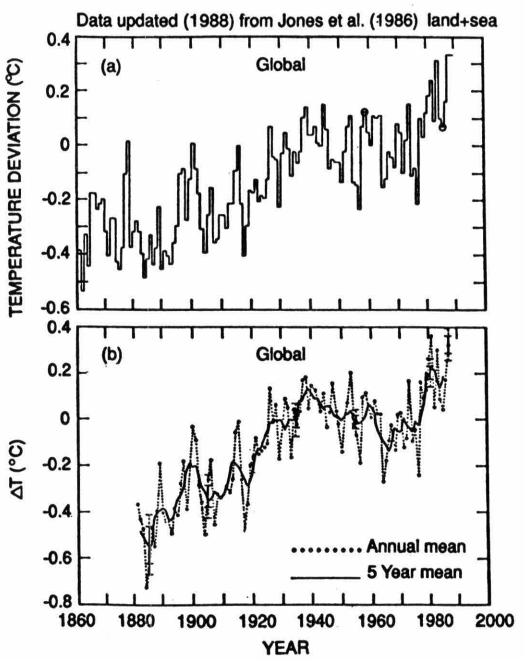
and using them for cooking will release less than one half of the CO_2 now reaching the atmosphere from the production and use of charcoal."

As an example of what other countries are doing to aid the cause, Thomas Russell of the Swedish Academy of Science said in a TV interview that Swedish government has taken a number of steps to decrease CO_2 production. "The government has in principle said that it will stop further emission of CO_2. Plans have been made to close down all nuclear energy plants (12 of them) by 2010." said Russell.

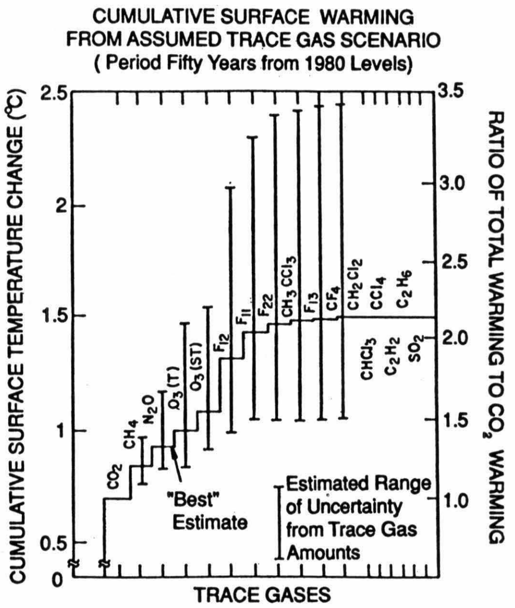
"Why do we buy insurance?" asked Schneider. "We invest in insurance because of the possibility that something might happen to us."

Paul Ehrlich agreed with a similar example of how inaction was not a realistic course of action for the issue of global warming. "Let's suppose there's only a five percent chance of global warming." he suggested. "If there's a five percent chance that the food you're eating tonight is poisoned, you're going to go to a different restaurant, right?" In the same light, he said, we should not take unnecessary risks with the possibility of excessive global warming.

A comparison of the global surface temperature trends of the past 100 years constructed from land and island stations and ocean surface temperature data sets at the (A) Climatic Research Unit and from a similar set of stations (minus the ocean surface temperature data set) at the (B) Goddard Institute for Space Studies. *Source:* P.D. Jones and T.M.I. Wigley, personal communication (1988). J. Hansen and S. Lebedeff, *Geophysical Research Letter* (1988) 15:323.



Various trace "greenhouse gases" contribute about as much to equilibrium global warming (see right-hand scale) as CO_2 for the "best" estimate case, but uncertainties in the projected scenarios of these trace gases are large (see vertical bars). Additional uncertainties in equilibrium temperature response from climate model assumptions are not included in the figure. *Source:* V. Ramanathan, et al., *Journal of Geophysical Research* (1985) 90:5547.



COVER STORY

A Time To Step Down

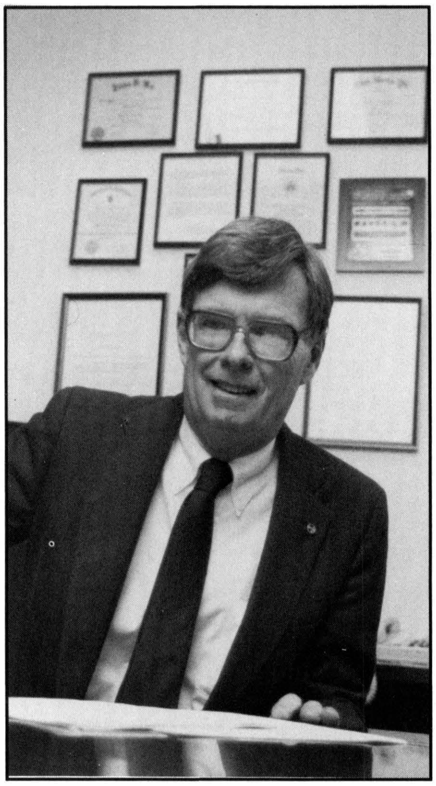
by JONATHAN HESS

In the year 1970, many people would not have guessed that the College of Engineering at Virginia Tech would be ranked in the top ten percent nationally. However, that is exactly where our college stands today and this move might not have been possible without the innovative mind of our dean for the past two decades, Paul E. Torgersen.

Throughout the past twenty years Dean Torgersen has played a vital role in the success and improvement of the College of Engineering. Well, the year is 1990, and now it is time to look back, in memory of Dean Torgersen's work and accomplishments as he has decided to step down as dean.

After receiving his B.S. in Industrial Engineering from Lehigh University and both his M.S. and Ph.D from Ohio State University, Paul E. Torgersen started his teaching career at Oklahoma State in 1959. Shortly after, Dean Torgersen was named the Department Head of Industrial Engineering here at Virginia Tech in 1967. At this time the College of Engineering was nothing like it is today. Although the dean at this time, Dean Worcester, was making pointed efforts to improve the college's name, the fact remained that the College of Engineering at Virginia Tech was in the bottom ten percent in the nation in terms of research funding. Aside from this the college was also operating under a virtually open admissions policy. It was obvious that changes needed to be made, but what changes? Then, in 1970 the College suffered a tragic loss. Dean Worcester was killed in a plane accident. Immediately a search began for a new dean.

Although he was only 38 at the time, the college felt that Paul E. Torgersen was what the College needed, and thus was appointed dean in 1970. Twenty years ago Dean Torgersen started his quest to make the College of Engineering at Virginia Tech one of the best in the nation, with many goals and aspirations almost all of which he fulfilled.



To put it simply, Dean Torgersen's aim was to improve the level of graduate research and in turn improve the college as a whole.

In the Spring of 1970 Paul E. Torgersen stepped into the position of dean very confidently, immediately setting forth a plan to strengthen the College of Engineering at Virginia Tech. At this time the school was predominantly an undergraduate institution with very little in the way of graduate research and studies. To put it simply, Dean Torgersen's aim was to improve the level of graduate research and in turn improve the college as a whole.

This improvement was by no means to be a direct result of the improvement on the graduate level. Instead, by improving the graduate level, more specifically by increasing the amount of research funding, an improvement in the quality of teachers is gained. The improvement in quality is a direct result of the increased research funding, because researching faculty are attracted to this additional money and therefore to teach at this University. Although this may seem to be an opinionated statement, it has been proven by evaluation that the faculty that do research receive better evaluations than teachers that do not do research. So, the College of Engineering is becoming stronger, but the improvement does not stop here.

Now that the quality of faculty has been improved, the undergraduate program has also been enhanced. Finally, with an excellent undergraduate program, the College of Engineering is able to attract a much better student body then before.

As time progressed, the plan described

above began to take form and become more specific. For instance, instead of just increasing research funding to improve our research capability in general, the specific areas where this money was to be applied became more focused. Some of the many areas which were explored were: composite materials, fiber optics, power electronics, computer-aided-design, human factors engineering, geotechnical engineering, and coal cleaning technology.

With the rapid advancement of these and many other research areas, it is obvious that space becomes a problem. However, from 1970 to present day the College of Engineering has obtained all of Patton Hall, the areas in Holden Hall which it did not already hold, all six floors of Whittemore Hall, and finally Hancock Hall whose construction is being completed now, and which will be partially opened by the Summer of 1990. Although a good deal of space has been obtained, it is still a problem; however, a new building for Architecture and Engineering which is on hold by the Virginia General Assembly would most definitely relieve the problem. In fact, maybe the one regret Dean Torgersen has is that this building was not completed during his deanship.

Aside from the vast improvements in research capability many other significant advances have surfaced. Perhaps the most important breakthrough for the College of Engineering was the establishment of the Personal Computer Initiative beginning in 1984-1985. This program, established in order to keep up with the rapidly advancing engineering technology, required that all engineering students have their own computer.

Another area of improvement as mentioned before was the attraction of bright students. To put this into perspective, in 1970 there was a nearly open admissions policy, meaning that almost everyone that applied was accepted. Conversely, today approximately 5000 students apply and only 1100 are accepted. A major contributing factor to this improvement in the student body, aside from the reasons discussed above, was a large sum of money left by John Lee Pratt. Significantly, a major portion of this money was used for the sole purpose of merit scholarships for entering freshman.

Besides the incredible impact Dean Torgersen has had on the College of

Engineering at Virginia Tech, he has many other personal and professional achievements. Perhaps the most distinguished honor he has received was his election to the National Academy of Engineering in 1986. This and some of his other awards — College Of Engineering's Outstanding Teacher award at Oklahoma State University in 1963, Distinguished Alumnus Award from Ohio State University in 1971, H.B. Maynard Book-of-the-Year Award for Industrial Operations Research, and Virginia Tech's first Affirmative Action Award in 1984 — give good hindsight into how dedicated a man Dean Torgersen is to the engineering profession.

However, when asked to reflect back upon his many great achievements, the one that stands out in Dean Torgersen's mind as being the most significant was the endowment fund that was raised by the Student Engineers' Council at Virginia Tech in 1985 for the purpose of creating the Paul E. Torgersen Leadership Scholarship. Perhaps the full effect that this award had on Dean Torgersen is best summed up through his words: "Some people get inducted into the National Academy of Engineering every year, but I have never heard, not just at this University, but at any University of students raising a $20,000 endowment to establish a scholarship for a dean."

Looking forward to the future, Dean Torgersen plans to continue teaching the class for Industrial Engineering majors that he has been teaching during his deanship. The one change he plans to make to this class is a reduction in its size by adding more sections. He feels this is very important because with the large classes he has taught while being dean there has not been enough student teacher interaction. Dean Torgersen believes such interaction is essential to effective teaching.

He has also been working on a course concerning production and productivity. This class is just one of many classes under a program developed by the College of Engineering that will be aimed to teach non-engineering majors various technological literacy subjects, such as the one above. Along with many other topics, this course when it is completed will touch upon areas like what the United States is doing or not doing such that it is not as productive as countries like Japan.

Outside of the teaching arena, just recently Dean Torgersen was named President of Virginia Tech's Corporate Research Center (CRC). This part-time position will offer Paul E. Torgersen many challenges as he steps away from the dean's office. He has high hopes for the CRC, but does not feel success will hap-

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pen overnight. Dean Torgersen's reasoning for this is best paraphrased when he says: "There are an increasing number of Corporate Research Centers being developed around the country. The idea is not new anymore. They are competing for a very finite number of corporations that might establish some research unit." However, he does feel that with time and a little bit of luck the CRC will grow and prosper.

Two decades have elapsed since Paul E. Torgersen stepped into the powerful position of dean of the College of Engineering at Virginia Tech, and now after bringing our college to its most successful era in the history of the school he has decided to relinquish his title as dean. When asked why , he simply states: "It's time. It's going to be good for the College of Engineering. The college is ready for somebody else, they may not know it, but they are ready. It's time for me too. If I'm ever going to back out of this and do something besides being dean, I have to do it now."

Well, maybe it is "time," but the fact remains that Paul E. Torgersen will be deeply missed in the deans office by fellow faculty, students and alumni alike. The College of Engineering is truly lucky to have had such a kind and personable man, who has always put the concerns of others on the top of his priority list. Such qualities in leaders like Dean Torgersen are all too rare in the world today. On behalf of the students of the College of Engineering, we salute you Dean Torgersen. The College of Engineering will not be the same without you behind the dean's desk.

Many of Virginia Tech's engineering students, faculty, and staff spend countless hours working on regional and national design competitions. The competitions give students a chance to experience involved design projects; the best way to learn engineering skills is to apply them first hand.

The prestige of Virginia Tech is also increased by the competitions as students show their Hokie know-how. Only a few of the engineering design competitions are detailed below — others will be covered in a later issue.

VT SOLARAY

Virginia Tech is entering GM Sunrayce USA 1990, a 1800 mile solar powered car race across the United States. The competition is sponsored by General Motors, the U.S. Department of Energy and the Society of Automotive Engineers. The race extends from Disney World in Lake Buena Vista, Florida to GM's Technical Center in Warren, Michigan.

Virginia Tech's racer, named VT Solaray, will compete with 31 other North American colleges and universities.

The VT Solaray is being built by volunteer mechanical and electrical engineering students under the organization of Dr. Charles J. Hurst and team captain Eric Schardt.

The competing cars race on secondary state roads through Florida, Alabama, Tennessee, Kentucky, Indiana, Ohio, and Michigan. The race begins July 9th and lasts 11 days with racing times between 9:00 AM and 6:30 PM. About 190 miles will be covered every day, except for the last day in which 90 miles will be covered. The cars and their teams rendezvous at a designated place upon completion of the day's leg of racing. The car that finishes in the least amount of time is declared the winner. Two racers that finish in the least elapsed time and another racer selected by the judges are sponsored by GM to compete in the 1990 World Solar Challenge to be held in Australia.

The VT Solaray must comply with several design specifications laid out by the sponsors of the race. Sunlight is the only power source allowed; batteries may be used to store charge. Each team is allowed to charge their car two hours before each day's race and two hours after.

The vehicle is 20 feet long and almost 7 feet wide. The solar array's dimensions are 4 meters long by 2 meters wide. The racer must include seat belts, brake lights, turn indicators, a horn, and a rear vision system. The VT Solaray is predicted to have a maximum speed of 80 mph and a normal cruising speed of 40 mph.

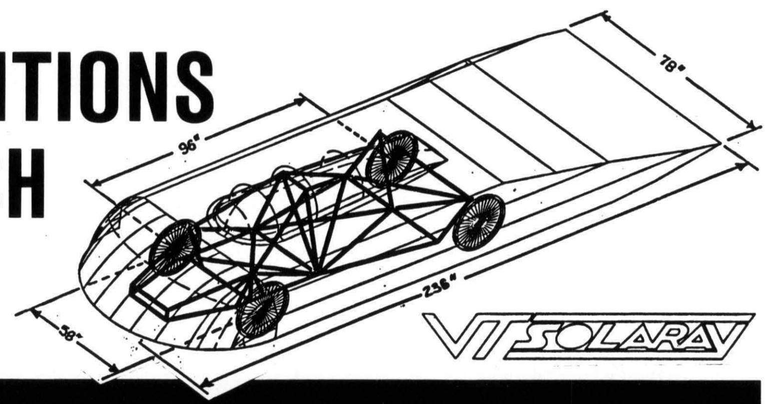
The frame of the car is made from light weight, high strength aluminum. A stronger, heavier aluminum is used for a roll cage that protects the driver. The aluminum and advice on welding were provided by Alcoa and Reynolds, respectively. The frame and the racer's suspension are under the supervision of Greg Murray.

The body of VT Solaray, whose design and construction is overseen by Don Guthan and David Hunt, is being made out of a composite material called Spectra with the assistance of Brunswick Corporation of Marion, Va.

Janis Oandasan, with faculty advice from Dr. Saifur Rahman, is working with solar cells donated by Applied Solar Company. The 200 silicon cells, organized in several parallel groups connected in series, provide 1 kilowatt at 90 volts. A peak power tracking circuit designed by Tom Lusco ensures that the cells transfer maximum power to the racer. The battery system which stores charge not used immediately by the motors is under the supervision of Lisa Blackburn. Bill Sanger and Dr. Robert Miller are helping with circuit design for VT Solaray.

DESIGN COMPETITIONS AT VIRGINIA TECH

by GRADY J. KOCH



Virginia Tech is one of only three schools designing its own motor for the racer; other competitors are using off-the-shelf motors. Tech's design, overseen by Moji Ijaz, uses two separate motors in the same housing. The DC brushless motors may be used simultaneously or separately for optimum torque and efficiency. The pulse width modulated control system for the motors was donated by Motion Control Systems of Dublin, Va.

Eric Taylor is in charge of wheel design. The wheel design incorporates hubs designed by the Virginia Tech team and uses high pressure, no-tread tires provided by Goodyear. The 4 wheel hydraulic braking system, managed by Keith Van Houtan, includes a device that uses the kinetic energy of the car to charge the batteries while braking.

Instrumentation is being carried out by Kerry Peters and Ed Kwasnick is in charge of steering and ventilation. Other significant contributions are being made by Jerry Lucas of the machine shop and by David Gillikin who supervises the interior design of VT Solaray.

THE CONCRETE CANOE

This is the 17th year that the Virginia Tech Student Chapter of the American Society of Civil Engineers (ASCE) has entered the concrete canoe competition.

The contest calls for building a functional two-person canoe out of reinforced concrete to compete in six races: men paddlers, women paddlers, and coed paddlers in sprint and marathon distances. In addition, teams are judged on a technical paper, a poster board display, an oral report, and the appearance of the canoe.

Virginia Tech's canoe will be raced on April 7th in Norfolk, Va. where Old Dominion University is hosting the Regional Concrete Canoe Race. This event includes colleges and universities from Virginia and West Virginia; four to six schools usually compete.

The Hokies have won the Regional Race in the past two years and hope to win again this year so that they may advance to the National Canoe Race to be held in Buffalo, New York on June 23nd. Virginia Tech has placed 7th out of 18 in the National Race in the previous two years.

This year's canoe is a little over 17 feet long, has a maximum width of 31 inches, and weighs 200 pounds. The rocker of the canoe, the dimension indicating how much the tip of the canoe would rock if it were balanced on a level surface, is one inch.

Building the canoe is a six-month project involving roughly 1000 man-hours of work. The project began last September when the ASCE, assisted by faculty advisor Dr. Richard E. Weyers, organized 25 team members into 3 groups: design and construction, concrete mix, and paddling.

The design and construction group, chaired by Mike Fitch, began its task by first researching canoe designs. Textbooks, fiberglass canoes and commercial manufacturers' data were used as references. Previous years' designs were critiqued by watching video tapes of the canoes in action and by analyzing statistics of their design and performance.

Two different designs were developed independently and 1/10 scale models were constructed of each. The two models were tested in the water tank located in Norris Hall for speed, lateral stability, and turning ability. One of the two designs proved to be clearly better.

The drawings of the better model were enlarged to full scale. Cross sectional drawings spaced at 10 inch intervals along the long axis of the canoe were traced onto ½-inch plywood and cut out. The plywood sections were nailed onto four-by-four studs to produce a collapsible male mold; one-inch wide luan panelling strips were used to cover the cross sections. Putty was applied over the strips and sanded smooth. Finally, two layers of concrete — with a layer of wire mesh sandwiched in between — were placed over the entire mold to a total thickness of ¼-inch.

The job of the concrete mix group, chaired by Doug Lauer, was to choose a wire mesh and concrete mix for optimum performance. Considerations for a wire mesh are tensile strength and ease of manipulation which are determined by the dimensions of the square cells that

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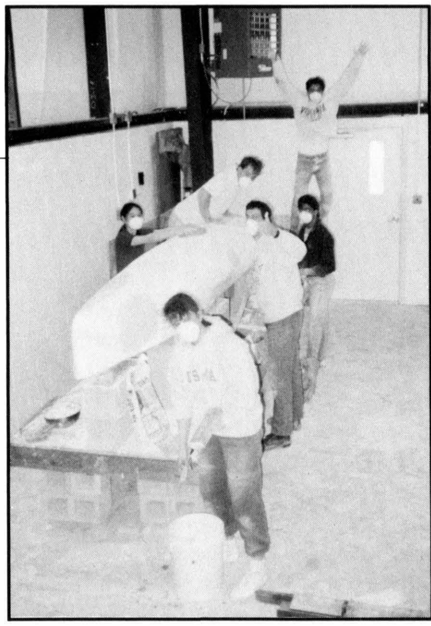

Design

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make up the mesh. Ingredients of the concrete mix, including Portland cement, silica fume, fly ash, high range water reducer, and retarder, must be blended for high strength and low unit weight. The accomplishment of the group was a concrete with a compressive strength of 12000 psi (typical construction concrete has a strength of 4000 psi) and a unit weight of 130 pounds per cubic foot.

The paddling group, chaired by Ian Gibson, began practicing last September and had several practice sessions until winter came. Training started again in February; the racers practice on the Duck Pond at least twice a week. Fiberglass canoes are used for training as well as a concrete canoe from the 1988 competition.

AEROSPACE DESIGN PROJECTS

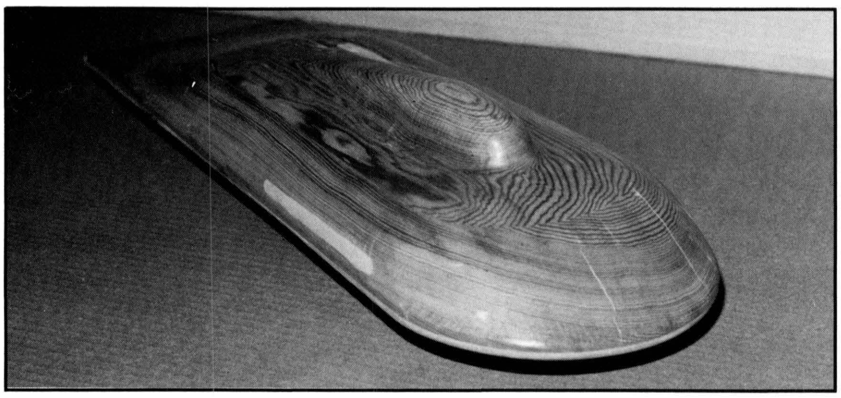
Part of course requirements for seniors studying Aerospace Engineering is three credit hours each semester in working on a design proposal. The design proposals are sent out by the American Institute of Aeronautics and Astronautics (AIAA).

Awards for this national competition include cash prizes and notable recognition. The contest is judged by a group of university professors and engineers from NASA and private corporations.

Last year a design proposed by Virginia Tech students for a Solar Sail Mission to the Moon won high honors. This year aerospace seniors are working on 3 different proposals: a Short Take Off and Vertical Landing (STOVL) aircraft, an Aerobraking Transfer Spacecraft, and a Laser Powered Orbital Transfer Vehicle.

Students choose one of the proposals to work on. Four groups are working independently on the STOVL, three groups are working on the Aerobraking Transfer Spacecraft, and one group is working on the Laser Powered Orbital Transfer Vehicle. Each group, which includes about 10 people, submits a proposal to the AIAA.

The STOVL aircraft has the ability to take off from a runway as short as 300 feet long (an F-16 requires a runway of 1000 feet) and land vertically. This short take off and vertical landing ability is made possible by the jet's vectored thrust — the jet's engines can be pointed at an angle.



A wooden mock-up of the VT Solaray, designed by volunteer mechanical and electrical engineering students.

The STOVL is similar to the British designed Harrier fighter but can fly at supersonic speed, unlike the Harrier. The STOVL is a desirable fighter because it can operate in remote areas close to where its support is needed — airbases with long runways are not needed.

Virginia Tech students are considering many details in their proposed design: propulsion, stability control, aerodynamics, structures, performance, controls and systems, and weights.

The design proposals for spacecraft address the problem of economically transferring from one orbit to another. When Space Station Freedom is in operation frequent trips to a storage satellite, called the Geoshack, will be necessary. It's desirable to do this with the least amount of fuel consumption possible.

The Aerobraking Transfer Vehicle saves fuel in descending from a high orbit to a lower one by using the earth's atmosphere to slow down the craft's velocity in a controlled manner. The Laser Powered Orbital Transfer Vehicle is pushed into a higher orbit by having a laser fired from a satellite push the craft, thereby saving its fuel.

Aerospace seniors are considering many design problems for the spacecrafts: propulsion, orbital mechanics, aerobraking, structures, and support systems.

Plastics: What Are They Really?

by STEPHEN PAYNE

Imagine hundreds of years ago, when the world operated with a very limited technology. No automobiles. No electricity. No air conditioning! Think about this though: what did people use for toothbrushes?

Other 'small' items like buttons, knobs or cosmetic containers were not around, or at least they were nowhere near as refined as they are today. These items did not come about primarily until the invention of plastic.

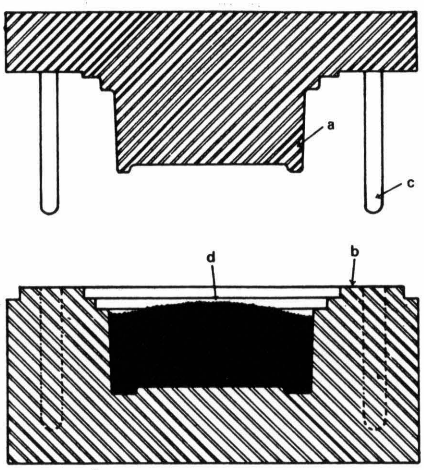
Plastics are man-made materials, combining carbon with organic or inorganic elements like oxygen and nitrogen.

Since a plastic is solely man-made, its properties can be easily controlled. Using the many different raw materials and combining them by various methods results in a seemingly endless assortment of desired properties in the final product. Plastics are becoming more widespread thanks to their light weight, good physical properties, lower cost, and adaptability to mass production methods.

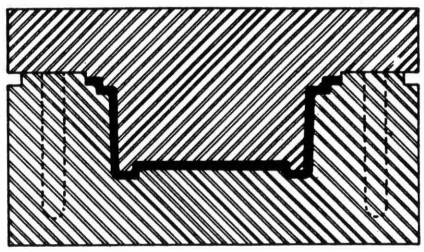
All plastics, whatever their properties or function, fall into one of two groups: thermoplastic or thermosetting. Thermoplastics are plastics which become soft when exposed to sufficient heat and harden when cooled, no matter how often the process is repeated. Some examples of thermoplastics are acrylics, nylon, and polystyrene. Thermosetting plastics, on the other hand, are ones that are set into permanent shape when heat and pressure are applied to them during forming. Some thermosetting plastics are materials like polyesters and epoxies.

The production of many different kinds of plastics entails a number of different production methods. First of all, the plastics industry consists primarily of three components: materials manufacturers, processors, and finishers.

A materials manufacturer formulates the basic plastic compound from a com-



Cross section of a simple two part compression mold in open position. (a) Male mold; (b) Female mold; (c) Guide pins; (d) Molding compound.



Cross section of a simple two part compression mold in a closed position.

bination of chemicals. Usually these basic compounds are distributed in the form of granules, powder, pellets, or flakes for processing into the finished product.

Plastics processors are divided into a few different categories. Molders produce the finished products by forming the plastic in a mold of the desired shape, and compose the biggest part of the processing stage. Extruders turn out sheets, film, rods, and tubing for use in woven-type products like seat covers and industrial screening. Reinforced plastics manufacturers combine the polyesters, epoxies and phenolic compounds with such reinforcements as glass and synthetic fibers to form strong, rigid structural plastics by forming or molding. Also, coaters use a special layer of plastic to coat fabrics and paper.

Next, the fabricator and finisher use a collection of machine tools to convert the plastic sheets or rods into finished products such as industrial parts, jewelry, or signs. The plastic sheeting and film are used to produce articles like shower curtains, rainwear, and upholstery.

The basic component, but most important step in producing a plastic product, is molding. Compression molding is the most common method of forming thermosetting materials. Compression molding is simply the squeezing of a material into a desired shape through the application of heat and pressure to the material in a mold.

Injection molding is the principal method of forming thermoplastic materials. In this type of molding the material is softened to a fluid state, and is forced through a nozzle into a cold mold. Once cooled, the mold opens and the product is ejected from the press.

Other techniques are transfer molding and pulp molding. Transfer molding, used generally for thermosetting plastics, is similar to compression molding in that the plastic is cured in a mold subject to intense heat and pressure. It differs from compression molding in that the plastic is heated before it reaches the mold and is forced into a closed mold by means of a hydraulically-operated plunger.

Pulp molding, also used for thermosetting plastics, is a process where a porous form is dipped into a tank containing a mixture of pulp, plastic resins, and water. The water is then drawn off the form by a vacuum, causing the pulp and resin mixture to adhere to the form which is then molded into the final shape.

Being one of the most common and practical techniques, the compression molding process deserves some special

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attention. In the explanation of this process, the company Danbury Plastics, Inc., a compression molding company in Connecticut that manufactures caps for perfume bottles and other cosmetics, will be considered. They use two main types of compounds for molding, urea and phenolic, depending on the characteristics desired in the final product.

When the plastic material arrives at the factory, it comes in large 250 pound sealed drums or 50 pound bags. All of the material comes in the form of a certain color powder. Part of this material is put through a pill press, a machine that compresses, without heat, a certain amount of powder into small pills or pellets.

The powder and the pellets are then taken to the area of the factory that houses many different molds and presses.

First, a measured amount of powder is placed into the mold by a wooden plank with preformed holes and a removable bottom. Once the powder is properly placed into the mold, the pills are placed on top of the powder in the same way. In this way, the denser and thereby stronger part of the cap is made from the powder. When the press begins to close, the pill pushes down on the powder and begins to compress it, releasing the air trapped in between the granules. When the press nears the point of being totally closed, the material flows upward towards the skirt of the cap, thus producing a very dense and very strong piece.

The presses stay closed for anywhere from 40 to 50 seconds, depending on which kind of material is being used. For instance, with urea molding compounds, the machines operate at a temperature of 275-310^{0}F and an enormous pressure of 75 tons per square inch. Phenolic compounds demand a slightly higher temperature, an equivalent pressure, and a longer cure time than that of the urea compounds. If no pill was used in this process, the powder would flow towards the top of the cap when the press closed, but the final product would contain some porosity in this portion of the cap, and would be considerably weaker.

After the press is opened, the caps are ejected and removed via a slotted board with rubber tracks to catch the caps from the top part of the press. Finally, these are cleaned with a high pressure hose. There are usually anywhere from 24-36 cavities in each press, so in a normal eight hour shift, there can be anywhere from 9,000 to 14,000 pieces made by a single press.

Each morning, the previous days' caps are loaded into a tumbler machine which effectively removes 'flash' or remnants from the molding process.

Wet cloths are then added to the tumbler machine and the caps are given a final washing.

Next, all the caps are brought into the inspection room to be checked for flaws. Some caps might have slight discoloration, caused by a material that is too hard or too low a pressure was applied during the molding process. Others might have blisters or rippled surfaces, due to air being trapped in the mold or the material containing moisture. All caps are thoroughly inspected for such flaws, and are then marked for packing and shipping.

Other processes involved in customizing caps entail lining and metallizing. Lining involves the placement of a paper-like disc automatically placed inside each cap.

Metallizing is a process involving the coating of the cap with a protective and attractive layer.This is often performed by spraying a misty clear lacquer coat on the caps.

Following the first coat in the process, deionized water, silver nitrate crystals, in a certain colored top coat are added. With the use of infrared light, this is then baked on.

At Virginia Tech, there happens to be a lot going on in this area of research. Last year, Dr. Donald Baird, a professor of chemical engineering, developed a process for manufacturing lightweight reinforced plastic products that were previously difficult to make. Baird's method uses thermoplastics, the branch of plastics that can be melted and easily reshaped.

The main component of this new method is liquid crystals. These crystals are used to put the reinforcing fibers into the composites. In this process, the fibers are created when the liquid crystals and thermoplastic are melted together and forced into a mold. Since the fibers are created at the same time as the plastic, the fibers bond better to the plastic than they do in the thermosetting method. The next step in this area of Baird's research is to form the plastic into experimental shapes before it cools.

Currently, Baird is concerned with controlling the characteristics of his products. He uses such things as heat transfer and fluid mechanics to obtain the desired properties in the material, and then works on controlling them. Baird is currently working on blending a polymer matrix with a rod-like material to get a special fiber.

Virginia Tech devotes approximately five to six million dollars to polymer research each year, Baird said. Of special interest to the automotive industry is the reinforcement of cheap polymers with a small amount of expensive polymers. This process increases the stiffness of the material, and thereby expands its use.

Dr. Norman Eiss, a professor of mechanical engineering at Virginia Tech, maintains that a definite relationship exists between Baird and himself. Eiss says that he depends on others for materials processing, extrusion, and similar processes. Once he gets the materials, he tests them for friction wear and examines surface topography, using such machinery as compression and injection molders.

Also, Dr. Alfred Loos, another professor at Virginia Tech in the department of Engineering Science and Mechanics, works with molding composite materi-

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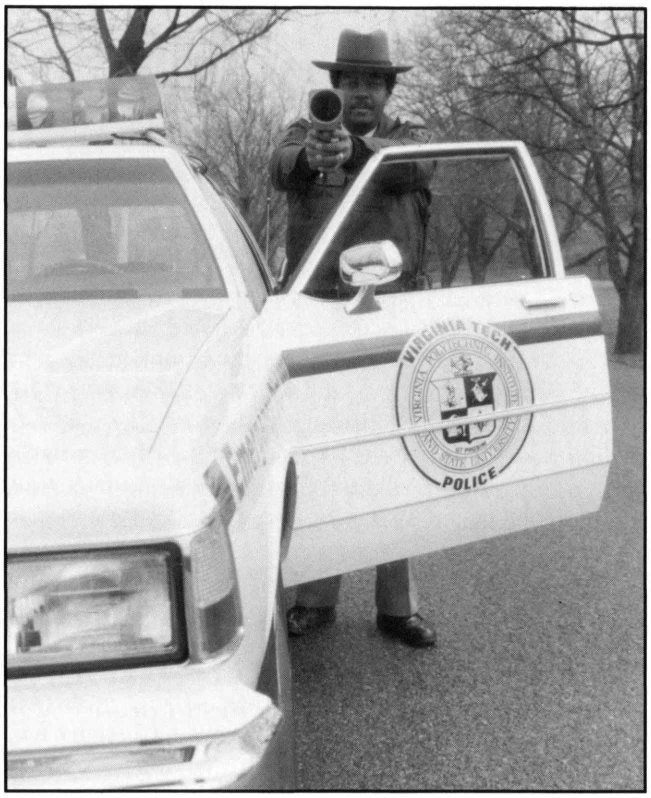
POLICE RADAR VS. RADAR DETECTORS

by STEPHEN LIM

Chances are that you have been clocked recently by some form of radar.

You may have walked into a department or grocery store that uses a simplified form of radar as a door opener, rather than a doormat switch. Low-power microwaves (5 mW) are constantly radiated from a Gunn diode source and horn antenna that are mounted in a box above the doorway. These microwaves are reflected from everything in their path. However, when you moved toward the doorway, you reflected the microwaves back to the antenna at a different frequency, due to the Doppler Effect. A mixer diode in the antenna detected that frequency shift, which was amplified and used to trigger the door opener. The microwave door opener is a very simple form of radar, which has many applications, including speed measurement for law enforcement.



Officer A.C. Lynch of the Virginia Tech Police Department demonstrates hand-held radar equipment.

At some time, motorists are likely to be clocked by radar emitted from a police cruiser. In response to this likelihood, about 15% of all motorists use radar detectors to warn them of approaching police radar. In 1981, an estimated 60,000 police radar units were in use nationwide, resulting in more than 30 million annual speeding tickets. For an average person, traffic radar and radar detectors are likely to be the most familiar application of microwave technology next to the microwave oven.

Contemporary traffic radars still operate on the same basic principle as their post WWII ancestors, that of the Doppler effect. A beam of microwave energy is sent from the antenna and reflected back from all objects in its path. Moving objects reflect back the energy at a slightly different, or Doppler shifted frequency.

The Doppler shift can be observed by listening to an approaching siren. As the siren approaches, the pitch rises, but after it passes, the pitch falls. A traffic radar measures the Doppler shift of the strongest reflected signal and uses it to calculate and display the speed of the moving object. When radar is used from a moving patrol car, the radar samples the Doppler signal reflected from the road to figure the patrol car speed and then subtracts it from the Doppler shift reflected from oncoming cars to arrive at their road speed.

Because traffic radars must be affordable to police departments, they lack many of the features that military or aircraft units provide. Traffic radars show only the speed of a target, and the speed of the patrol car, if used in moving mode. The radar operator must have sufficient training and experience to recognize when the radar is working properly and when the indicated speed is valid.

Police began using radar for traffic enforcement in 1947. After several legal challenges in the 1950s, radar was generally accepted as prima facie evidence in speeding cases, meaning that the accused was essentially proven guilty with little recourse. Most people regarded radar as being infallible. Conviction rates of over 90% were typical for those pleading not guilty.

Radar's legal status was given a shakeup in 1979, when Judge Nesbitt of Dade County, Florida saw a TV news report that showed a radar gun clocking a tree at 86 mph. Judge Nesbitt instituted nine days of legal hearings that resulted in the dismissal of 80 traffic cases, acknowledging that radar was indeed capable of making mistakes due to operator error, external interference, or lack of calibration. Experts estimated that as many as 10 to 30 percent of speeding tickets were issued in error before 1981.

Since Judge Nesbitt's decision, radar units have been subject to review but there still is no formally adopted federal standard for traffic radar equipment. However, improvements have been made in the overall quality and reliability of the radar equipment, as well as training of radar operators.

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Since 1947, traffic radar has developed from a bulky stationary unit that occupied a car trunk, to a small unit that can be hand-held. Modern units can be used while the patrol car is moving to clock cars approaching from the opposite direction. This innovation frees officers from stationary speed traps, and allows them to monitor speeds while on patrol.

Radar came into widespread use after the federally-imposed 55 mph speed limit was enacted in 1974, requiring the states to enforce the speed limit or face withholding of federal highway funds.

Many radar sets were purchased with federal funds provided by the National Highway Traffic Safety Administration in order to enforce the new speed limit. As a result, 50,000 radar units were in use by 1978, with the number of speeding arrests by state police alone rising from 5.7 million to 8.0 million in the period between 1973 to 1978. The increasing numbers of speeding arrests fueled interest in devices like CB radio and radar detectors.

Radar detectors were first conceived soon after the use of traffic radar began, but did not become popular or effective until after speed limit enforcement intensified in the 1970s.

The first models were relatively unsophisticated, and lacking in sensitivity. A 1962 review of a "Radar Sentry" described a $40 device that "gives out a cheery burble that turns into an insistent squeak once the radar zone has been entered, usually within 300 ft of the radar installation."

Through years of development and commercial competition, current models cost between $39 to $650 and begin beeping and flashing up to five miles away from traffic radar over flat terrain, although a more typical figure is about one half mile.

Since their inception, radar detectors have fueled various degrees of controversy. Some officials applaud them because they permit a single officer operating radar to slow down traffic traveling in both directions. Several states and cities passed laws in 1962 to ban devices like the Radar Sentry, including Virginia and Connecticut, although in other states detector laws have been repealed in light of the assurance of the Federal Communications Act that no radio receiver may be licensed, restricted or banned.

Radar detectors operate by receiving the microwave signal transmitted from a police radar gun. The microwave signals occur only in frequency bands allowed by the F.C.C. at 2.544, 10.525, 24.15, 34.36 GHz. For a continuously transmitted radar signal, a radar detector will always have an edge, since the radar must receive the signal reflected from the car, which is many times smaller than the original signal that the detector sees. As police radars have gone to lower power, instant-on, and various frequencies to avoid detection, detector manufacturers have steadily developed newer and more sensitive designs.

Passive (crystal video) radar detectors were the first to be sold commercially, but as the need for more sensitivity grew, other types of detectors were developed. Superheterodyne detectors appeared on the scene, followed by frequency scanning superheterodyne detectors, each more sensitive than before.

Most recently, Cincinnati Microwave introduced new radar detectors using digital signal processing (DSP), claiming that the technique increased sensitivity even further.

Passive detectors operate by using a horn antenna fed into a resonant cavity containing a crystal detector and a modulator diode. A low frequency alternating current, generally about 1000 Hz, is fed into the terminals of the modulator diode, causing it to change capacitance, shifting any standing wave pattern in the cavity at 1000 Hz.

If a radar signal was present in the cavity, it would be modulated and received in the detector diode as a 1000 Hz tone. From there the signal would be amplified and fed into a synchronous detector, which would trigger an alarm if the signal exceeded a threshold set by a sensitivity control.

Each new type of radar detector has become more sensitive by decreasing its received bandwidth. Reducing the bandwidth has the effect of fine-tuning the detector to the frequencies where a police radar signal can be expected, much like a telescope zeros in a very small part of the sky, but with greatly increased clarity and resolving power.

Similar to a telescope, a sensitive detector has been designed to zero in on only those areas of the microwave spectrum that are of interest and magnify them enough to identify the presence of weak signals. Hence a modern radar detector will not respond to microwave ovens like its predecessors.

Superheterodyne detectors operate using the same principle as used by nearly all radio receivers sold today, except at higher microwave frequencies. The incoming radar signals are at such high frequencies that it is difficult to amplify or process them, so they are shifted to a lower frequency that is much easier to handle. The problem with using this method is that the wide bandwidths required (50 MHz for X-band, 100 MHz for K-band) allow much noise to enter the system and reduce sensitivity, since noise is often measured in terms of bandwidth, or in Hz.

The frequency scanning superheterodyne receiver makes the refinement of reducing the bandwidth to much less than the total monitored frequency range, allowing the noise effects to be reduced proportionately. This type of detector scans its small bandwidth (about 1 Mhz) across the frequencies of interest many times per second, much like a laboratory spectrum analyzer.

Radar detectors and traffic radar units have evolved in response to each other.

Continued on next page

The very first traffic radars operated at 2.544 Ghz (S-band) and required relatively large and cumbersome antennas. By 1975 most radars operated at 10.5-10.55 GHz (X-band). Radar detectors needed only to monitor this band of frequencies to be effective.

A new 24.05-24.15 GHz (K-band) frequency was introduced in 1975 to avoid radar detectors, as well as to allow for smaller antennas. It wasn't long before radar detectors were produced to receive X and K bands.

The latest development is 36.34 GHz (Ka-band) radar, which is mostly experimental, yet there are already several detectors on the market that can receive this new band.

Perhaps realizing that radar detectors could be quickly developed for any new frequency, radar manufacturers developed "instant-on" radar as a rather effective detector countermeasure. This development allows the radar to idle without emitting a detectable signal until a target is sighted. Then the operator can trigger the radar and read the target speed almost instantly. A detector would register nothing until the operator triggered the radar, and then it would be a race of the driver's brake reaction against the radar units time to lock-in the speed.

Ka-band or Photo radar, which detects and photographs speeders, is currently used by two communities, Pasadena, California and Paradise Valley, Arizona to issue tickets, and by other states on an experimental basis. Under this system, a radar unit with a very short range is connected to a camera. When a speeding car passes by, a photograph is taken of the front of the car, plus the time, date and speed. The photograph is often clear enough to show the driver's face plus the front license plate. Tickets and photographs are mailed to vehicle owners, and to challenge a ticket, the owner must be able to prove that someone else was driving the car.

In most areas, laws would need to be enacted or changed to allow this system to work. One of the biggest problems is that

The battle between radar and radar detectors will probably continue.... healthy sales (of detectors) suggest a breakdown in respect for the law, or perhaps that highway speed limits need to be changed again.

assuming the car owner's guilt tends to violate the premise that the owner is innocent until proven otherwise.

Despite photo radar's questionable legal status in America, it enjoys widespread use in Germany where a similar device is also used to identify red-light runners. The advantage claimed by manufacturers of photo radar is that it is impartial and accurate and that it reduces the cost and danger of writing tickets, because an officer is no longer required to give chase and make a traffic stop. If photo radar is truly accurate, then it would solve some of the problems suffered by conventional traffic radar.

Traffic radar can work very well if only one car is within the beam of the antenna, but in practice, interference and heavy traffic can cause confusing or erroneous readings. Highway vehicles vary greatly in their ability to reflect microwaves so that a small sports car might not cause a reading until approaching to within 500 feet, while a tractor-trailer might be clocked over a mile away. Thus the reflection of a small car might be overshadowed by that of a larger vehicle following behind, causing a traffic radar to show the speed of the larger vehicle rather than the smaller and much closer car's speed.

Use of the radar while moving provides opportunities for additional error. Most of it is due to having to calculate the patrol car speed from the ground reflection. Usually the ground will be the strongest reflector, but roadside signs and tractor-trailers are very good reflectors as well. Occasionally such objects can affect the patrol cars indicated speed by lowering it, but since the patrol speed is subtracted from the oncoming car speed, this could result in a faulty conviction, unless the operator checks the indicated patrol speed against the speedometer.

Although other means exist for measuring vehicle speeds, radar remains as the most widely used method for speed limit enforcement. Unfortunately, radar falls short when the roads are most dangerous, in heavy traffic, poor visibility or winding roads. Alternative speed checking techniques besides radar include the following:

1. Pacing, where an officer follows the suspect vehicle closely for a specified time or distance and clocks the speed using the patrol car speedometer.

2. VASCAR, or Visual Average Speed Calculator And Recorder, which determines the speed of a suspect vehicle by timing its passage through a predetermined distance, and then calculating the vehicle speed from the time it took to travel through that distance.

This method could be used by officers in cars or airplanes. It is more difficult to use than radar because it requires measurement of the timing interval, usually a pair of white lines painted across the road, and then pressing a button when the suspect vehicle passes over the beginning and end of the interval.

The battle between radar and radar detectors will probably continue for the foreseeable future. Although rural highway speed limits have been raised to 65 mph in most states, they remain at 55 mph on many highways. The market for radar detectors has remained healthy despite the speed limit change.

The legality of radar detectors, devices that are designed to allow lawbreaking with impunity, in 48 of our 50 states is a testament to the freedom enjoyed by Americans compared to nations where radio receivers must be licensed.

However, their healthy sales suggest a breakdown in respect for the law, or perhaps that highway speed limits need to be changed again.

Plastics

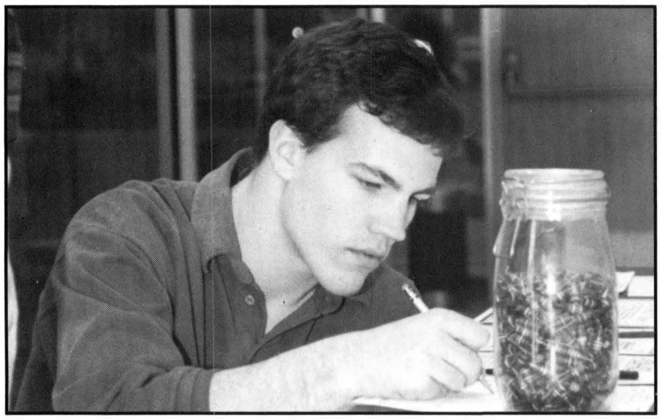
Continued from page 6

als. Loos works on the making and processing of prepregs, an array of reinforced fibers that is much stronger than its counterparts. These prepregs are formed in different ways, ranging from a woven type pattern, in the same way that a fabric is made, to straight axial patterns.

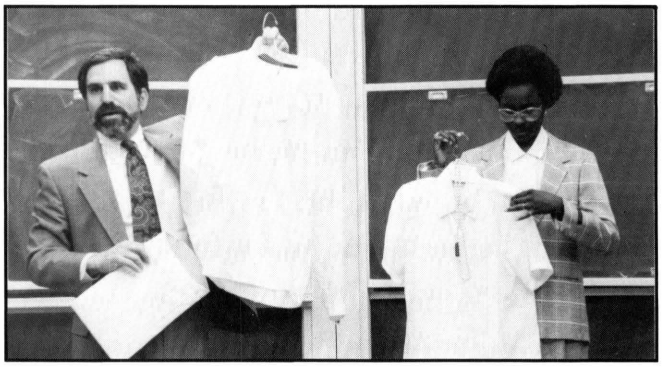
Dr. James LaPorte, a professor of technology education in the College of Education, discussed the opportunities available at Virginia Tech in learning about these kinds of processes. In certain classes offered in the department, students make a product using different kinds of molds and preforms, in effect learning the entire process. These courses emphasize a hands-on approach to all work, one of which involves a mock company working to produce a saleable product.

So the next time you go to put on your cologne, grab the handle of your frying pan, or use a telephone, just think about where it came from. Could you imagine using some of these things without plastic? Maybe a wooden or metal telephone wouldn't be that bad, but with the use of plastics today, anything is possible.

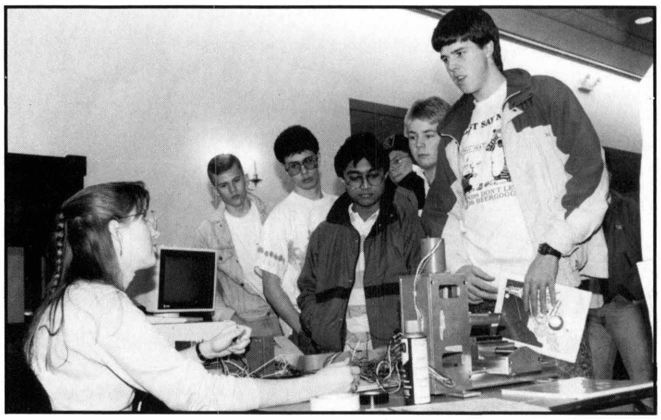
PHOTO ESSAY: E-Week Activities



Paul Andrukonis, general engineering freshman, competes in the "Resistor Count Contest."



Scene from the "Dress For Success" Fashion Show. Left: Jeff Wendell, President and CEO of John Norman Clothiers. Right: Marlene Corbin, chemical engineering senior.



Angela Ridgway, right, a graduate student in industrial engineering, answers questions from Engineers' Week attendees.

Photos by Scott Dau