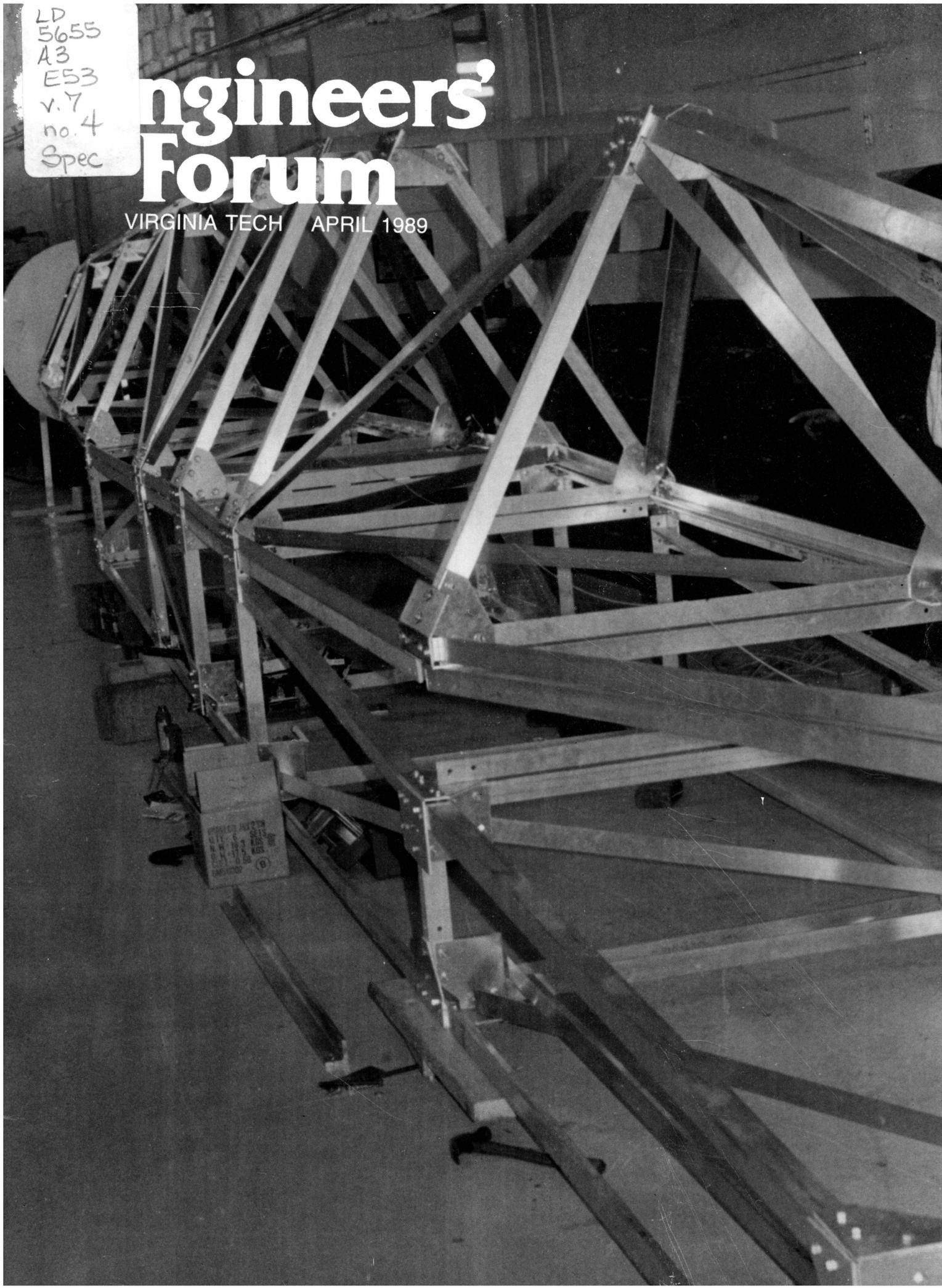


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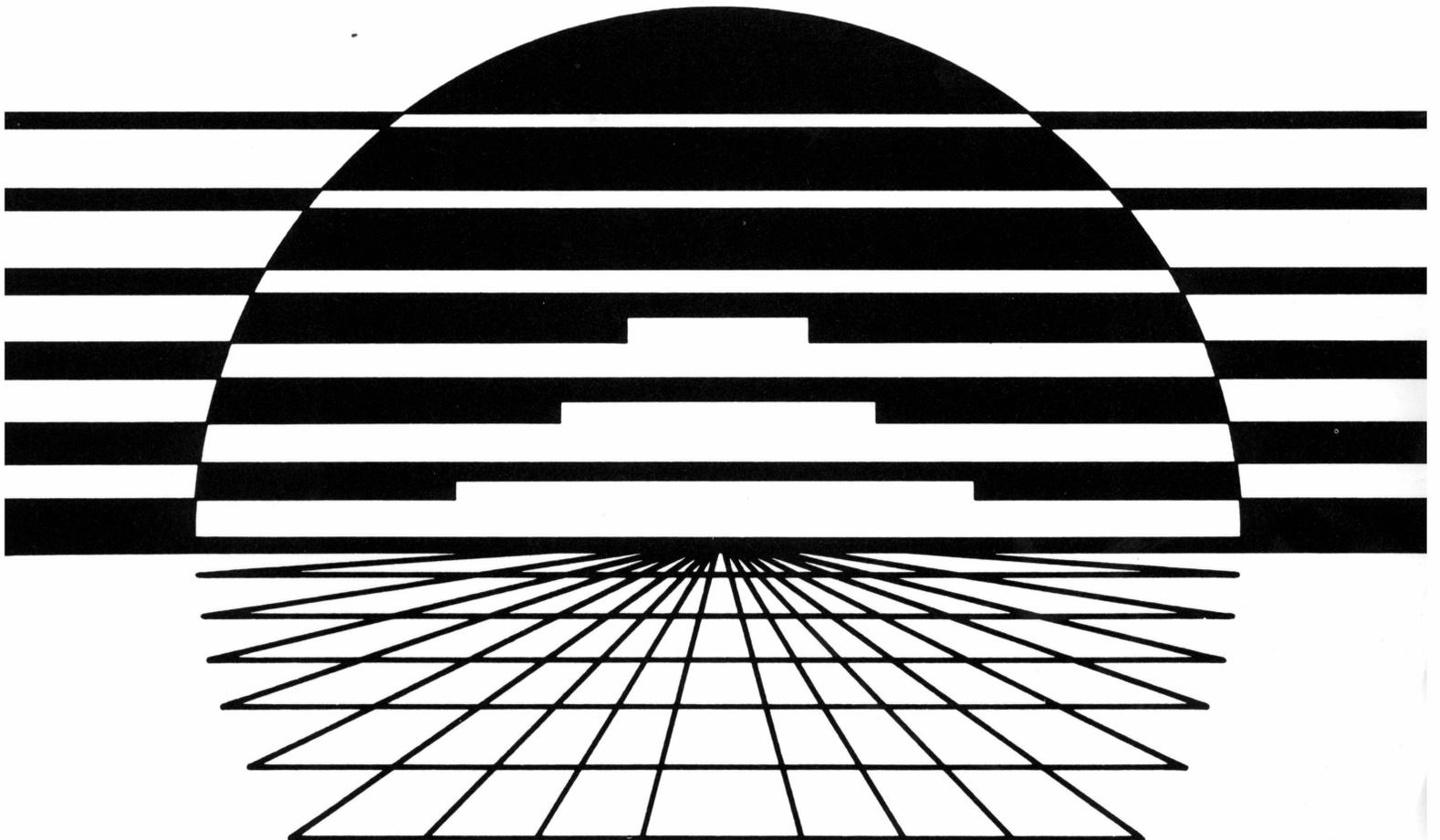


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ON THE COVER

The National Aero-Space Plane mock-up frame under construction. Photo by Howard Kash.

Engineers' Forum

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Engineers' Forum

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EDITOR'S PAGE

Engineers Earn Valuable Recognition For College

An ambitious group of Tech engineering students have set out to do something most aerospace companies could only dream of. In the span of only five months, students from Tech's American Society of Mechanical Engineers (ASME) and American Institute of Aeronautics and Astronautics (AIAA) chapters will have designed and constructed a complete scale mock-up of the National Aero-Space plane. The task is indeed a monumental one, but the recognition gained for Tech's already reputable College of Engineering will be the reward for the efforts of these 40-some students.

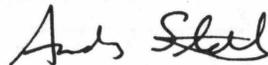
The project was literally dropped into the lap of Tech's ASME and AIAA just a few months ago after approval from the White House Office of Science & Technology Policy. Virginia Tech was chosen for the project due to its highly recognized student engineering societies. The reason for such a tight deadline? To prepare the mock-up for the Paris Air show in early June.

The NASA/DoD National Aero-Space Plane is itself currently in the development stages. So when the NASP Joint Program Office of Wright-Patterson Air Force Base tapped Tech for the mock-up construction, it was not merely to obtain a display model. This mock-up will be used by project engineers to determine cockpit size and location and other physical features.

The mock-up will be 75 feet in length when completed, corresponding to about 57% of the size of the proposed plane. To better facilitate organization of the project, the students are divided into various groups, including the CAD/CAM group, the wing-construction group, and of course the public relations group. The students are guided in their efforts by Mechanical Engineering Professor Walter O'Brien and Associate Dean for Academics Jim Marchman.

Progress on the project is proceeding rapidly as you read this. After the mock-up's unveiling at this year's commencement exercises, it's off to the Paris Air Show. There, not only will the plane be on display; the mock-up will be used as the centerpiece of the U.S. pavilion. And right on the exhibit will be a plaque crediting the design and construction to Virginia Tech Engineering students. Plans are now being made for exhibits at the Dayton Air and Trade Show, as well as Oshkosh and Air Show Canada.

Tech is very fortunate to have been chosen for this project, and its dedicated engineers are working long hours to take maximum advantage of this opportunity. The College of Engineering and every engineering student owes them a debt of thanks.



Andrew E. Stalder
Editor

Micromachines:

Technology in miniature

By Grady Koch

Miniaturization, which has already revolutionized electronics, is making strides toward opening a new frontier — micromachines. Engineers have made a gear 300 microns in diameter and 50 microns thick and could easily reduce these dimensions by a factor of 10 (a human hair is about 100 microns in diameter).

Efforts are also underway to produce miniature sensors; an acoustic sensor has been made that can fit onto a silicon chip. The possibility of machines this size provides a fantastic toy for the imagination. Researchers have suggested applications such as cholesterol shredding machines that could be injected into the bloodstream, sentry robots invisible to the naked eye, and miniature probes to examine normally inaccessible areas.

These ideas are a long way from being transformed into reality, but a beginning is underway. The miniature gears and springs being made in laboratories today could be the start of a revolution.

Micromachines are made by a process called photolithography, the same process used to fabricate integrated circuits. The shape of the component is first laid out as a black and white pattern. This drawing is photographically reduced to make a microscopic transparency, called a mask. The mask is laid over a wafer of material, usually silicon, that has been coated with a film of photo-sensitive emulsion. The wafer is then irradiated with light that causes any unmasked areas to polymerize. The unpolymerized

areas are removed from the surface of the wafer with a chemical etchant. Extremely small and complicated patterns can be made by this method, limited only by the wavelength of light used to polymerize the photo-sensitive emulsion.

Problems exist with this method of manufacturing, however. Photolithography is geared toward making very thin layers; micromachine parts are relatively thick, requiring many applications of the process.

Another problem is in removing the completed part from its substrate. The parts are removed now by etching away the substrate from behind the part. Forming and removing substrate weakens the strength of silicon. Photolithography is quite expensive — many components would have to be modified to be cost-effective.

So far, only basic components such as springs, gears, and cranks have been made. These components have been used to build simple machines with compressible springs and rotating members.

Many problems, beside those of manufacturing, need to be solved before a more

complex machine, such as a motor, can be built. A method for powering the devices must be found. Lubricating parts is also a problem; the nature of conventional lubricants between surfaces separated by less than a micron is uncertain.

Simply working with micromachines presents plenty of problems — consider trying to assemble a motor from these tiny components or trying to find a 10-micron-long spring after you dropped it on your lab bench.

Four Virginia Tech professors, K. Ramu, D. A. de Wolf, L. Roe, and J. G. Tront, presented a proposal to the National Science Foundation containing ideas on the architecture and control of micromachines, the first consideration of this problem. Their paper considered topological and thermodynamic aspects of control.

For example, a theoretical analysis of the switching current and energy in a micromotor was made. Dr. Ramu, who led the study, plans to continue research in this area and is considering offering a graduate-level course exploring micromachine technology, including control.



Grady Koch is a modern-day Renaissance man: writer, poet, and, of course, EE.

	Notes from a graduating senior:
	Being the oldest and wisest member of the Forum staff
	(well, at least the oldest), I was chosen to write this
	insightful guide for upcoming seniors in the College of
	Engineering. So forget all the other stuff you have
	heard — here's the real scoop ...
	by Karen Koger

TOP TEN TIPS

for a Successful Senior Year

1 GET A REAL SUMMER JOB.
 This means something somewhat relevant to your major, especially for those who have not had any engineering work experience yet. So no more flipping burgers or lifeguarding, even if they are raising the minimum wage. A good summer engineering job will give you experience, provide money for school, and help you decide what you really want to do after graduation. Company recruiters are usually more interested in work experience than anything else (even grades!). University Placement Services in Henderson Hall can help you find summer employment opportunities.

2 PREPARE EARLY.
 Pick up a few blank Personal Data Sheet (PDS) forms at the Placement office and start filling one out over the summer. Then make an appointment to meet with a placement office staff member as soon as school starts next fall. The placement staff can help you finalize your PDS so you can start interviewing early. Also, this summer, shop for an interview suit. Make sure it fits well and buy some comfortable shoes because you will be wearing this outfit 2-3 times a week during your senior year.

3 DON'T PROCRASTINATE.
 I know we are all guilty of this from time to time (even me!), but it's not too late to improve your study habits. Take note of test dates and project due dates, because usually they all occur during the same week. I think professors do it on purpose for some kind of student stress experiment. Anyway, the quality of your work will improve if you start working on your projects before the last minute. I know the saying, "if you wait 'til the last minute, it only takes a minute," but trust me on this one. Start early. Besides, all that coffee is bad for you.

4 GET TO KNOW YOUR CLASSMATES.
 It's a lot easier and more fun to get through engineering school by working together than going at it alone. Trade phone numbers. At 2 a.m., a quick call to an informed classmate can be a real lifesaver when you're stuck on a problem.

5 TALK TO YOUR PROFESSORS.

Try to go see all your professors during their office hours to ask questions about class or just to chat. Most of them are more than willing to talk to students about jobs, research, graduate school or even about fun stuff like hang gliding. Many of them have worked in industry and may have worked for a company that you are considering. You will probably need a couple of faculty references, so make sure they are familiar with your work and also know something about you personally.

6 TAKE CARE OF YOURSELF.

You have heard this one before, probably from Mom. Eat right (lots of veggies), get enough sleep (ha!), and exercise. A regular eating/sleeping schedule and exercise program will keep your energy level up and you are going to need all the energy you can get.

7 GET INVOLVED.

Remember there is more to school than classes and job interviews. Get involved with engineering societies, sports teams, social clubs, religious organizations, etc. etc. The *Engineers' Forum* is always looking for new staff members. If you are so inclined, run for an office or volunteer to be a committee chairperson. Recruiters love it and you can have some fun, too.

8 LEARN TO TRAVEL.

The plant trips usually start in January. Make a master list of everything you need to take (it's the same for every trip), so you can pack in 15 minutes if required. A good hang-up bag is helpful. Buy travel-size bottles of shampoo, toothpaste, etc. Learn to love airplane meals. Keep all receipts. The Blacksburg Limousine Service will take you to the airport for \$15 if you don't want to drive.

Become familiar with the Pittsburgh and Charlotte airports; you have to go through at least one of those to go anywhere. Join a Frequent Flyer program.

9 KEEP YOUR OPTIONS OPEN.

Consider graduate school. The Virginia Tech Graduate School office is in Sandy Hall. Newman Library has catalogs for many other schools on the 2nd floor. Consider the armed services. The Navy has several good programs for graduating engineers, especially their Nuclear Program. Consider many job possibilities, even ones you think you would hate. Take as many plant trips as you can, because a visit to the plant is the best way to get a feel for the actual work environment.

10 DON'T PANIC.

Senior year is hectic and stressful, but also fun and exciting! Thousands of students have made it through, and you probably will, too. Appreciate your friends and the general craziness of college life while you're still here.

Now you are ready. Good luck and hang in there!



TOM GLAAB

Karen Koger is a senior in Mechanical Engineering and a compulsive list-maker.

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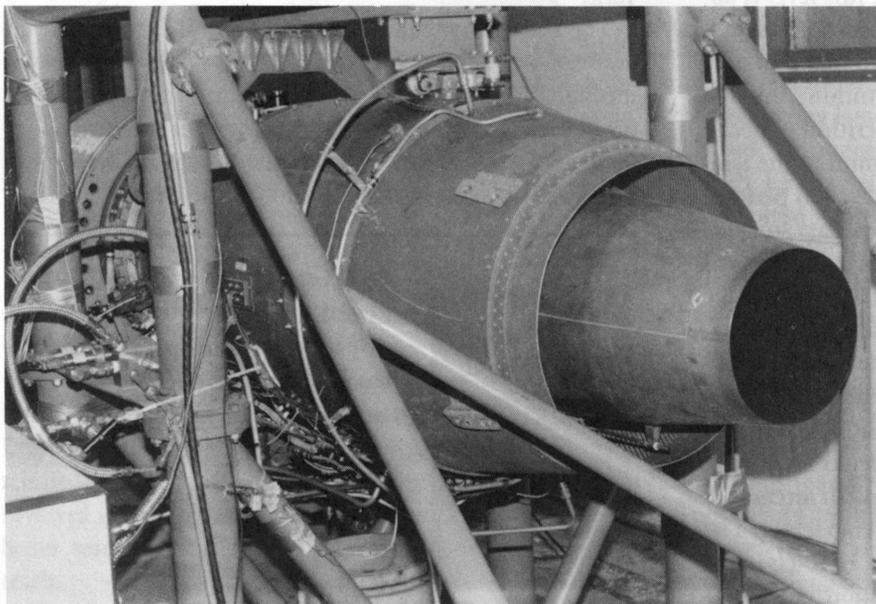
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Tech's ME Propulsion Lab Offers Unique Educational Experience

by Tony Giunta

Tucked away in a large nameless building at the Virginia Tech airport, hidden from unsuspecting passersby, is the Mechanical Engineering Department's Propulsion Laboratory.



HOWARD KASH

The JT15D testing apparatus

As the only university facility of its kind currently in operation, the propulsion laboratory serves a dual purpose. It affords graduate students the opportunity to gain 'hands-on' experience with an actual gas turbine engine, and also provides local and national industries, through program sponsorship, with a means to test and develop new technology.

Directed by Dr. Walter F. O'Brien of the Mechanical Engineering Department, the propulsion lab is a somewhat recent addition to the Virginia Tech's Center for Turbomachinery and Propulsion Research.

Created in 1976, through funding from the University and from the Office

of Naval Research, the lab is located in what was formerly a World War II-era engine mechanics training school. Following the modernization of the airport facilities already in existence, the propulsion lab began operation in the late 1970's. The Center's first acquisition was a T-64 helicopter engine loaned by the Navy.

In the early 1980's, this was replaced by the engine which is currently in use, a Pratt & Whitney JT15D-1 gas turbine. More powerful than the T-64, the JT15D is the type of engine used in small business aircraft, particularly the Cessna Citation, and is capable of producing approximately 2000 pounds of thrust. The JT15D's strength became evident during the initial testing of the engine, when the jet blast supposedly pushed a passing Volkswagen off the side of the road.

In the past several years, a great deal of experimentation has been conducted using this engine, and, fortunately for motorists, a blast deflector has since been installed.

Much of the research conducted by the propulsion lab has been directly related to current problems and needs in industry. For several years, the experimentation was sponsored in part by the Rosemont Aerospace Division, and more recently by a local company, the Vatel Corporation.

Concerned primarily with turbine blade analyses, previous investigations have been

Continued on page 8

Tech's ME Propulsion Lab Offers Unique Educational Experience

Continued from page 8

conducted to measure such factors as the rotating clearance of the blades and the temperatures to which they are subjected. The testing which was completed earlier this year was concerned with innovative methods for determining these temperatures.

... during the initial testing ... the jet blast (supposedly) pushed a passing Volkswagen off the side of the road.

During the operation of a gas turbine engine, the turbine blades are stressed under extreme temperature conditions. For the JT15D, this level is approximately 1050 degrees Kelvin during maximum power.

Because the turbine internal environment is critical, a precise means of determining the temperature is needed. To perform this task, the graduate students

at the propulsion lab tested the applicability of special optical fiber instruments called pyrometers, which measure the temperatures of the gasses surrounding the turbine blades.

Inserted directly into the engine, the pyrometers are considerably more accurate than the methods currently in use. Although the pyrometers are still in the testing stage, Dr. O'Brien believes that in several years these devices will have been installed in most military and some civilian aircraft.

At the present time, the lab is in a state of remodeling. The JT15D is undergoing maintenance, while the air inlets in the laboratory wall are being enlarged in preparation for the next project.

Just recently receiving funding from the Martin Marietta Corporation's Energy Systems Division, researchers will evaluate the accuracy of another method of temperature determination, thermographic phosphor measurements. The project of graduate student Ted Andersen, this procedure will involve the use of a high power "Yag" laser to measure the radiated energy intensity from phosphor coated turbine blades. Considered to be even more accurate than the pyrometer readings, the thermographic phosphor testing is a very promising method for future applications. With financial backing now secure, the research should commence in May or June.

The future seems promising, as more industries become aware of the research and development possibilities that exist through the propulsion lab. While engineering corporations profit from the testing of new technology, the continuation of these and other projects additionally benefits the students, who gain valuable experience through these investigations.



TOM GLAAB

Tony Giunta is an AE who took his interest in jet propulsion one step further with this article. He vows to never drive a VW Beetle anywhere near the Propulsion Lab.

WHERE HAS THE FASCINATION GONE?

The beauty of Kepler's motion in the heavens,
Physics that put footprints on the moon,
Lost 'cause I've got a kick-!@# test at eleven
Digital ability to calculate faster than comprehension
Silicon switches that remove mathematical bounds,
Reduced to due dates that fill the mind with apprehension
Whirring electrons mastered into quantum states,
A mystical explanation of particle behavior,
Now ridiculous because my average is at stake
Though I try to revel in the light of knowledge
I feel that something is dreadfully missing,
It's hard to be fascinated with the rigors of college.

— Grady Koch

RESEARCH vs. TEACHING: *Is There Really a Conflict?*

by Tom Glaab

SCHEDULE OF... *B. H. CHO* ... 3. QTR. 19.89

OUR	MON.	TUES.	WED.	THURS.	FRI.
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9	IBM/K			NASA/6	
10	EE5216		EE5216	Fairchild	EE5216
11	PATIL		CHOI		
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1			CHOI	EE4284	
2			VPEC		
3			Seminar	↓	
4					

TOM GLAAB

The schedule of a typical professor.

A common opinion among students is that a professor who also does research work tends to value his research more than his students, making him a bad teacher. In response to this accusation, Dean of Engineering Paul Torgersen has released a report which shows that faculty involved in research work actually make better teachers than faculty who only teach.

The College of Engineering is currently the only college at Virginia Polytechnic Institute and State University which requires all of its faculty to distribute teaching evaluations among its students. From these evaluations and "activity reports" submitted by faculty, some interesting figures arose.

The "teaching faculty" teach one-third of all engineering classes, and they received a rating of 3.11 out of four in student evaluations. The "teaching/research faculty," who teach the other 67% of engineering classes, received a 3.37.

Associate and full professors; and a few classes for which teachers did not submit teaching evaluations.

Dean Torgersen claims that exclusion of these courses did not affect the results of his study, since teachers of small classes typically receive higher ratings than average, new faculty did not clearly fit into either the teacher or teacher/researcher category, and elimination of EF faculty did not affect the results.

Teacher/researchers "have been involved during the 1988 calendar year in research funded from external sources and have either published at least one refereed paper in a major technical journal or have presented a refereed paper at a

The average for engineering faculty was a 3.28.

Not all courses were used to arrive at these numbers. Those excluded were: classes with less than five students; classes taught by visiting faculty and instructors; courses taught by deans and department heads; Engineering Fundamentals classes (EF professors only teach EF classes, and few are involved in any research); newly appointed

major technical meeting" and also teach. Certain teacher/researchers draw more than \$100,000 in research funding each year, and the rating for these "teacher/exceptional researchers" was a surprisingly high 3.52.

If only undergraduate courses are considered, teachers received a 3.05 while teacher/researchers earned a 3.34. Teacher/exceptional researchers received a 3.55 Engineering Fundamentals faculty received a 3.20, which is slightly below the college-wide average of 3.28, but Dean Torgersen believes that "freshmen are somewhat more difficult to motivate and teach."

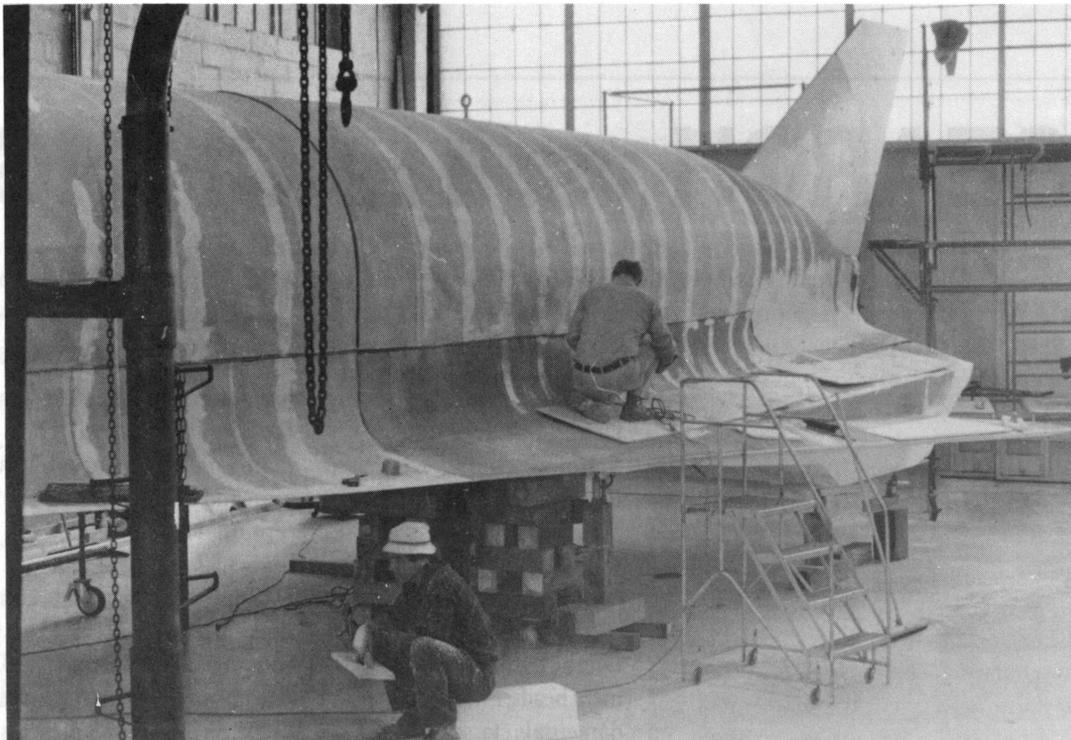
Another surprise is that "non-native" faculty received a 3.28 — exactly at the average for the college. These are of course average figures; some teachers are exceptional while others greatly need to improve. But as these numbers show, Dean Torgersen says we should not apologize for teacher/researchers. Instead we should encourage more teachers to do research and vice versa, and then "as President McComas has proposed, we need to ensure their commitment to effective teaching in general, and undergraduate education in particular."



HOWARD KASHI

Tom Glaab an EE, is Business Manager and advertising guru for the Forum. After yet another all nighter, Tom says, "I'm not upside down, you are."

HOWARD KASH



Body panel construction on the NASP mock-up.

Tech Engineering Excels with the National Aero-Space Plane Project

by Jonathan Hess

After many set-backs in the 1980's, the National Aeronautics and Space Administration, (NASA), is moving forward with an amazing new concept. As former President Ronald Reagan expressed in his last State of the Union address, "We are going forward with research on a new Orient Express that could, by the end of the next decade, take off from Dulles Airport, accelerate up to 25 times the speed of sound attaining low earth orbit, or fly to Tokyo within two hours." These words were in reference to what has been called the National Aero-Space Plane, (NASP), or X-30 program.

Sponsored through a joint effort between the Department of Defense and NASA, the vehicle involved in the X-30 program will travel at orbital speeds, potentially Mach 5 to 10. The official NASP goal has been defined as "technol-

ogy development and demonstration to provide the basis for hypersonic flight vehicles leading to space transportation systems, superior U.S. military aircraft, and civil transports that will have technical, cost, and operational advantages over existing systems."

Recent advancements in the areas of hypersonic propulsion, materials and structures, and computational fluid dynamics have been promising; however, an operational aero-space plane is not foreseeable until the year 2000 at the earliest.

In early 1986, development for the NASP program began, centering around a "manned, hydrogen-powered, single-stage-to-orbit vehicle" that will take off and land in a horizontal position and maintain hypersonic speed, cruising for extended periods of time. After careful evaluation, it was decided that General

Dynamics Corp., Fort Worth, Texas; the North American Aviation Operations division of Rockwell International, Los Angeles, California; and McDonnell Douglas Corp., St. Louis, Missouri, would be the airframe contractors for the NASP program. Rockwell's Rocketdyne Division, Canoga Park, California and the Pratt and Whitney Division of United Technologies, West Palm Beach, Florida will be in charge of engine development for the aero-space plane. The aero-space plane's present design is comparable in size to the shuttle orbiter or a 727 airliner.

Aside from the contracts granted to the companies listed above, NASA has also funded a project to design and build a mock-up of the National Aero-Space plane that is 57% the theoretical size. Based on the excellent reputation of both the American Society of Mechanical En-

NASP

gineer's, (ASME), and the American Institute of Aeronautics and Astronautics, (AIAA) at Virginia Tech, NASA chose our University to take on the mock-up project.

The model is being designed and built by undergraduate students in both Mechanical and Aerospace engineering, under the supervision and direction of Dean James F. Marchman and Dr. Walter F. O'Brien.

Students began to work on the original designing and planning stages in mid October, while the actually physical structure was not started until early January. The Aero-Space Plane model is to be completed by May 5, so that it may be displayed at commencement exercises.

Although, the Aero-Space plane will be an eye-catching attraction at graduation, NASA has outlined specific goals for the mock-up to achieve. In order to achieve the goal of exhibiting and displaying the overall concept of the National Aero-Space plane, it will be featured at various air shows around the world. Its first major public appearance will be at the Paris Airshow this summer.

Though displaying the concept to the public is important, the primary goal of the model are the study of crew and module locations, as well as other major features. Overall, NASA plans to gain knowledge by studying the overall concept that the Aero-Space plane mock-up will provide.

Construction of the seventy-five foot model by Tech students has been very detailed, starting with preparatory framework design utilizing CAD computer systems. The frame uses truss structuring and is made of aluminum metal. The framework is divided into two major body sections and several limbs, including the wing pieces, vertical stabilizers and the nose cone. As far as strength is concerned, the Aero-Space plane mock-

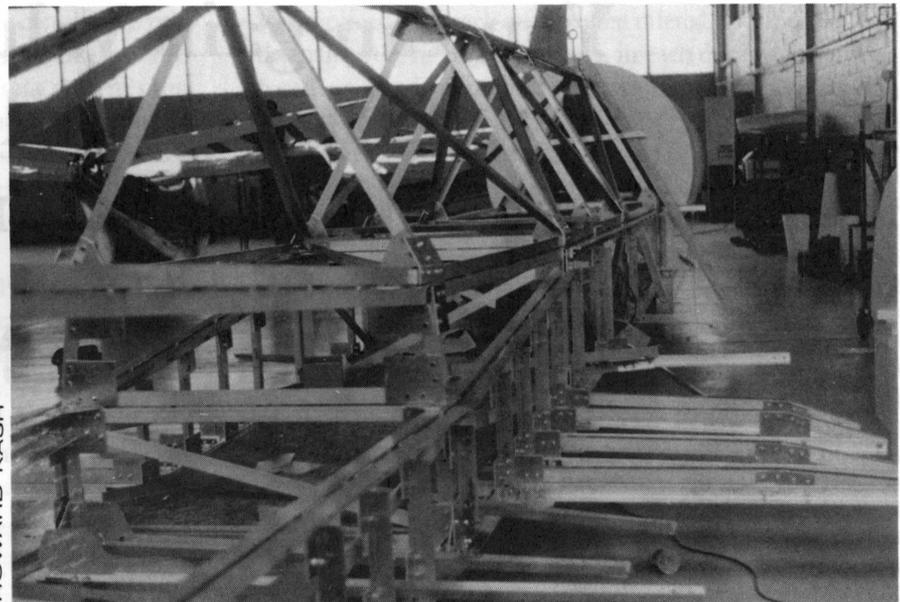
up has been designed with one-hundred mile per hour wind loads in mind, while the frame has a safety factor of 13.5 under static loads.

In order to simplify transportation of the Aero-Space plane, the framework is being bolted down to a trailer system. This trailer system will be invaluable when it comes time for Tech students to put the various pieces of the Aero-Space plane into the back of a tractor trailer, which will then transport it to Norfolk, Virginia. At Norfolk, the plane will be moved to the belly of a C-5 aircraft, which will in turn fly the Aero-Space plane to Paris. Many of the students that

have been involved with the Aero-Space plane mock-up plan to attend the Paris Airshow in order to assemble and disassemble the various pieces of the plane.

After completion of the framework, the body of the plane will be formed, using close cell expanded polystyrene. This material is comparable to heavy duty styrofoam, as it weighs two pounds per cubic foot. Next, a layer of open weave fiberglass will be applied around the expanded polystyrene. Finally, the finishing system for the surface of the plane is being provided by I-Core, a company that specializes in exterior fin-

Continued on page 12



HOWARD KASH

A look down the frame of the 57% mock-up.

NASP

Continued from page 11

ishes. They have provided Virginia Tech with a white substance called i-cote. The i-cote is a finely sanded substance which will be applied in two coats to the outer shell of the Aero-Space plane.

As finishing touches, red and blue stripes, completing the patriotic colors of the United States, will be placed on the mock-up. In addition to this, the team will make sure that the familiar "square root of one" or VT symbol will be placed on the tail to add Tech's own personal flair.



TOM GLAAB

Jonathan Hess went to great lengths to get information on the NASP project. When not dodging cars, Jonathan studies electrical engineering.

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“...traditionally 5% drop out of Engineering in their freshman year, and roughly the same amount drop out of school in that same time.”

Engineering Fundamentals puts prospective engineers to the test

by Tom Glaab

Once again, freshmen in the VPI engineering program have had to choose their desired field of study. Freshmen enter the Engineering Fundamentals (EF) department where they spend a year learning general engineering concepts and have a chance to learn about the different disciplines offered here.

The class of 1992's tentative departmental placements are shown in the sidebar. These placements are conditional on a cumulative QCA of 1.9 at the end of Spring semester. Previously, departmental selection was based on a student's first two quarters' grades, so placement was firm. This year the EF department decided that two grading periods were still necessary, but selections were made based on one semester's work so students would be able to schedule appropriate classes for next year.

According to Dr. R.H. Pusey, Associate Professor for Engineering Fundamentals, in the past not as many students failed out in the third quarter as did in the second quarter, but it's "hard to say" what will happen this year. Traditionally 5% drop out of Engineering in their freshman year, and roughly the same amount drop out of school in that same time. "This is not unusual to Engineering," said Dr. Pusey, "a lot of students decide that college just isn't the place for them."

By using second semester grades some students will lose their assignments, but others will be able to raise their QCA enough to get into a department. There are about 150 engineering students who didn't make grades first semester and about 80 trying to get into engineering from other depart-

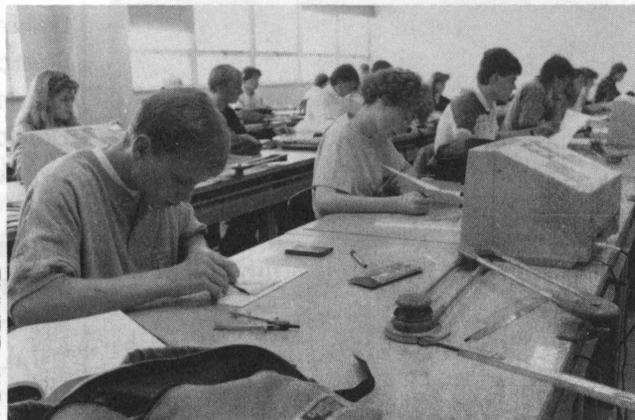
ments. Dr. Pusey expects many of those students who don't make grades in the Spring to do so over the summer. Two semesters also allows for a more accurate record of a student's progress. If he has a bad semester he still has a chance to get out of EF and into a department of his choice.

If a student has a cumulative QCA of 1.9 or better he is allowed to choose three disciplines from the 12 offered. The top applicants for each one are then offered a position in that department. The caps, or quotas, in each department are set based on faculty numbers and available facilities. As the demand for certain departments gets higher and higher these caps have to be enforced more strictly. Except for the high-demand departments of Aerospace, Ocean, and Computer Engineering, none filled up this year, meaning that almost every eligible engineering freshman got into one of his top three choices of department.

What happens after this is unknown to the EF department, since they don't keep track of students after they leave EF. However, in EF this year's students have not done as well as previous students. This does not seem to be a matter of the students' "smartness" or high school performance; rather it seems to be a problem with semesters.

According to Dr. Pusey more students are "having trouble" in their classes, but he attributes this to the restructuring of classes due to the semester conversion. Since the freshmen have never taken courses at VPI under anything other than semesters it seems unlikely that the problem lies with the students. When asked if the problem laid with the

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Engineering Fundamentals

Continued from page 13

professors' inability to adapt to semesters, Dr. Pusey said that he did not know how much of the students' difficulties were due to professors. He also said that the department might just be premature in its judgement, and that things might work out in the end after all, but he was very confident that the problem is most likely due to the restructuring of the EF program.

Previously, the first quarter of EF focused on problem solving, BASIC, and the engineering programs available at VPI. The second quarter was a course in FORTRAN, and the third quarter taught engineering graphics. This year BASIC was removed from the introductory courses and made into a one hour elective since 95% of incoming freshmen already had experience programming in BASIC. The first semester of EF consists

of an introduction to engineering and the start of FORTRAN. The second semester finishes FORTRAN and covers graphics.

The EF department wants to further change the curriculum to make it a little more logical. FORTRAN and the intro to engineering would comprise the first semester, while graphics would take up the entire second half of the year.

According to Dr. Pusey, the exclusive use of FORTRAN for programming is something the department would like to phase out. This is because the goal of the EF department is to teach problem solving, both by computer and by hand, not just a computer language. There is a fear of teaching things that the student will never need again, which is why the emphasis in EF is teaching students to use the computer as a tool to do what they want it to do, not just writing strange

programs that have no use outside of the classroom.

Incoming engineering freshmen were sold the Quattro spreadsheet program with their computers, and the EF department would like to show students how to use it to solve engineering problems. There has been talk of teaching a class on Quattro, but getting the proposal past the curriculum committee will be difficult because the class would teach one type of software exclusively. Despite this difficulty the EF department would like to expose students to the many different types of software available to them, and will try to do this through the introductory courses.

There have been many changes in the Engineering Fundamentals department this year, mostly due to the semester conversion. What effects this will have on the VPI College of Engineering in the years to come is, in the words of Dr. Pusey, "hard to say." The College of Engineering is over 100 years old and has survived many changes, suggesting that the semester change will not be fatal.



TOM GLAAB

Students at work in the Randolph Computer Lab, a convenient facility open to all undergraduate engineers.

Department	Quota	Placed
Aerospace Engineering	95	95
Ocean Engineering	15	15
Agricultural Eng.	45	4
Civil Engineering	180	70
Chemical Engineering	100	56
Computer Engineering	40	40
Electrical Engineering	300	190
Eng. Science & Mech.	45	22
IEOR	85	57
Materials Engineering	40	13
Mechanical Engineering	225	153
Mining Engineering	45	3
TOTAL	1,215	718
		(60%)

COMPUTER VIRUSES

by Andrew Predoehl

In September of 1983, a graduate student at the University of Southern California who was interested in computer system security wrote a computer program, called VD, that could copy itself and modify other unrelated programs stored on the computer system. The revised programs, when run by their owners, would similarly modify other programs to continue the copying. Such a program, known as a virus, acts like its biological namesake by "infecting" a host program or disk and reproducing itself when run.

The student, Fred Cohen, wanted to learn how quickly such a self-reproduc-

ing program could infect all the programs on a multi-user computer system, specifically the VAX 11/750 minicomputer he was using. Cohen found that VD could infect the system in, on the average, half an hour. Other users never noticed the virus while it ran. The computer system administrators reacted by barring Cohen from further access to that computer.

AN IMPOSING GUEST

Today, viruses exist for most popular computer systems. All virus programs share the same general structure as Cohen's virus. For example, all viruses require a host program. Such a host

program may be an ordinary program, such as (on IBM PC's) an executable file like XCOPY.COM, or a "bootblock" program: a special program to start up the computer, stored in a special part of the disk. It is that bootblock program that makes a particular disk a so-called "system" disk.

If a virus uses a particular program as a host, whenever the infected program runs, the virus runs. Usually when a virus runs, it only reproduces itself; however, most viruses also do something else when they are triggered, such as writing a message on the screen or erasing a disk in the drive.

The "trigger" can be almost anything; the virus may check the system date and run amok on Friday the 13th, or it may count the number of times it has successfully transmitted itself to other programs and act up once that number reaches a pre-set value.

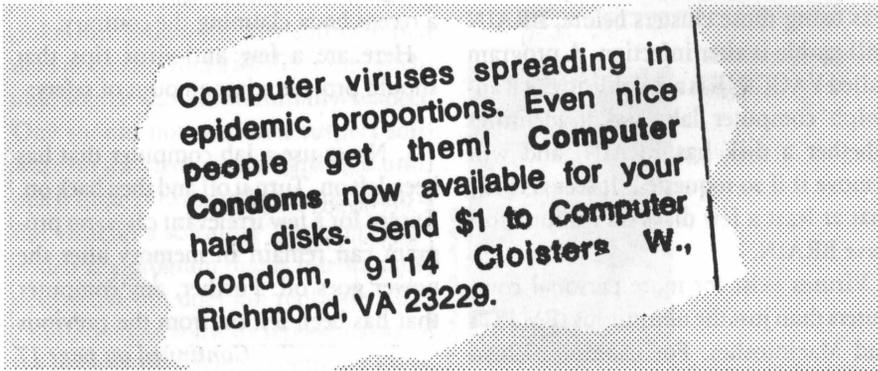
Not to be confused with a true virus program, a worm is another type of program that reproduces itself, but it requires no host. Last November a worm caused a furor when it invaded computers connected to InterNet, a national computer network. Worms, like viruses, can be malicious, if they seek and destroy data; however, any worm which is successful at reproducing itself on a large scale is annoying, since several thousand or million copies of itself take up vast amounts of memory and processor time, two resources computer users loathe to have stolen. The InterNet worm was not malevolent, but it did clog many computer installations across the country, while exposing some inadequacies in computer network security.

Fred Cohen's viral intentions were benign — he was purely interested in research, and VD was easy to remove from the system. However, the average virus is at best annoying and at worst psychopathic.

Consider a virus first reported at Le-

Continued on page 16

**Classified notice from the Collegiate Times,
Fri., Feb. 24, 1989:**



Computer viruses spreading in epidemic proportions. Even nice people get them! Computer Condoms now available for your hard disks. Send \$1 to Computer Condom, 9114 Cloisters W., Richmond, VA 23229.

COMPUTER VIRUSES

Continued from page 15

high University in 1987: this virus for the IBM PC attached itself to COMMAND.COM, which is the program that contains the code for memory resident commands like DIR and COPY; whenever a computer was started with a disk containing such an infected copy of COMMAND.COM, the virus would wait in memory until the user executed one of these commands, and then it would attempt to infect the disk in the accessed drive. If the virus managed to infect four other disks, it would then totally erase the disk currently being accessed.

Most viruses manage to escape notice for some time before they are caught, in the meantime quietly copying themselves onto hundreds of disks perhaps. A virus in the bootblock of a hard disk could easily infect every disk that is subsequently put in that computer's floppy drive; often, a computer user inadvertently infects his friends' disks as well as his own, causing the continued spread of viruses, often around the world.

LOCAL INFECTIONS

Not surprisingly, a few viruses have found their way to Blacksburg. Richard Simpson, a computer science major, was invaded by a virus called nVIR, which infected his hard drive and a few floppies. Though not really sure how or when he got it, Simpson reports, "I noticed it when my computer refused to boot." nVIR destroyed his hard disk's system folder, the Macintosh equivalent of the IBM PC's CONFIG.SYS and AUTOEXEC.BAT. He was able to reconstruct the system folder after about four hours of work; he also had to erase several

programs that had been infected.

Currently Simpson uses two programs to protect himself from further attack: VirusDetective, which recognizes most known viruses; and Vaccine, which operates in addition to other programs, and informs the user whenever a program writes to the disk, warning, in theory, the user when a virus reproduces itself. Anti-virus software for the Macintosh is available from the McBryde 120 computer lab and from the University Bookstore.

One of the most recent viruses on campus is the BRAIN virus. BRAIN exclusively infects 5.25" drives on the IBM PC. 3.5" disks and hard disks cannot be infected, at least by the present version of BRAIN. The virus has infected the disks in the Randolph computer lab a few times; however, according to the lab manager, all the lab disks are now clean.

BRAIN is a bootblock virus that loads itself into memory and infects subsequently inserted floppy disks when other programs access them. The virus comes from Pakistan, where, evidently, two programmers wrote it to discourage pirates of Pakistani-sold commercial software.

Unfortunately, BRAIN quickly spread from pirated software to general users; the author borrowed a copy of BRAIN (from which the illustration was made) from a graduate student who picked up the virus from the Randolph computer lab.

BRAIN does not cause any terrible evil. When it infects, it takes three disk clusters (units of storage on the disk surface) to hold the program code; if a file was using those clusters before, BRAIN will garble it after infection. A program called VACCINE is available in the Randolph computer lab, and it identifies whether a disk has BRAIN, and will remove it if so requested. It seems likely that at least a few disks on campus still have BRAIN.

Viruses exist for more personal computers than just the ubiquitous IBM PC's and Macintoshes. For example, Lloyd

Eldred, a graduate student in aerospace engineering, runs a local computer bulletin board, the Coconut Telegraph, off his Amiga 1000.

Eldred borrowed a public domain disk that unfortunately included a bootblock virus known as the SCA (Swiss Cracker's Association) virus, from which his system was infected. Before he discovered the virus, he unknowingly infected a few friends. Fortunately, the SCA virus does not usually do any permanent damage, and it is easy to remove from ordinary disks. The extent of its activity is that it keeps count of how many times it replicates itself onto a new disk; after 16 copies it announces to the surprised user, "Something wonderful has happened. Your AMIGA is alive!!! And even better, some of your disks are infected by a VIRUS."

VIRUS SAFETY

The only totally virus-proof computer system is one which is always off. Despite such a fact, the virus situation is not bleak. Simply exercising prudence will prevent viral infection most of the time.

First, there are a few myths associated with viruses. Absurd as it may sound, some have picked up the notion that computer viruses are organic; they are merely programs, although they are undesirable programs. Also, one cannot get a virus merely by hooking up his computer to a modem and calling computer bulletin boards — a virus infection only occurs when the virus can copy itself to another host program or into the computer's memory; neither is possible when using the computer as a terminal, despite a recent hoax claiming the contrary.

Here are a few anti-virus tips that should provide a fair amount of safety:

1. Never use a lab computer that has been left on. Turn it off and then back on. Except for a few irrelevant cases, no program can remain in memory after the power goes off. Further, any computer that has been left on from the previous

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user may be infected by a virus; do not trust the previous user to be virus-free. Such misplaced trust is one way the BRAIN virus spreads. As an aside, it is best to wait thirty seconds to a minute before turning the power back on, so that the computer's electronics aren't harmed.

2. Write-protect your disks whenever possible. All properly designed disk drives will not allow a program, virus or no, to write to (that is, store something on) a floppy disk if the disk's write-protection is engaged. Of course, to write-protect a 5.25" disk involves placing a small opaque sticker over the notch in the disk on the right edge; to write-protect at 3.5" disk involves sliding back the small switch in the top right corner to reveal the hole. It is wise to write-protect all disks on which nothing needs to be written, such as program disks and full data disks, so that there is no chance those disks can be infected by a virus.

3. Always make backups of everything important. Do not use software distribution disks (that is, the original copies) of commercial programs whenever possible; use copies. If one must use the original disks, keep them write protected at all times. Make backups of important data such as word processing data disks, and keep the backups up to date. Hard disk users should be especially diligent in making backups, since most hard disks cannot be write protected.

4. Use extreme caution when using unknown programs. Any software that does not come from a totally unimpeachable source should be initially suspect. One should not run such suspect software on a system with a hard disk until one is quite confident that the program is not viral, or a so-called "Trojan horse," which is a program that is intentionally destructive but does not replicate itself. Public domain software represents one of the greatest resources to computer users,

but it also represents a source of danger; caution can eliminate most of the danger.

IBM PC users, especially hard disk owners, may also wish to get into the habit of running a virus lookout program such as CHECKUP; CHECKUP is "shareware" (that is, software sold without overhead from advertising, marketing, or distribution costs, distributed by users), and the program's author even waives the fee when the program is for private use. It is available from local computer bulletin boards. CHECKUP examines files and keeps records of the status of programs stored on disk, and will detect any changes made to a program, including changes due to virus infection. Complete instructions are included; the only requirement is that one register himself as a user (the registration form comes in the instructions).

Should a virus manage to infect one's system anyway, removal and reconstruction

COMPUTER VIRUSES

are topics broad enough to warrant a whole series of articles. The severity of a virus attack will determine how much the user needs to do, ranging from running a vaccination program to reconstructing the entire file structure on a hard disk. One should consult computer publications and other computer users to find out the best way to recover from virus destruction.

CONCLUSIONS

Virus programs represent a threat to computer users who do not take adequate

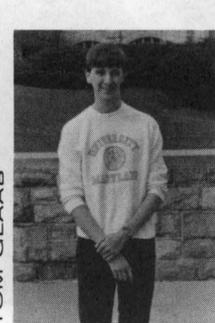
Continued on page 19

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Sector 0 in boot area in hex format          Cursor at offset 447, hex 1BF
2E2E2E2E 342E2E2E 2E002E00 00000020 20202020 20205765 ....4..... We
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4B20414C 4C414D41 20495142 414C2054 4F574E20 20202020 K ALLAMA IQBAL TOWN
20202020 20202020 2020204C 41484F52 452D5041 4B495354      LAHORE-PAKIST
414E2E2E 50484F4E 45203A34 33303739 312C3434 33323438 AN..PHONE :430791,443248
2C323830 3533302E 20202020 20202020 20204265 77617265      280530. Beware
206F6620 74686973 20564952 55532E2E 2E2E2E43 6F6E7461 of this VIRUS....Conta
63742075 7320666F 72207661 6363696E 6174696F 6E2E2E2E ct us for vaccination...
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2ED82ED0 BC00F0FB A02E7CA2 2E7C2E2E 2E7C2E2E 2E7CE857 .+.u. =.á.ó.í. . . .!$W
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002E50CB 5153B92E 00512E36 2E7CB200 2E2E2E7C B82E2ECD . . P . OS . . . Q . 6 . . . . l . q . =
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2ECD21A2 3C5F2E2E          Press Enter for help      . = ! ó < _ . .

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A sample virus output



Andrew Predoehl, as a CpE, is the Forum's resident computer expert.

A CASE FOR SPACE

*Student Engineers' Council
lobbies in Richmond for
funding for new
engineering/architecture
building*

by Julie Feil

"For these reasons, we, the engineering students of Virginia Tech, believe that it is imperative that the Virginia General Assembly authorize the funding of a new engineering/architecture building."

This statement concluded the student engineers' petition that many students signed a few months ago. The petition stated many of the facts and figures about the desperate need for space:

"Presently, the Virginia Tech College of Engineering has 57 square feet of classroom and laboratory space per student while the Engineering School at the University of Virginia has 114 square feet per student (exactly twice the amount of Virginia Tech). Furthermore, based on a comparison of square feet per faculty member, Virginia Tech's College of Engineering is ranked 44th out of a total of 44 publicly supported engineering colleges in the U.S."

At final count, the petition had approximately 3000 signatures from engineers of all majors and all levels.

In the first week of February, Julie Feil, Theresa Gidley, Ian Sobieski, and Ron Shultz presented the petition to Senator Hunter Andrew, Senate Finance Chairman, and Delegate Dorothy McDiarmid, House Appropriations Chairwoman. The students were very positively received by both Congressmen. Delegate Joan Munford, D-Blacksburg, introduced the students to the House of Delegates that afternoon. The visit attracted media attention, including WDBJ Channel 7 news, the Richmond Times Dispatch, and the Roanoke Times and World Report.

On a list of 83 state capital projects, the Tech building proposal is ranked 37th. Although this ranking may not seem high, the proposal is the highest ranking proposal for planning money (as opposed to construction money), which will come in August from lottery profits.

Hopefully, profits will be enough that Tech will get planning money this August and not have to wait until August 1990.



Julie Feil, Ian Sobieski, Theresa Gidley, and Ron Schultz present the petition for space to Senator Hunter Andrews (above) and Delegate Joan Munford (below).



Computer Viruses

Continued from page 17

precautions against infection, and the worst case results can be disastrous; however, most virus attacks at Tech have been, so far, less than cataclysmic, and simple guidelines for virus prevention can keep the average user reasonably safe from attack. The danger of viruses, by itself, is no reason to discon-

tinue using bulletin boards or publicly available software, when one remains careful; nevertheless, viruses do exist, and one who is foolhardy may someday wish he could turn back the clock when his computer suddenly and inexplicably decides to erase all his files.

The VTLS is now accessible to off-campus students!

Off-campus students who have a 300 or 1200 baud modem can now call the VTLS (Virginia Tech Library System) up and use all of its functions.

To do this, call the CBX at (703) 232-2020. At the "CALL, DISPLAY, MODIFY" prompt type CALL VTLAN. When you get the "#" prompt type "CALL ABC." Hit "ENTER" a few times and you will be connected. To end your session and return to the CBX type "/LOGOFF."

Remember, if you have any technical problems with the new video, data, or phone services on campus call the CNS diagnosticians any time at 231-6780.



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P A C K E T

R A D I O

by Kendall E. Giles
KC4DYW

On Hams and Digital Communications

Amateur radio operators, also known as hams, have long been leading the way in the field of radio communications through their experimentation and public service. Today, hams are pushing radio and computer technology even further in the field of digital communications with what is known as packet radio, which is possibly the answer to the search for error-free communications.

What exactly is packet radio? Basically and very simply, packet radio is something like the union of radio and computer communications, using elements of both fields to achieve virtually error-free transmission and reception of data. With the help of a computer, a terminal node controller, and a receiver, anyone with a valid ham license can send and receive almost anything that can be digitized, such as text, voice, pictures, and music. Such technology is very experimental and, true to form, hams are lead-

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PACKET RADIO

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ing the way in expanding and perfecting this communications system.

DIGITAL COMMUNICATIONS

Modern communications, as far as engineers are concerned, owe their origin to an artist and experimenter named Samuel F. Morse, who in the late 1800's invented a method of data transmission consisting of a code of dots and dashes. By pulsing an electric current on and off, elements of two different time lengths separated by a spacing interval are formed into unique combinations to represent the characters of the alphabet, numbers, and punctuation.

This form of radiotelegraphy is the original form used in amateur radio and, even today, mastering Morse code is a necessary prerequisite for the licensing exams for amateur radio operators.

Morse code served for years as the means of sending messages over long distances, replacing the old Pony Express. Sending digital pulses of "dits" and "dahs" is a much more efficient way of communicating than analog, or voice communication, because less power is needed to transmit the signal and the information can be received and understood under adverse conditions, presented by distortion and static, at times when voice would be rendered incomprehensible.

However, both Morse and voice are interpreted by human operators working at the radio receivers and thus messages are subject to human error. They are fine modes for everyday communications, but in terms of reliable communications, a better system is needed.

A Frenchman named Emile Baudot devised a code consisting of five on-off conditions for every character. Baudot code was the first of several direct printing (connected to typewriter-like devices rather than computers or humans) forms of radioteletype. By combining bit conditions of one and zero (electric "on" and "off") into combinations of five, the entire alphabet plus numerals, punctuation, and control codes are represented. Data transmission is initiated with a start bit, followed by the information to be sent, and termi-

nated by a stop bit. However, since Baudot is asynchronous (not referenced to a common timing signal), error is introduced because the armatures of the receiving and transmitting typewriters are subject to drift differences. Baudot also suffers from sensitivity to errors caused by signal fading and static.

Rather than using on and off keying to transmit data, radio amateurs next developed frequency shift keying (FSK). Here, the on and off conditions are represented by shifts of two different tone frequencies, called "mark" and "space." These two signals are separated by a spacing of usually 200 Hz and rather than using telegraph lines, suited for pulsed DC code, frequency shift keying and phase shift keying messages are sent over standard voice grade lines by modem.

But even though the error situation is improved with Baudot, radio operators are in search of perfection and so the search continued.

Other forms of codes were invented and other systems of error detection and correction were developed, some of which are still used today. The American Standard Code for Information Interchange (ASCII) is a popular code of eight bits used extensively in computer communication. One of the simplest methods of error detection was achieved by using the eighth bit as a sum check. If even parity was agreed upon by the transmitting and receiving stations, the eighth bit is calculated so that the total sum of the ones in the byte is an even number. That way the receiving station can check for errors by comparing the parity of the received data. However, this method, though simple, is far from being perfect because the parity bit is just as subject to distortion or interference as the other bits. This means that bad data can arrive even though the parity bit is properly set.

AMTOR, or Amateur Teleprinting Over Radio is a more reliable system of data transfer. Using a derivative of the Baudot code, AMTOR is made up of four marks and three spaces. The originating station is called the master station while the receiving station is called the slave station.

In the automatic repeat request mode, intelligence is sent by

Continued on page 22

PACKET RADIO

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the master station in blocks of three characters each. The receiving station acknowledges errors in data with a repeat request to the master. This form of "interactive handshaking" occurs very rapidly and sounds very much like chirping birds or a chorus of crickets.

In the forward error correction type of transmission, each character is sent twice separated by a time interval equal to four spaces. Received data is tested to see if it meets the four mark-three space ratio and only data that passes is printed. The transmission speed of both modes is about 100 baud and the integrity of the data is very high. However, perhaps the most reliable and flexible communications system now is packet radio.

PACKET RADIO

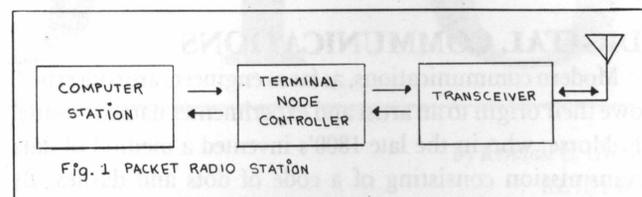
Packet radio is relatively new. It was started in Montreal, Canada in 1978 by Doug Lockhart, VE7APU, and the Vancouver Amateur Digital Communication group. Since then, packet radio has spread worldwide, with immense popularity in Canada, the United States, and Japan.

Packet radio is on the forefront of expanding technology and has enormous communications potential. Hams have always provided a public service of, among others, free non-commercial message communications, usually by Morse code, voice, or radioteletype. What makes packet radio important is that in situations of emergency and disaster, error-free intelligence can be assured and time- and life-saving maps, drawings, pictures, etc. can be transmitted to the emergency scene, similar to the fax service that is used over phone lines.

Packet radio, however, does not need phone lines. Information is sent by electromagnetic waves from station to station by microwave line-of-sight links across short distances, by HF and VHF jumps over large distances, and by satellite hops across the world. Though this may sound like a complex process, it really is not at all difficult to understand.

A "packet" is simply a grouping of digital data containing the information being sent plus some information used to manipulate the data. The process is something like using a computer, a modem, and the phone lines to link to a bulletin

board system. Files and messages are broken into these packets and sent via radio waves. A device called a terminal node controller (TNC) interfaces the computer and transceiver to form a packet station, as shown in Figure 1.



The TNC is essentially a smart modem. It is a micro-computer controlled, self-contained unit consisting of a modem and an assembler/dissassembler which processes the commands and data into packets, formats them, transmits them after determining a clear path, receives incoming packets and processes them for display, and provides for over-all error correction.

Whereas voice communications utilize "repeaters" to amplify and boost a signal on one frequency and simultaneously transmit it on another frequency, packet radios utilize digipeaters, or digital repeaters. A digipeater uses a store and forward system whereby a packet is received on one frequency, stored in the digipeater's memory buffer, and is then transmitted again on the same frequency to another station with the appropriate address. Due to the fast transmission speed of the packets and the buffer capability, only one frequency is used and that channel is only tied-up during the length of each individual packet transmission. Considering the fact that packets are about 128 bits in length and transmission speeds are at the common but low end of 1200 baud, much more information can be sent much more quickly and much more accurately than systems using Morse code, voice, or radioteletype.

Using a packet switching protocol, AX.25, agreed upon by the ARRL (American Radio Relay League) in October, 1984, individual packets are kept from colliding into one another as they are shot from station to station. This traffic system also helps to reduce errors even further.

Continued on page 23

PACKET RADIO

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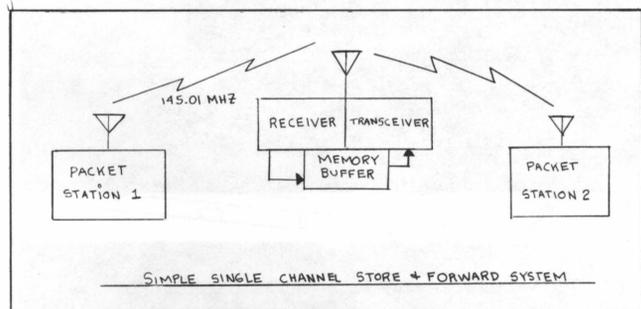
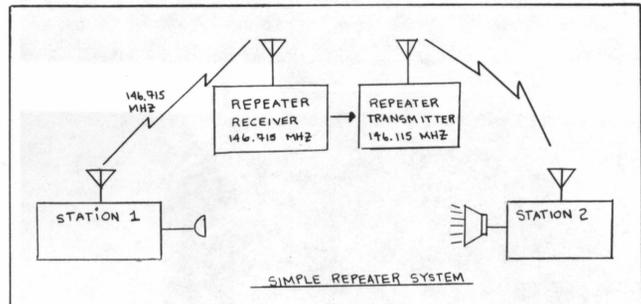
Admittedly, there are still many features and operating procedures to be worked out, but being able to participate in and experiment with such evolving technology is one element that makes amateur radio so exciting for the millions of people worldwide who are known as hams.

At the current level of development, a packet radio user can talk with a friend by keyboard, send files and programs to others without tying up the phone lines or paying exorbitant long distance fees, log into PBBS (packet bulletin boards), receive messages and have them waiting in the computer when away from home, and help and experiment with advanced digital communications such as long distance satellite hops with the hams' own PAKSATS (Packet Satellites) and OSCARS (Orbiting Satellites Carrying Amateur Radio) as well with picture and audio transmissions. The future of packet radio is virtually unlimited.

With a global amateur integrated digital network system, the communications world will be completely revolutionized. Thanks to hams and their ever present desire to experiment and push technology to its limits, the changes have already begun.

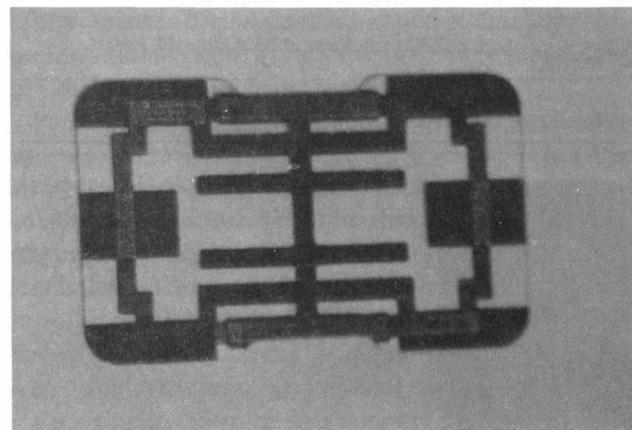
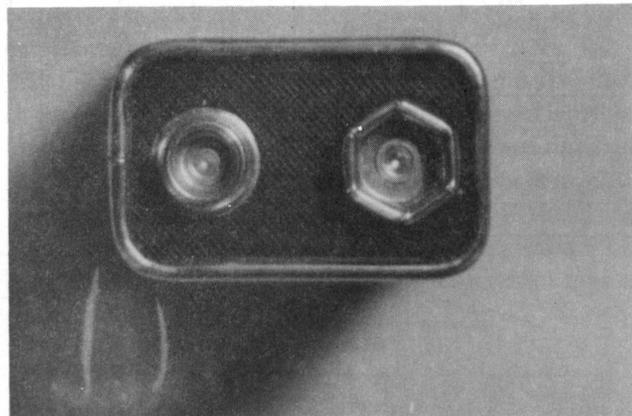
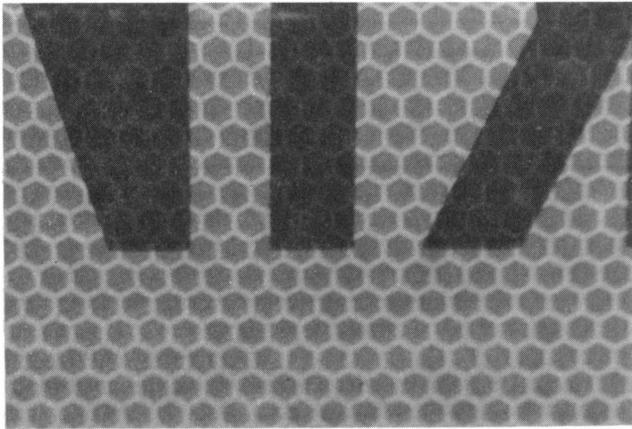
Soon will come the day when an engineer, relaxing somewhere in the Caribbean receives sudden inspiration, whips out his computer, types up in memo form the solution to a problem plaguing his company, and presses a key to have it "packetted" off to his boss' station. Upon returning home, he sees waiting at his packet radio station a digitized picture of his company president smiling and presenting a nice big fat bonus check and saying that the engineer's solution came just in time to prevent financial ruin. Imagine, all that and the engineer never had to leave his beach-side hammock, thanks to packet radio.

A bit far fetched? Well, perhaps, but such events, though admittedly not commonplace, will surely be possible in the future with the efforts of hams applying their enthusiasm, experimentation, and ingenuity to the world of digital communications.



TOM GLAAB

Ken Giles is an EE and current president of the Student Engineers' Council. He apologizes for his squirrely behavior.

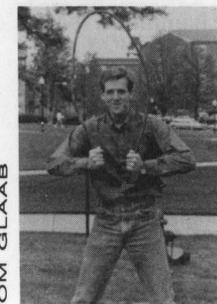
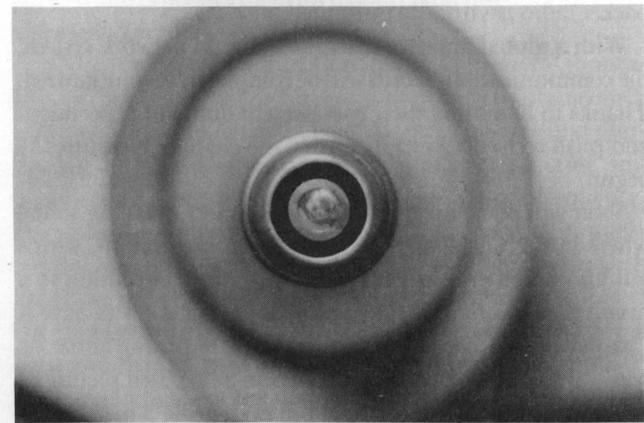
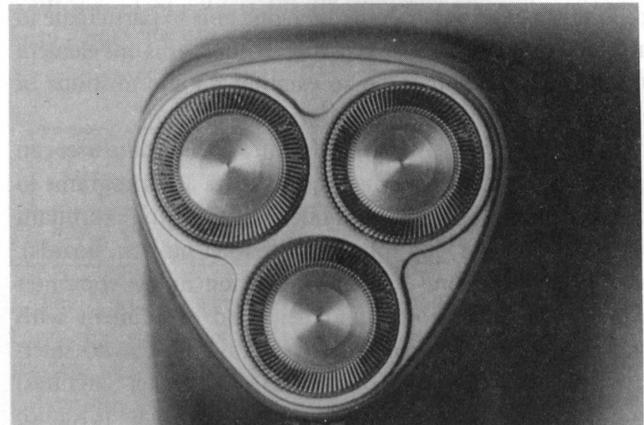


PICTURE QUIZ

Photos by Howard Kash

Match these items with the photographs on this page:

- | | |
|-----------------------------|---------------------|
| Ignition coil | Fingernail clippers |
| Electric razor | Lightbulb |
| Rolm phone | Aerosol can |
| "No Parking" Sign | AV battery |
| Printer cable pin connector | Tweeter |
| Wood knot | Lunch ticket |
| Bike stuff | |

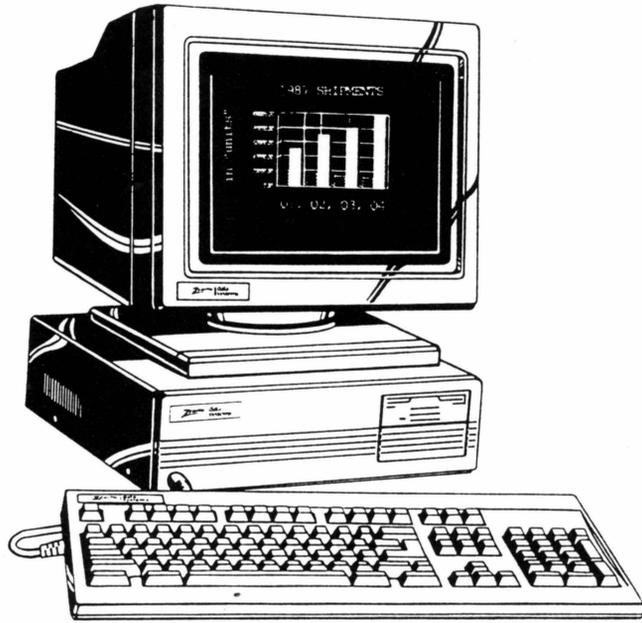


TOM GLAAB

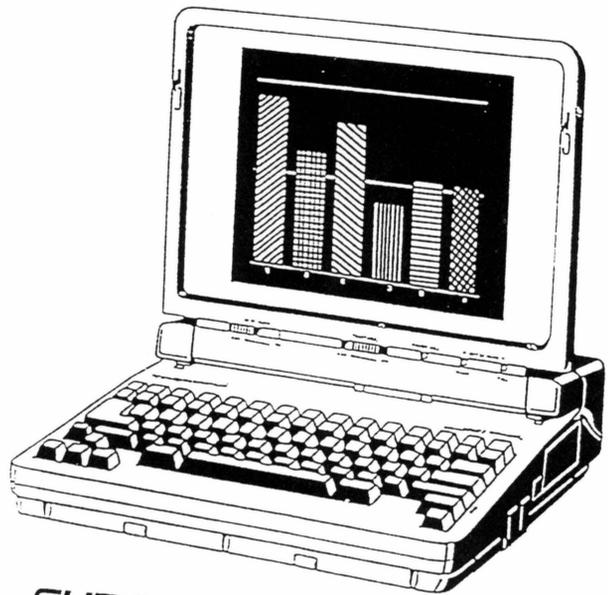
Howard Kash, an EE, is responsible for many of the pictures you see here. He can also bend steel in his bare hands, but we're not so sure about the "able to leap tall buildings in a single bound" part.



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