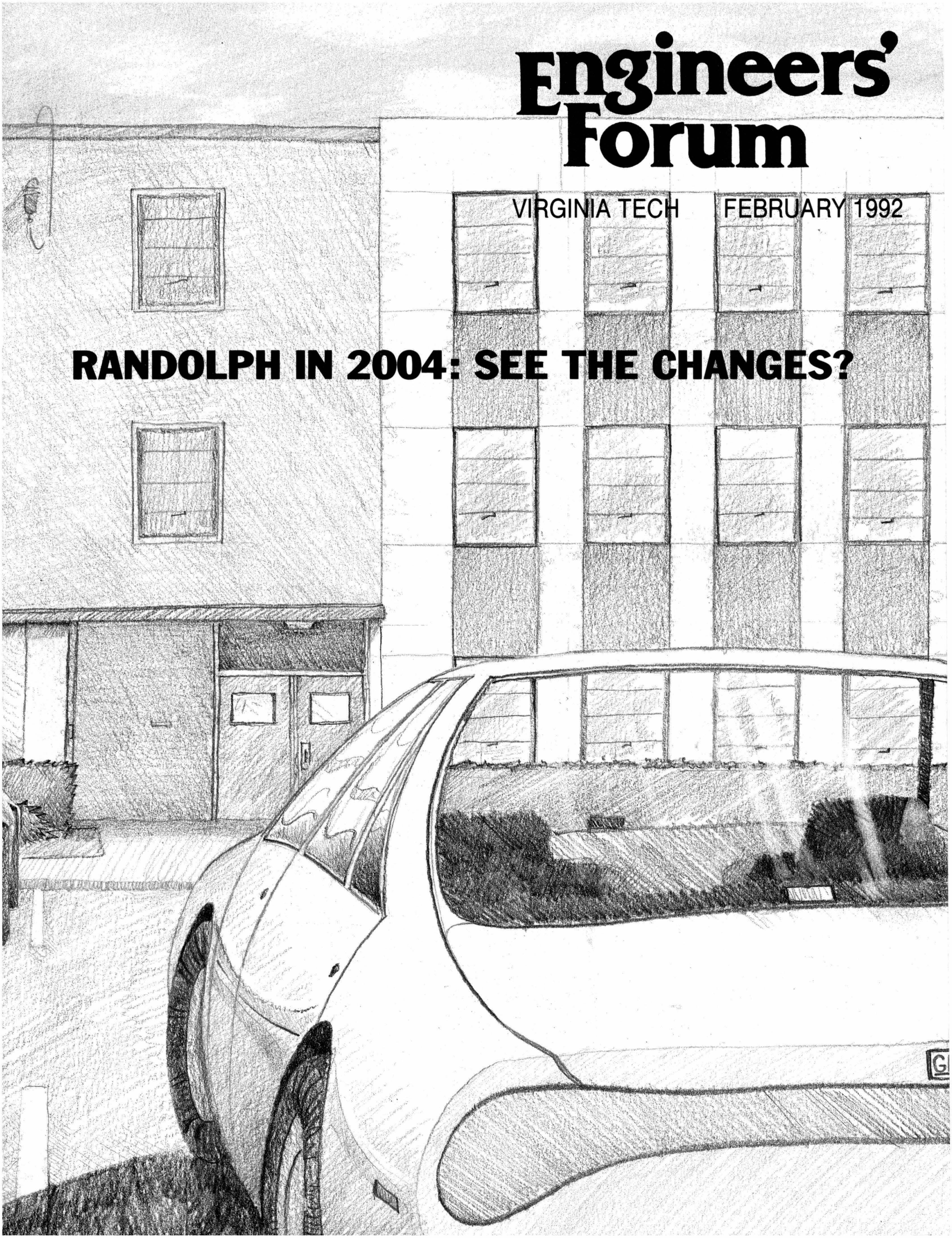
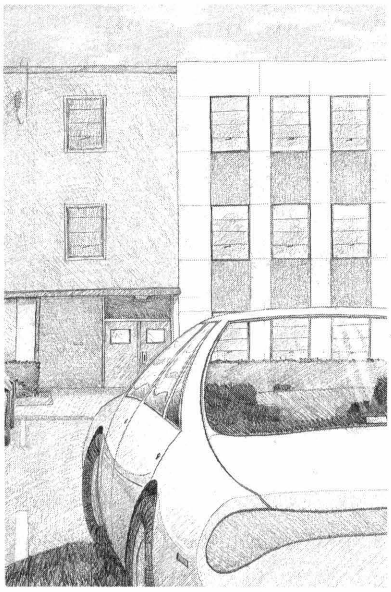
Engineers' Forum

VIRGINIA TECH FEBRUARY 1992

RANDOLPH IN 2004: SEE THE CHANGES?





On The Cover

No changes you say? Inside: numerous curriculum and policy changes have taken effect. Artwork by Aaron Golub.

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VOLUME 10 NUMBER 3 FEBRUARY 1992

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

EDITOR'S PAGE

Re-Engineering: Solution or just latest trend?

Often times, "buzz-words" can seriously impede a company's efforts to solve a complicated problem. Too often, large and small firms are quick to adopt a new philosophy that is the "latest on the market" and "bound to solve all of their problems." However, many times these new philosophies tend to distract companies from the real problems and actually make matters worse.

Jumping on the "buzz-word" bandwagon can cost a great deal of money, frustration, and, in the end, leave the company in worse shape than before. The industrial world is full of millions of unique situations, each requiring its own unique solution. This does not mean there are millions of different "buzz-words." Rather, what works for Company A may not necessarily work the exact same way for Company B.

A fairly new engineering philosophy is "re-engineering" — NOT a "buzz-word" but a simple methodology used to increase operating performance substantially. Although this sounds like the "perfect" relief for most troubled companies, re-engineering has been rarely adopted in practice.

According to Richard Wilkinson, a management consultant with Cleveland Consulting Associates, most companies, when given a choice, prefer "to improve established approaches and ignore the high likelihood that their existing framework is fundamentally inappropriate to their current business realities." Indeed, many companies suffering from stagnant operating performance have avoided the foundation of re-engineering — re-thinking the basics.

Instead of wasting time and money avoiding the inevitability of change, it is time to think of the future and become facilitators of this change. The only way to achieve this is to break away from the archaic assumptions and rules that have guided many companies down the path of destruction.

It seems that not even the glacially-paced improvements in computers and information technology have been able to fully help firms cope with change. In the Harvard Business Review, Michael Hammer says this may be because companies "leave the existing processes intact and use computers simply to speed them up." He goes on to say that merely speeding processes up "cannot address their fundamental performance deficiencies." Certainly, companies cannot fully unleash the power of the computer by automating last decade's organizational goals and processes.

What was important one decade ago may be important no longer; furthermore, the technologies of yesteryear are outdated. It is time to use modern technology to redesign — not simply automate — our businesses. Change engulfs our world every day, yet we all feel some crippling devotion to cling on to what we are used to. Wasting time trying to make "the way we have always done it" work will no longer do.

The time has come for industry to face the challenge of tomorrow. A good way to start is to rethink current organizational priorities and goals and use the current potential of technology to re-engineer our businesses.

Jonathan S. Hess

Jonathan Hess, Editor

On-Location at the Channel Tunnel

or,

"What I Did On My Summer Vacation"

by Andrew Predoehl

There I was, four miles off the southeast coast of England, underneath tons of sea and chalk — deep in the heart of the Channel Tunnel, one of the largest undersea tunnels in the world. So why was I falling asleep?

Last May, 30 Tech engineering students, including myself, visited the Channel Tunnel construction in an 11-day trip to England and France. (See "EuroTunnel: Engineering the Channel Tunnel," *Engineers' Forum,* April 1991.)

It began in Fall of 1990, when Pamela Kurstedt, Assistant Dean of Engineering, contacted juniors in all different engineering majors about a study abroad to see large-scale engineering in action. After reviewing essays and interviewing semi-finalists, Dean Kurstedt selected 30 students. We met several times to gain background information and to pick report topics. By the end of the semester we all had a facet of the tunnel to investigate, and we were excited to go.

On May 9, we assembled at Dulles International Airport in Washington, D.C. The flight to London was a long one, and economy class is the domain of cramped seats. Except for a tiny nap, sleep was hopeless. At 7:30 a.m. Greenwich time, we landed in England. As we descended we could see little cars driving in the left lane of their little roads. (Later we saw that the roads looked tiny because they really are tiny.)

We staggered through customs, groggily feeling as if it was still 2:30 a.m., boarded our bus, and headed into London.

That afternoon we visited Windsor castle. The next day, we took a guided tour of London. The following day, we coached to Folkestone, which is on the coast, near Dover. It is the location of Farthingloe Construction Village, a community of pre-fab housing plus a cafeteria and recreation rooms, built to house the tunnel workers.

The village was surrounded by barbed wire and resembled both an army barracks and a concentration camp. The ominous Dover clouds made the atmosphere gloomy. This was our new home — but only for two nights.

Early the following morning, we met with the Transmanche Link (TML) engineers — the engineers who designed and were building the tunnel for EuroTunnel. For four hours (without a break), we listened to engineers talk ("in broad brushstrokes" as one engineer put it) about the tunnel. After a quick lunch came the part we were all waiting for — the visit.

We arrived at the Shakespeare Cliff construction site a little before 2:00 p.m. Security was tight; you can't even get near the shaft without an electronic passcard. We assembled in a conference room of a building on the site and received safety instructions. No group our size had visited the tunnel; and no group our size would visit again — TML found it was too much work.

After we learned how to use a device for converting carbon monoxide to oxygen, we went into locker rooms to change. We put on orange jumpsuits (called "boiler-suits" in Britain), rubber boots ("Wellingtons"), and hardhats ("hardhats"). We each put a little numbered tally on a pegboard to record our existence (in case of an emergency), and got into the elevator.

A 360-foot shaft goes from the surface to the tunnel, and the elevator ride takes a long time. At the bottom it is dusty and noisy, lit by a dusky twilight, but singularly impressive — wide tunnels criss-cross every way and rails run off into the distance.

Dr. B. David Brown, TML's engineer-in-chief, led us around, explaining what operations we were seeing. Trains of spoil (chalk waste) regularly pass through this area, on their way to the spoil reservoir. Further, personnel carriers take crews from here down to the boring machines. We boarded a carrier to take us to the crossover cavern, a huge underground room that permits the tunnel operators to route a train on the opposite track. The crossover is several miles into the tunnel, well underneath the sea. We got aboard and rumbled forward.

Several TML engineers accompanied us, and, during the trip, we got a chance to interrogate them about various topics. However, the personnel train doesn't move very fast and it's a long trip with monotonous scenery. It's also dark and quite warm. Furthermore, although it was around teatime in Folkestone, we were jet lagged e-

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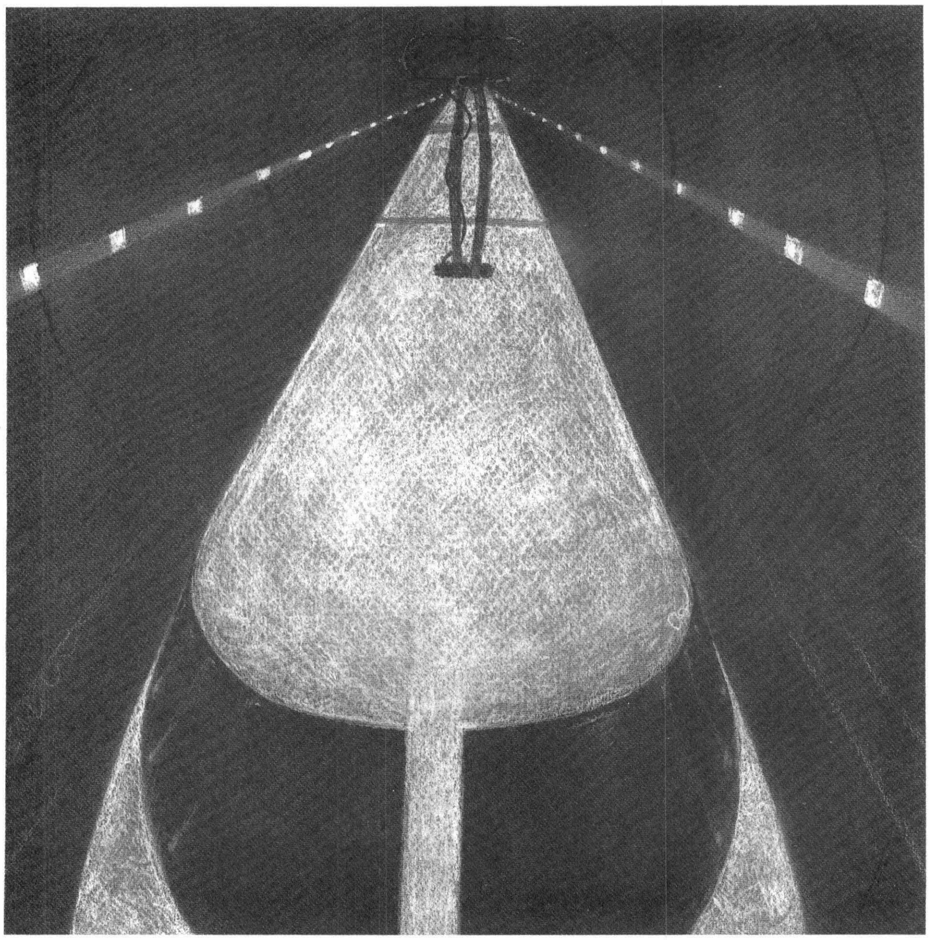
During the ride out we continued asking the engineers questions about our topics, and these one-on-one conversations were very informative. By the time we left, it was evening, and we returned to Farthingloe abuzz with information we'd gathered.



nough that to many of us it felt more like nap-time. I saw quite a few heads nod, then bow, and I was not immune myself.

Everyone woke up when we stopped, and we got out. The surroundings had changed. The tunnel, from what we could see from the train, was row after row of concrete segments, with ironwork punctuating the ceiling every few hundred meters, reminiscent of American highway tunnels, such as the Fort McHenry Tunnel in Baltimore. The crossover, on the other hand, was huge: 512 feet long, 59 feet wide, with a 35-foot ceiling — not quite wide enough for football but still pretty big. Amidst the dust and noise of work crews, the engineers pointed out the features we'd been hearing about. We then asked them questions. In my case I buttonholed an engineer from Scotland to ask him about instrumentation; he showed me installations and described what measurements they took during the tunnelling process.

During the ride out we continued asking the engineers questions about our topics, and these one-on-one conversations were very informative. By the time we left, it was evening, and we returned to Farthingloe abuzz with information we'd gathered.

The next day we visited the Folkestone Exhibition Center, toured the Folkestone terminal (still under construction) and had a nice farewell lunch with a few of the TML engineers, giving us another opportunity to ask questions. We gave them some Virginia Tech t-shirts and they gave us all chunks of chalk from under the channel.

Earlier we'd noticed that in the exhibition center they sold all kinds of souvenirs, and among them, they sold paperweights that were clear plastic with a chunk of white rock in the center. Someone asked Dr. Brown about those, and he laughed and pointed out that nobody ever said the rock inside the paperweight came from the tunnel, but what we were holding was the real thing.

NEXT STOP: FRANCE

From Folkestone, we set off to Dover, and ferried to Calais. The next morning we drove around the construction site at Coquelles, guided by an American engineer from Bechtel. We saw parts of the site from a distance, and got another opportunity to get answers to our questions.

That evening we coached to Paris, and the day after that we visited the Universite de Technicale de Compiegne, an engineering school not far from Paris. Loren Johnson, a Tech student studying there for a semester, was to meet us, but wires got crossed and we missed him.

The remainder of the trip was Paris. We toured the city the following day, and the next few days were our own. We split apart, so each could explore Paris as he or she wanted.

On May 20 we flew back to Dulles. Over the summer, we worked on our papers. This past semester, we met several times so we could each present our paper to the group. This completed the requirements for the class; however, the exciting and unforgettable part of the study was the trip itself. Several of us remarked that now that we had been overseas, we would leap at the chance to go again: a trip like this shouldn't have to be a once-in-a-lifetime opportunity.

International Submarine Races

ESM department plans to compete in 1993

by Keith Wieber

We all know that ASME builds and races cars, and that ASCE casts concrete canoes. But why stick to the surface? Next year, if all goes as planned, the Engineering Science and Mechanics department will be sending a dozen students to Florida to race a submarine designed, built, piloted, and even powered by Tech students.

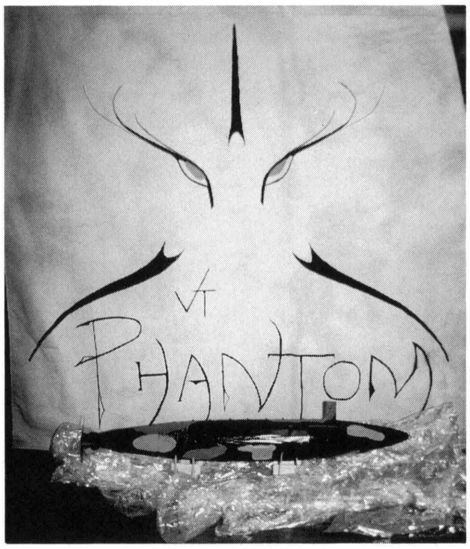
Presently, Virginia Tech's ESM department is preparing to compete in the International Submarine Races jointly organized by the H.A. Perry Foundation and the Department of Ocean Engineering at Florida Atlantic University.

The H.A. Perry foundation, established in 1987, internationally promotes innovative research in undersea technology through education and experimentation. The foundation encourages advancements in scientific and technological capabilities through institutional grants and supporting programs amidst interested persons from business, government and other non-profit organizations. Common beneficiaries of the foundation are students and practicing engineers.

The submarine race is held every two years; the first competition was in 1989. The summer of 1993 race will be Virginia Tech's first appearance at this event. Some of the participants in the 1991 race were the U.S. Naval Academy, the Florida Institute of Technology, the University of British Columbia, the University of Florida, the University of Washington, Technical University of Berlin, Texas A&M University, West Virginia University, Massachusetts Institute of Technology, and the University of California, Santa Barbara.

Competing vehicles will be judged in three categories: cost effectiveness, innovation, and speed. The submarines are judged by a panel of accomplished experts in the field of marine technology. The 1991 competition awarded $500 per category. Cost effectiveness and innovation of each sub was scored on a scale of 1 to 10. Speed was determined by a series of single-elimination races. A grand prize of $5,000 was awarded based on the highest total score, with each category equally weighed.

The 1991 first-place winners for overall performance, innovation, speed, and cost effectiveness were, in order, Benthos Inc., Imagineering, Florida Atlantic University, and University of California, Santa Barbara.



Submarines competing in the international submarine races also must adhere to a set of 11 vehicle guidelines. Vehicles must operate with two people: one of which is responsible for propulsion and the other for duties such as navigation, steering and safety. All control and propulsion systems must be human-powered and operated. All vehicles must be fully flooded and fully enclosed. Primary SCUBA is worn and back up SCUBA must be on board for each person. The on-board air supply must be at least 150% of the air required for the occupants to complete the single elimination course of 2/3 km. A "dead man" switch, which releases a safety buoy to the surface in the event of an emergency, must be provided to each of the occupants. The occupied compartment must include a hatch or canopy release mechanism which is readily operable from both inside and outside the vehicle. A quick release mechanism must exist for any personal restraint system. A flashing strobe light visible in clear water from 360 degrees and 17 meters must be on board. All vehicles must be painted high-visibility colors with large identification numbers clearly displayed.

The race organization will also design a small surface buoy which each submarine is required to tow. The judges and race organizers reserve the right to disqualify a contestant at any time during the competition if they suspect the contestant's participation would be dangerous or not in the competition's best interest, or if the vehicle fails to meet the competition guidelines.

Presently, the ESM department is planning to enter the International Submarine Races. Preliminary design work has begun. The department would like to send approximately 12 students to the competition, which takes place in Singer Island, Florida.

In order for the ESM department to enter the race, their submarine, named "The Phantom," must pass a safety inspection and function test prior to taking part in the races. The crew must currently have a nationally recognized SCUBA certification card and must be 18 years or older.

The design team will be striving to reach the previously unattainable goal of five knots for their submarine.

College of Engineering

Given the state of the economy and the need to stay ahead in the engineering field, the College of Engineering will be relying on a restructuring and multimedia development to carry it into the '90s.

by John Cole

During the 1980s, Virginia Tech's College of Engineering experienced a significant amount of growth and change. For the first time, the college gained national recognition for its research and graduate programs, complementing an existing excellent reputation for undergraduate efforts.

Change was everywhere; the major catalyst being the advancements made in the computer field. Virginia Tech became the first school to implement a program (referred to as the PC Initiative) requiring all incoming freshman engineering students to have a personal computer.

As the college entered the 1990s, growth slowed. Faculty positions were cut, hurting research and teaching efforts. National economic problems were reflected in the College of Engineering. And, despite a rise in enrollment in both the arts and sciences and graduate engineering programs, undergraduate enrollment was down this year. However, the graduate program enrollment has been increasing substantially over the last few years, while national forecasts have predicted declines in undergraduate enrollment in the coming years.

In addition to these problems, Tech's engineering program has to compete with the growing number of schools offering quality programs in engineering. In-state programs are now being offered at the University of Virginia (UVa), Old Dominion University, George Washington University, and George Mason University (GMU). Programs are being introduced at Hampton University and possibly Virginia Commonwealth University.

Even though some of these other programs are growing rapidly, Tech has enough of a reputation to be only seriously challenged by UVa and certain departments of some schools, such as the electrical engineering department of GMU. Tech is in competition with these schools not only for students and resources from the state, but results in research and development.

Among the major ways the college will deal with the ongoing changes are plans to expand on the personal computer programs already established, to refine the course structures from upper level and graduate classes down to entry level courses, and to allocate resources better to improve Research and Development.

Another major goal is also to keep interest and enrollment in the College of Engineering up, despite the declining numbers of high school students and increased competition.

"To successfully compete in times like these you have to be innovative, use your resources wisely, and simply be better than everybody else," according to Dr. Wayne Clough, Dean of the College of Engineering.

UTILIZING COMPUTERS

When the PC Initiative was introduced at Tech, it was a new and innovative program. Now, schools all over the country now use computers widely for many, if not more, of the same applications as Tech. There is concern that Tech will be eclipsed in the ever-growing computer field. Most of the concern comes from the fact that even though computers are used, they are not utilized to anywhere near their capability. There also seems to be a notable drop-off in amount of use after the freshman year.

"In my freshman year I used the computer almost every day, while in my sophomore year all I've used it for is word processing," said Judson McIntosh, a sophomore in civil engineering.

However, the college and Dean Clough are optimistic about the future of computers and their use in teaching students. Goals for the near future are to upgrade from the now-required '286 computers to '386's and to incorporate a wider spread of programs (such as Microsoft Windows) into use. There are also definite plans underway to make widespread use of computers in the classroom as teaching aids, as an addition to the course material. In the past this was possible only on a small scale, with crude visuals and not much power. That is all changing with the development of "Multimedia," a breakthrough program Tech is working on with computer companies, along with a handful of other schools (see box).

STRUCTURING THE CURRICULUM

A major area of concern in the present curriculum structure is the fact that ESM, EF, and Physics courses all have similarities and they need to be better integrated to avoid repetitive learning. In the present system, a student can learn essentially the same thing in an EF, ESM, and a physics course. The boundaries between courses are nebulous. Eliminating the redundancies would create a more efficient course system. The same thing could be said for all overlapping courses in different departments.

Another area under consideration is the under-enrolled courses. Higher-level courses and graduate courses pose the major concern. Solutions being considered are to cut unnecessary classes or to only offer classes at certain times, a practice already being followed in smaller departments such as Mining Engineering. Under-enrolled higher-level courses reflect a trend toward "hyper-specialization,"

prepares for the future

whereas more money and faculty could be saved by offering a broader-based education.

Another way to save faculty and money would be to even out the faculty-to-student ratio, which is much higher in some departments than others.

Other plans include building bridges between departments, making it less difficult for a student to take multi-departmental classes. Doing so would allow students more freedom in choosing classes. Tech also has had some recent success with stepping up the offering of off-campus master's degrees in engineering.

In addition, the college is toying with the idea of offering a fifth-year option that would focus on management, international concepts, and language skills in conjunction with engineering.

The essential basic course structure will probably stay the same. However, one goal is to make design a greater part of the engineering program, especially at the freshman level. Changes at the freshman level and upward also will occur as a result of the changing environment and work-place situation going on constantly.

ALLOCATING THE RESOURCES

Initiating the multimedia system will take a lot of time as well as money for research, faculty, equipment, and places to put the equipment. Funds are also needed for planned, extensive outreach programs directed toward high school students to influence them to enroll in Tech's engineering program. The programs also call for the additional involvement of minorities and women in the college, as well as better retention of freshman and sophomore engineering students who are contemplating changing majors.

The college is not only competing for money from the state and students, but also from the other colleges within the university. Some plans in place are the construction of a new engineering/architecture building by 1996, upper quad renovations, and a 100,000 square foot technology center to be reviewed for consideration by 1998.

There are also plans to renovate aging buildings such as Patton, Holden, and Ran-

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Multimedia broadens range and applications of computers

Multimedia is a breakthrough program which is realistic but will take time to fully implement. Multimedia refers to applications incorporating advanced audio and video capabilities into computing, which could be used in a network in combination with other schools. It has a wide variety of classroom applications; a few other schools have already implemented multimedia applications into the classroom.

Virginia Tech is one of a small number of schools currently testing multimedia equipment. The College of Engineering is hoping to implement widespread use of multimedia into the teaching curriculum by the fall of 1993. Presently, Multimedia systems are in the hands of a few professors on campus who are working on testing and exploring the capabilities.

Dr. Joseph Tront has a system presently running multimedia in Whittemore Hall. It is a beta test model from IBM, one of only seven available for use. The computer is a PS/2 386 with an XGA display and stereo sound. In addition to a 3.5″ disk drive and an 80 Mb hard drive, the computer also has a CD-ROM drive, using CDs which store 600 Mb. One software program Dr. Tront has is Microsoft's Bookshelf, which consists of six books on the CD — among them, an encyclopedia, thesaurus, and a book of quotations. Using a mouse, one is able to quickly search through any one of the desired books, some of which have visual examples and animation to go along with a topic. The quotation book has quotes which you can not only see but also hear.

The College of Engineering is looking to weather the country's economic difficulties — and come out on top — with the help of restructuring and the development and implementation of multimedia.

In addition to the Dr. Tront's CD-ROM system, Dr. Thomas Walker has a videodisc system. The videodisc system is similar to the CD system, except the videodisc stores actual visual footage, such as that of Martin Luther King giving a speech, or that of a filmed surgical operation to be used for medical research.

The classroom applications of a full-scale multimedia system are astounding. A teacher would be able to easily set up a visual reference or even a hands-on application to be used in addition to classroom lecturing. The student could then get a copy of the program and continue to work on it on his own computer. A national network could be set up where schools could use or contribute programs of that nature. Best of all, the projected student systems with CD drives (to be sold through the Tech Bookstore) will be in the same price range as the systems presently sold.

The College of Engineering has a planned multimedia lab scheduled to open in April 1992, in 105 Hancock. Multimedia presentations are already being developed, and the lab anticipates more involvement. Representatives from IBM and Apple are frequently on campus, providing the latest technology.

A new acronym has been coined for Tech's new approach to computing here: LEAPE (Learning Engineering from an Advanced comPuting Environment). This reflects the College of Engineering's desire to remain at the top of the computer field.

Graduate School:

Dean Clough's optimistic plan

by Mike Reese

The engineering graduate school at Virginia Tech was recently ranked among the best in the nation. This honor was a result of hard work, but Dean Clough and the rest of the faculty have plans to keep pushing ahead.

After recently being ranked 20th in a survey of engineering graduate schools by *U.S. News and World Report,* Tech's program has gained national reputation as a leader in research and development, and as a magnet for talented students. This recognition was the result of years of effort, but this does not mean the job is complete. The college must now secure this reputation, and show that Tech has a first-rate engineering graduate program.

Many factors determined the national placement. Two key areas were research activity and faculty resources. Research activity is primarily defined as the total amount of dollars in engineering research and the total dollars for each faculty member. Tech, in 1990, had over $32 million in research; this was the 17th highest among the schools ranked by *U.S. News and World Report.* The other factor, faculty research, is made up of the following: percentage of faculty holding Ph.D.s, ratio of full-time Ph.D. and M.S. degree candidates to full-time faculty, percentage of part-time faculty, and number of Ph.D.'s granted.

Dr. Wayne Clough, Dean of Engineering, has proposed a plan to keep the college moving ahead. His plan covers multiple areas, from making the college run more efficiently to increasing the number of enrolled students. Tech is now on a level which

Dean Clough's plan would strive to make off-campus programs a developing area which can help lead Tech to new heights in the next decade.

puts it in competition with the best schools in the country; therefore, keeping the school's momentum going is in itself a difficult undertaking.

The leaders of the College of Engineering are also faced with ever-present budget cuts. Dean Clough's proposition takes these cuts into account. One of the steps is to evaluate all under-enrolled classes. This evaluation begins by defining an under-enrolled course as a class with 10 or fewer students; this standard has been increased from five. Under-enrolled courses will be cancelled or offered in either alternate semesters or years.

Decreasing the number of under-enrolled classes also alleviates another problem: a shrinking faculty. Unfortunately, the college does not have the funds to replace positions which open as professors retire.

Another part of this plan involves a division of graduate school which many students are unaware exists. This is the off-campus graduate program. Tech has been able to gain excellent results from this area. The college educates large groups of students with a small number of faculty in off-campus programs through classes on a television network system.

Tech's Northern Virginia Graduate Center is a part of this network, serving many graduate students working for Washington, D.C.-area engineering firms. Of course, research is close to the heart of the national defense system; every area of the Department of Defense uses engineers. The Graduate Center may attract more research grants as well as students who are considering graduate school because it is so close to Washington.

Dean Clough's plan would strive to make off-campus programs a developing area which can help lead Tech to new heights in the next decade. Nationally, the number of students that have enrolled in graduate programs has recently been on the rise because of the recession; this is true also here in Blacksburg. Dean Clough hopes the graduate program will grow to 1500 students.

Dr. Walter O'Brien said, "A graduate program thrives on good students." Dean O'Brien said that Dean Clough's initiatives would be good for the health of the program. Dean O'Brien is hopeful that as the recession

Future *Continued from page 7*

dolph built in 1928, 1940, and 1952, respectively.

The College of Engineering plans to deal with these budgetary needs by using money resulting from cuts in faculty and courses, and by using money allotted by the state and the university. Despite the economic problems, as well as the new projects and research being undertaken, the college doesn't anticipate any great financial difficulty. One of the main reasons is the support for new research being provided. Equipment for multimedia is being readily supplied as the products are being evaluated, which, in turn, helps the computer companies. The college is also being financed by a grant from the National Science Foundation for $15 million over five years.

Unless difficulties arise from the way the budget is structured, the College of Engineering could start the 1990s very successfully, with a refined course and faculty structure, and the introduction of a powerful new tool, multimedia. Dean Clough added, "The development of multimedia provides a tool which can be used across the whole spectrum of the curriculum, including engineering and non-engineering courses."

fades out, the number of students enrolling will still continue to flourish. This may take place as our society becomes more specialized; because engineers will need an even greater technical background, more students will enter graduate school.

It is important for the total enrollment to continue to grow, but it is also important to retain students after they receive a M.S. degree. Tech is looking to graduate more students with a Ph.D. In these tough times many students acquire an M.S. degree, but do not continue on to a Ph.D. Dean Clough states that retaining more students "provides an opportunity to compete with the top schools for the best faculty."

His plan covers multiple areas, from making the college run more efficiently to increasing the number of enrolled students.

The preceding ideas are ways by which the graduate program can change for the better in the future. There has already been a graduate review program instituted to enable each department to examine itself. Here, problems are discovered and brought to the attention of staff members. The final goal for each department is to enter into the top ten of competing universities in the department's field.

Over the past few years, whenever change and budget cuts have been mentioned together, an attitude has existed that there are major problems that need to be addressed. Although there are problems which have risen because of depleted funds, in this case, the changes being investigated are changes for the better. Tech is gaining respect in the engineering academic society, especially among graduate schools; the leaders of Tech realize this and are not content to remain at the present stage, and are determined to keep the college moving forward through the 90s.

Flow Condition Investigations in the Langley Calibration Shock Tube

A Co-op Report

by Anthony A. Giunta

Researchers at NASA Langley Research Center conduct a tremendous amount of wind tunnel testing and utilize a variety of measurement techniques and instrumentation. As new types of instrumentation are developed, it is necessary to test them before they are actually installed in a wind tunnel. By testing the instrumentation before installation many "bugs" in the system can be worked out, thus saving valuable testing time and money.

One of the facilities for this testing is the Langley Calibration Shock Tube. The Langley Calibration Shock Tube is divided into two main sections, the driver section and the driven section. Separating these sections is a replaceable mylar film, approximately 0.0035 inches thick. This mylar film is called a diaphragm and forms an airtight seal between the driver and driven sections.

The operation of the shock tube is fairly simple. Initially, air inside the shock tube is removed from both sections by a vacuum pump. For most tests the vacuum pump operates until the pressure inside the tube reaches approximately $50x10^{-6}$ m Hg. Once the desired pressure in the driven section is obtained, the vacuum pump is shut off and bottled nitrogen gas is bled into the driver section. Depending on the thickness of the diaphragm, the pressure in the driver section may reach 120 psi before the diaphragm ruptures. The difference in pressure between the two sections forces the nitrogen into the driven section at a velocity greater than the speed of sound, thus creating a shock wave similar to that produced by an airplane flying at supersonic speeds.

As the shock wave travels down the length of the tube it passes over several instruments which sense changes in pressure and temperature. These instruments record a timed history of the flow conditions within the tube before and after the shock passage. Data from these instruments is then sent to recording devices and display devices, such as a personal computer or an oscilloscope. The time for each shock tube test is approximately 0.0075 seconds.

The magnitude of the flow conditions within the shock tube during a test does not replicate those found in most wind tunnels. However, the speed at which these conditions fluctuate is reproduced by the passage of the shock wave. It is the ability of an instrument to capture these fluctuating conditions which determines if the instrument is suitable for wind tunnel use.

The Langley Calibration Shock Tube is used to test instrumentation before it is installed in a wind tunnel because of the time and money saved by using the shock tube.

As noted above, the Langley Calibration Shock Tube is used to test instrumentation before it is installed in a wind tunnel because of the time and money saved by using the shock tube. However, before instrumentation can be tested, the flow conditions within the shock tube must be accurately known.

Several shock tube tests conducted in 1989 revealed a flow condition anomaly within the facility. For this reason, a study was performed in order to identify the cause of the anomaly.

The tests which first revealed the anomaly were conducted using a hot-wire anemometer. A hot-wire anemometer is an instrument that is used to study a variety of flow phenomena. Primarily, it consists of a very thin wire mounted between two metal prongs. A feedback circuit which controls a current source is connected to the metal prongs and to a data storage device. The resistance of the wire varies with temperature and thus it is directly affected by the temperature of the surrounding fluid. As the wire temperature varies due to the changing flow conditions, the electrical current supplied by the feedback source fluctuates in order to maintain the hot-wire at a constant temperature. The magnitude and frequency of the fluctuations of electrical current are recorded by the data storage device for later analysis.

During the operation of the shock tube the output from the hot-wire normally would have indicated a steady temperature before the abrupt temperature rise as the shock passed the position of the instrument. Instead, the sensor output indicated a slight temperature decrease prior to the expected temperature jump.

One of the possible sources for the temperature drop was the ionization of a trace contaminant, such as sodium, during the formation of the shock wave. Some of the free electrons produced from the ionization would have been absorbed by the hot-wire, thereby causing the instrument to mistakenly perceive a drop in temperature.

To test this theory several thin-film resistance heat transfer gauges were manufactured. These gauges operate on the same principle as the hot-wire anemometer. However, for the thin-film gauges the temperature sensitive element is deposited or painted on a surface which is electrically nonconductive. The gauges for this study were mounted on the end of a 0.25 inch diameter quartz rod and inserted flush with the inner wall of the shock tube. Of these gauges, half were coated with a layer of silicon dioxide (SiO_2) and half were uncoated. The SiO_2 layer should have prevented free electron absorption by the coated gauges, while the uncoated gauges should have absorbed electrons, thereby creating the perception of a temperature decrease similar to that seen in the hot-wire anemometer data.

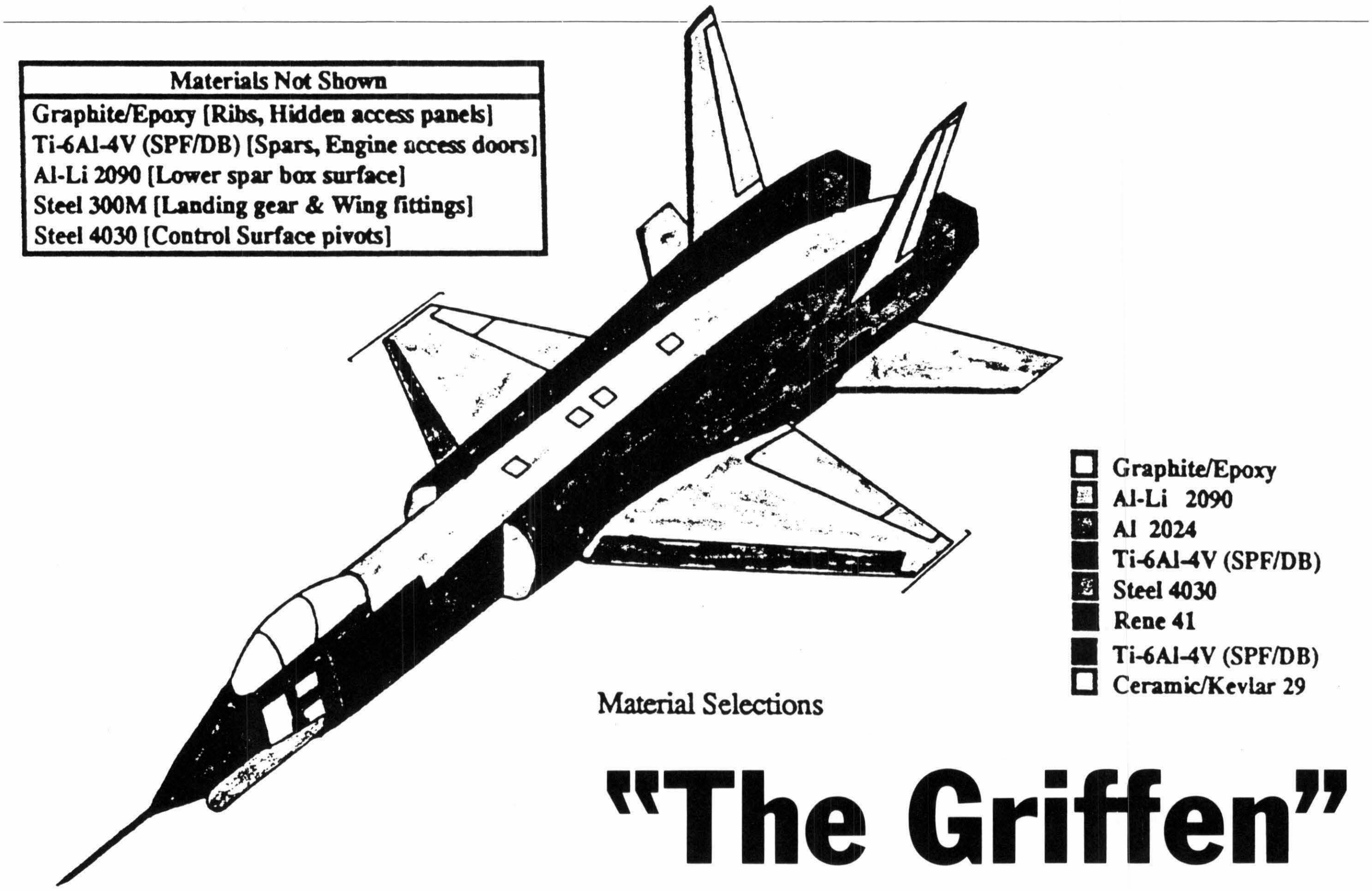
Although the initial testing of the thin-film gauges was promising, several difficulties hampered the progress of the study. The initial electrical circuitry constructed for the gauges produced a voltage output that was marginally above the noise level in the circuit. Because of this, it was difficult to distinguish the effects of the fluctuating flow conditions from random voltage changes.

Further, due to time constraints resulting from the end of the co-op semester, the testing of the thin-film gauges and the flow anomaly investigation could not be completed. However, the study will be continued by other co-op students in future work assignments.

Anthony Giunta observes:

"It has been my experience that a co-op usually is involved with only a small portion of a project or an investigation. As in my case, rarely does a co-op plan out and conduct an entire project from start to finish in one semester; although I was unable to finish the flow anomaly investigation, I gained valuable experience from the portion of the study that I was able to complete. I was able to draw on past classroom experience and apply it to some actual problems. Additionally, I have become familiar with some concepts which I will apply to my junior and senior level classes.

"If you are thinking about a co-op job there are a variety of employers out there. The job possibilities range from the technical side of engineering, in which I was involved, to the business side of engineering. The difficult part can sometimes be is deciding which job is the best for you. If you are interested in finding more information on a particular employer or you are interested in the co-op program in general, make plans to stop by the co-op office and talk with one of the advisors."



Material Selections

"The Griffen"

by Omar Khan

The griffen, a mythological hybrid of a lion and an eagle, is an apt name for the award-winning airplane designed by the aircraft design class of the Department of Aerospace and Ocean Engineering (AOE).

The Griffen received first-place honors in an aircraft design contest sponsored by General Dynamics Corporation and the American Institute of Aeronautics and Astronautics. It received this honor for meeting and exceeding its design requirements for a battlefield-interdiction and close-air-support attack aircraft with near-transonic capability, and cost-effectiveness.

It easily met two requirements of the contest. It fulfilled the most important requirement of being able to fly rapidly at sea level, and to reach the combat area. It also satisfied the secondary requirement for a high-low attack mission profile with the ability to loiter in the target area. Further it also met the short-field takeoff and landing requirements included in the specifications.

Like its namesake, the Griffen is strong, agile and fast. The plane's creators, members of Design Group II were: Robert Narducci, design leader; John Gallagher, configuration; William Wood, weights and balance; Matthew Rhode, aerodynamics; Matthew Nowinski, propulsion; R. James Lanzi, stability and control; Jay Hypes, mission performance; Mark Herrington, systems and avionics; and John Walker, structures. Course advisors were Dr. William Mason and Dr. Nathan Kirschbaum.

The Griffen was not designed overnight; it took the better part of two semesters to complete.

The Griffen was not designed overnight; it took the better part of two semesters to complete. According to Narducci, one of the more difficult aspects of the project involved the necessity of informing the nine members of the design team of the ongoing modifications to the plane during its design and integration phase. As co-advisors Dr. Mason and Dr. Kirschbaum stressed throughout the course, this is what future engineers in design teams can expect in their professions.

The Griffen was designed using a number of computational tools. One of the most important was ACSYNT, a CAD program for aircraft synthesis. This program combines analysis methods developed at the NASA Ames Research Center with a powerful geometry and graphical visualization capability developed by students in the mechanical engineering CAD Lab. This program allows the designers to interactively develop, visualize, and modify the aircraft configuration. ACSYNT will then estimate the aircraft size and weight needed to meet the design performance requirements. These results provide the students with a starting point for more detailed analysis of the design.

The twin-engine Griffen's configuration includes thrust vectoring and side-force generation to enhance target pointing and provide adverse landing capabilities, plus fly-by-wire control system technology, and active gust alleviation to permit piloting for

The Griffen received first-place honors in an aircraft design contest sponsored by General Dynamics Corporation and the American Institute of Aeronautics and Astronautics.

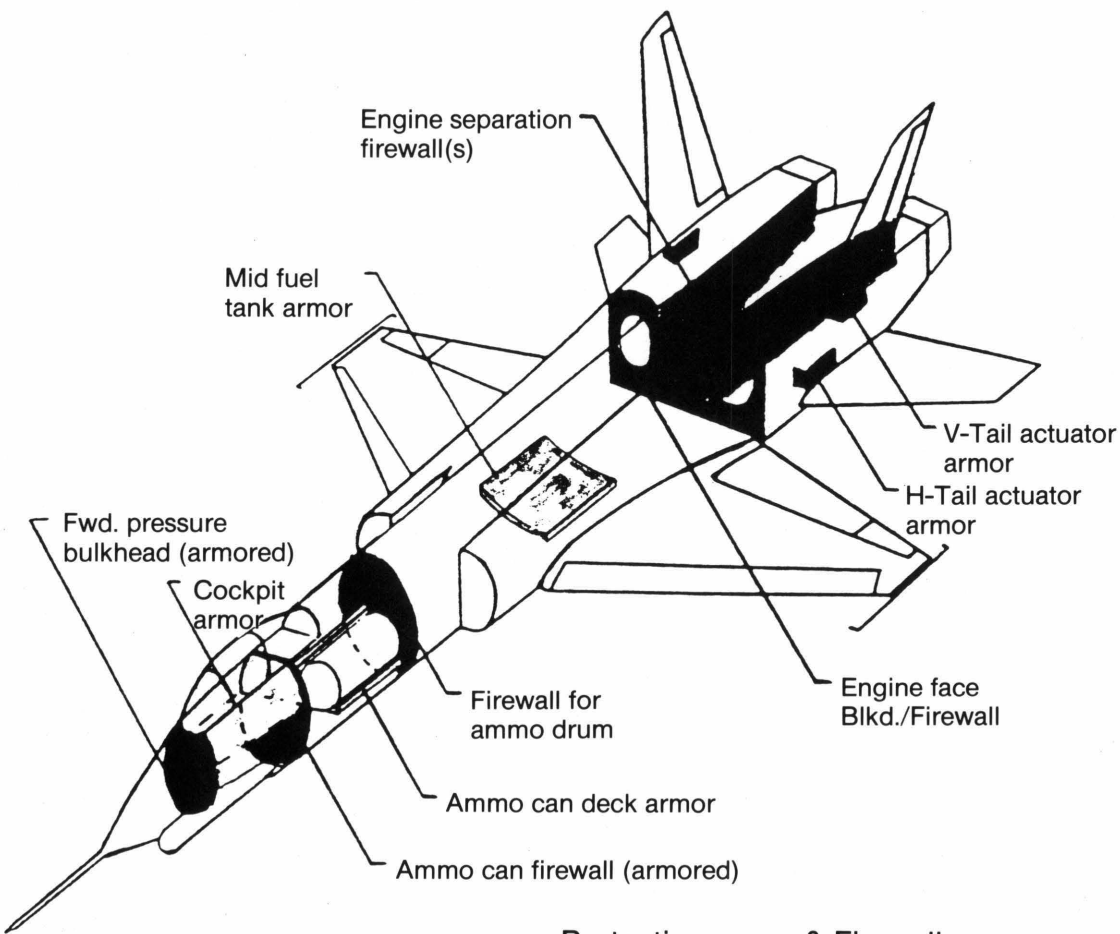
long duration, high speed, low altitude flight.

Another feature of the Griffen is the the LANTIRN (Low Altitude Navigation and Targeting Infrared System for Night) system. LANTIRN allows the pilot to navigate easily toward targets and attack in the dark. This system was employed successfully in Operation Desert Storm.

The Griffen's arsenal consists of a design mission load of twenty 500-pound bombs, a rotating seven barrel anti-tank cannon with 1350 rounds of ammunition and two defensive air-to air Sidewinder missiles, integrated in low drag attachments to enhance vehicle performance and reduce weight.

The survivability of the Griffen is enhanced due to its armored cockpit enclosed in ceramic/Kevlar and titanium alloy armor, which gives it the ability to fly on one of its two engines, and to fly with a loss of one of its two widely-separated vertical tails.

If the mythological Griffen were real it would probably be proud to have the Griffen airplane named after it. Strong, agile, and fast, the two could fly together.



Protective armor & Firewalls