engineers' FORUM

VIRGINIA TECH • APRIL 1995

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Engineers do it better

I was going to write about how engineers aren't freaks, about how we're no different from anyone else out there.

That was before I took a flight out to Kansas.

At Roanoke, I boarded the first of several planes on which I was to fly that day with youthful arrogance. There was only the smallest little voice in the back of my head making vague whisperings about all of those air tragedies that happened last fall, planes falling from the sky like so much wrecked steel and humanity.

I was more worried about my luggage than my life. (After all, I'd just driven on I-81. How could it get worse than that?)

Then we took off.

That little plane was shaking like a bad amusement park ride. Looking grimly out the window at the wing, I was mildly comforted that I wasn't an aerospace engineer.

Don't get me wrong. I'd flown before: everything from four seater Cessnas to trans-Atlantic 747's. There wasn't anything I couldn't handle.

We landed in Charlotte scant minutes later. No sweat.

We boarded our next plane, a flight which would last the better part of three hours. I actually managed to fall asleep during the take off.

I ate, read a magazine, and was thinking about going back to sleep when it started. When the noise started.

Stewards and stewardesses reassured passengers, which was fine until they offered an explanation.

"Oh, it's just air going through the vents."

Of course, there aren't any "vents" on the fuselage, as an observant engineer would and did notice upon boarding the plane.

Of course, I was fairly sure it was just a latch that had come loose during flight and was banging around.

As I watched the earth more than six miles below, I thought of classroom discussions of redundant systems and factors of safety. Everything would go well, I reassured myself, because engineers had designed this plane.

As I watched the earth more than six miles below, I thought of classroom discussions of redundant systems and factors of safety. Everything would go well, I reassured myself, because engineers had designed this plane.

Then I thought of all those FORTRAN programs that never really worked, but I'd gotten away with anyway. Great.

Wholly discomforted now, I realized that engineers have to be different. Engineers have to know what they're doing and do it well. If an engineer has a bad day designing or building a bridge, skyscraper, or, God forbid, a plane, the results could be tragic.

I'll try to remember that the next time I'm cursing a dynamics professor for harsh grading.

Ray Easterling

Ray Easterling
Editor-In-Chief

engineers' FORUM

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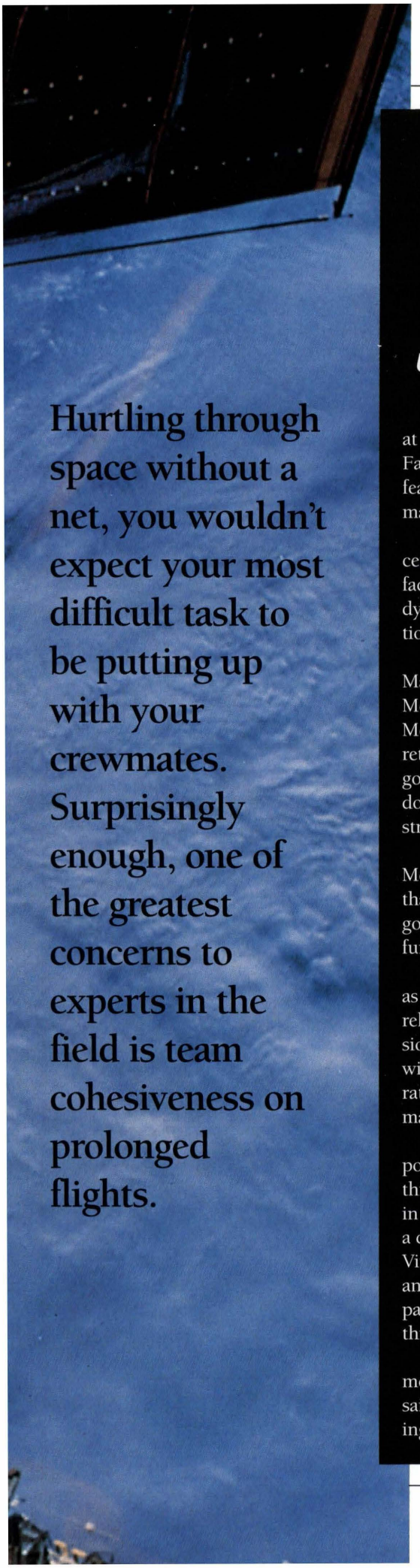

The Martian affair

by Ray Easterling

A journey to Mars hinges not only upon design and aerospace engineering, but upon human factors considerations as well.

Hurtling through space without a net, you wouldn't expect your most difficult task to be putting up with your crewmates. Surprisingly enough, one of the greatest concerns to experts in the field is team cohesiveness on prolonged flights.

A panel of experts convened recently at the Third Annual Mid-Atlantic Human Factors Conference to discuss the feasibility and factors inherent in a manned voyage to Mars.

The focus of the symposium concerned the incorporation of human factors, psychological aspects, and social dynamics into prolonged space exploration voyages.

"We want to go back to the moon, to Mars, and then to the stars," said Patrick McGinnis, flight surgeon for NASA. McGinnis gave a tentative schedule for returning to the moon by 2003 and then going to Mars by 2014. "I find this doubtful. NASA has put its mission of strategic exploration on the back burner."

"It's a sad situation," said Jon McBride, shuttle astronaut. "It's unfair that NASA has to compete with" other government programs with dissimilar functions, McBride said.

McBride, who served for three years as NASA's representative for congressional relations, pointed out that most congressional representatives might be concerned with the next two years of their terms, rather than a scientific operation which may take decades to produce results.

"I'm not convinced we have the political will to sustain a Mars effort at this time with these deficits we're running in the government," said Dwight Holland, a current Cunningham fellow in the Virginia Tech department of industrial and systems engineering. Holland was part of an Antarctic expedition, spending three months at remote field sites.

"[Going to Mars] is going to be the most difficult thing we ever do," McBride said. "It's not the designing and engineering, it's the human factors aspect [which will be the most difficult part]."

The topic receiving the most attention was the issue of prolonged living in an isolated confined environment. It is estimated to take 500 days to journey to Mars, which would be followed by a 6 to 12 month stay on the planet, followed by a return trip of an additional 500 days.

"Significant psychosocial stress will occur on long duration space flights," said Holland. "How will the crew handle the problems when -not if- they occur?"

History has shown people in isolated, enclosed environments do not fair well unless able to leave those environments, even with the best selection and training, Holland said.

"The hardest thing during a flight is keeping good relations going with the ground and among the crew . . . the flight becomes increasingly difficult," said cosmonaut Lebeder stated in his diary during a 211 day mission. The Soviet and ensuing Russian space programs have placed greater emphasis on long duration flights than most space programs in other countries.

"We have to solve our [problems] together, taking into account the feelings of the other. Here we are totally alone. Each uttered work assumes added importance," said cosmonaut Valery Ryumin, indicating the fragile social state of crew dynamics on prolonged missions.

In direct support of this, Taber MacCallum, president of Paragon Space Development Corporation, cited the his personal experiences during two years of isolated and confined environment habitation in Biosphere Two.

"The biggest problem by far was the

See Mars, page 5

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Mars

Continued from page 3
internal psycho social dynamic, caused by the difference in opinion of how to run the project," MacCallum said. "Health and social safety were jeopardized to an unacceptable level."

He said the eight member crew essentially split into two group of four during the isolation in the biosphere, located in Arizona. The rift is still evident in the group members today, even though they have been out of the biosphere for more than 18 months.

"We thought we knew who we were going in with," MacCallum said. "When we went in, we were all very good friends. Despite ideal conditions, we had major problems."

These considerations, past experiences coupled with research, and new innovations all need to be taken into account in planning the mission to Mars, or any prolonged, isolated event.

"Why is this important?" McGinnis asked. "Well, our workers in space are some of the most valuable industrial workers we have. Not only are they smart and well trained but there's a lot of infrastructure that goes into helping them do their job."

Astronauts will be exposed to adverse temperatures, atmospheric conditions, decompression sickness, microbiology and toxicology, restricted habitability and restricted hygiene, McGinnis said. Deconditioning, existence of a closed life-support system, and limited escape capabilities will all add to the already heightened stress levels of the crew. Additionally, it is expected that astronauts on a mission to Mars will be exposed to dangerous levels of cosmic radiation.

Irritability, anger, and hostility, research has indicated, are directed towards outsiders during the first 90 days of a mission. Afterwhich, these emotions tend to turn inward on other crew members, McGinnis said.

"You have tensions and conflicts withing the crew which have indeed disrupted missions to the point of premature termination," McGinnis said. McGinnis indicated that countermeasures need to be implemented to negate these effects.

The five member panel, which included the aforementioned and Jim Muccio of the University of Virginia Medical College, discussed several solutions and considerations to realize in planning prolonged closed environment habitation. The majority of which involved human factors consideration in the space program, an aspect which is threatened under the current economic and political climate.

"It's the human factors that will drive these long duration space flights," McBride said. EF

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BIOSPHERE: *Researching isolation within*

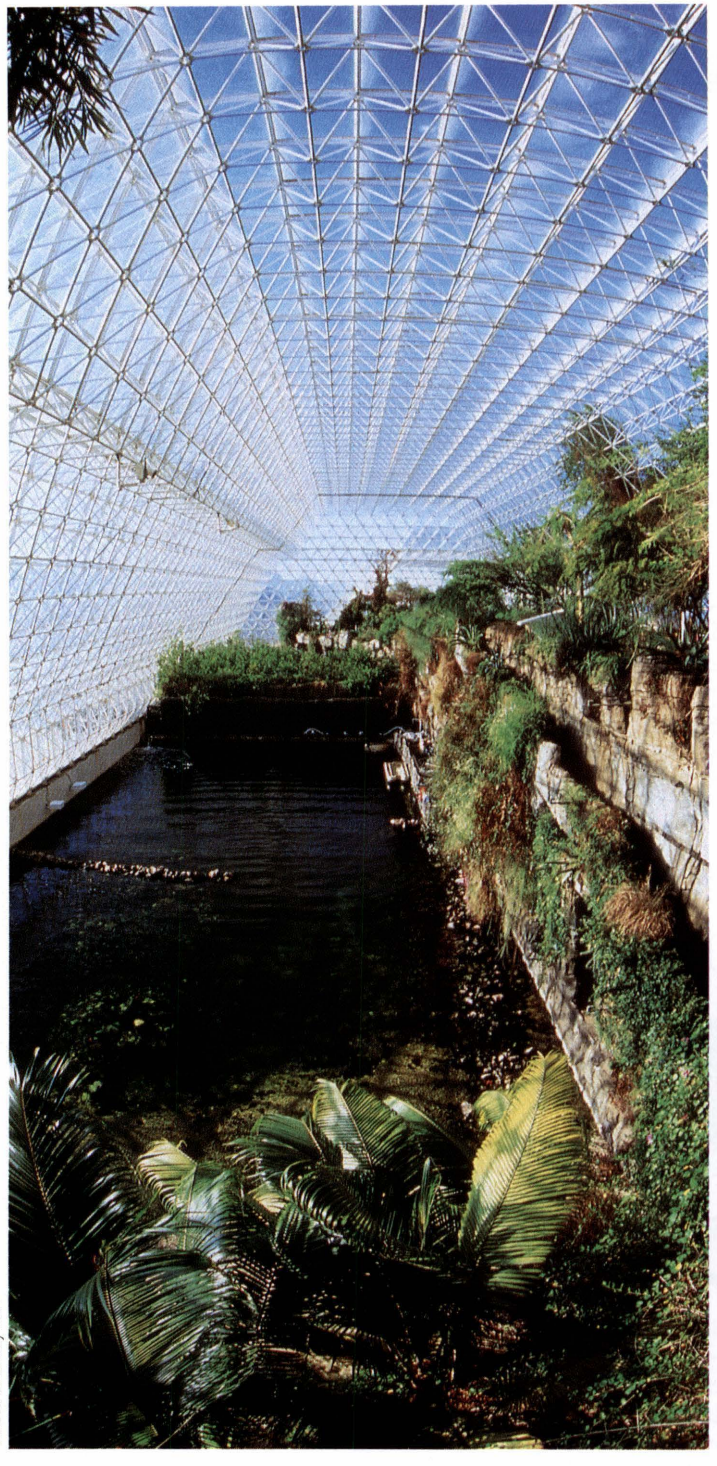

Photo courtesy SBV

by Michele Romanoski

The concept of the biosphere is relatively new. A Russian geochemist, Vladimir Vernadsky, originally defined the biosphere as "the environment in which we live; it is the 'nature' that surrounds us as to which we refer to in common parlance." It was through similar thinking that the "whole earth" idea came about. When it became apparent that all the life systems on Earth were interconnected (an idea made especially clear when photographs of the entire planet were released from NASA), the biosphere concept was accepted into mainstream culture.

A second definition originated with Professor Clair Folsome, who introduced the idea that a biosphere was a contained environment in which the conditions remain at equilibrium. Folsome tested this by sealing seawater into an airtight flask and watching to see how long it would take for the microscopic system living in the seawater to die. These flasks had amazingly long lifetimes, as the environments inside the "ecospheres" would reach a stable point and continue thriving. Many of the ecospheres collected by Folsome are still alive, including some that date back to his first experiment.

The knowledge that life could survive in a closed system caught the interest of many space advocates, while the biosphere idea attracted the attention of environmentalists. One group decided to merge the two ideas on an extremely large scale and Biosphere 2 was initiated. Biosphere 2 was an attempt at the largest artificial closed environment yet attempted. At completion, it contained three acres of tropical biomes, areas for agriculture, and living space for eight people. The habitat was

Photo courtesy SBV

(Above) Biosphere 2 contains extensive environmental features, including rain forests, agriculture fields, a savannah and desert, all in 3.15 acres of enclosed space.
(Right) The Biosphere 2 complex exterior.

a closed system

sealed in 1991 and included, along with its human contingent, various insects, birds, snakes and lizards residing in the wilderness, and goats and pigs for human consumption. During the two years in which the first team was sealed in, several problems occurred. But, according to Taber MacCallum, a biospherist for that first experiment, "if everything goes the way you think its going to go, you basically haven't learned anything."

Among the major problems were depressed food supply and oxygen depletion. Due to a miscalculation of sunlight diffusion through the structure of the Biosphere, the agriculture area produced less food than originally expected. When this occurred, those animals in the agriculture area competing for the same food as the human contingent were eaten. Because they eat the stems of plants that humans cannot, the goats were spared.

A more difficult problem originated with the oxygen loss. Over time, the system was losing oxygen. Because the Biosphere was a closed system, the oxygen was somewhere inside the structure. The air composition, however, did not indicate increased levels of carbon dioxide, which would account for the oxygen deficiency. When the percentage of oxygen in the air reached 14%, the cognitive abilities of the biospherians was judged to be in danger, so oxygen was pumped into the structure. It was finally discovered that the concrete in the internal structures of the Biosphere was absorbing carbon dioxide at a tremendous rate. Without this absorption, however, the carbon dioxide levels inside Biosphere 2 would have quickly risen to unlivable conditions.

There were other problems independent of the engineering of the Biosphere itself. Human factors are of extreme importance in an enclosed environment. With a limited food supply and low oxygen, stress factors were extremely high, added to the day-to-day maintenance of the wilderness and agriculture production. Frequent medical exams were given to the biospherians by the resident doctor to see the effect of lower oxygen on their systems and what adaptations, if any, would occur. The inhabitants had lower blood pressure, lower white cell count, and lower blood sugar than normal.

Of most importance to those interested in building ships for long-duration missions is the effect of the isolated environment on the inhabitants. The biospherians' personal lives were kept private from the press, but a split did occur within the group during the two-year stay. The division within the Biosphere is important to recognize, because similar problems are guaranteed to occur in other isolated environments. An understanding of how the biospherians related may give some insight on how to reduce stresses within small groups. In any engineering situation, the human factor is always the most difficult to predict. EF

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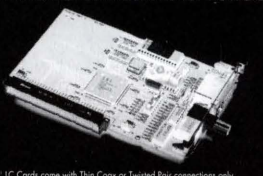

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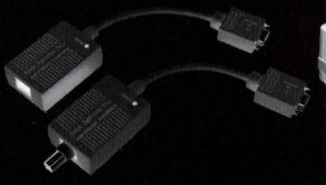

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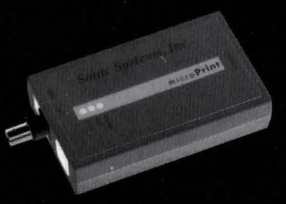

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The F-22 Advanced Tactical Fighter:

by Nathan Phillips

The F-22 Advanced Tactical Fighter, product of design teams from Lockheed, Boeing, and General Dynamics, will be the most technologically-advanced aircraft in the world. Using the Air Force directed "integrated product team" concept to design individual modules, and coordinating the computer-aided design packages for all companies involved, the F-22 has made dramatic improvements in capability and efficiency over the original prototype.

However, at over $100 million per fighter (TR Aug./Sep. 1992, p. 44), about twice the cost of a new F-15 and over three times that of an F-16, Air Force and congressional officials must decide if the improvements are worth it. The final judges of an aircraft's performance, however, are those who work in and around it. The pilot, maintenance crews, and tactical officers must know the capabilities and limits of the F-22, and how it compares to the current predominant fighter: the F-15.

Most articles discussing the F-22 concentrate on budget cuts and potential postponement of the F-22 program, particularly from 1994 to 1995. Aviation Week & Space Technology has published many articles discussing the unique design process of the F-22, focussing on technical problems and solutions as well as congressional and Department of Defense funding for the program. Technology Review concentrated more on whether the US needs the advanced tactical fighter (ATF) in "The F-22: An Exercise in Overkill" by David Callahan (TR Aug./Sep. 1992, pp. 43-49). The most compact source of information on the F-22 is Jane's All the World's Aircraft, 1993-94, "Lockheed F-22" entry; however this approach gives little discussion on the pilot's perspective. By analyzing the features of the F-22 from the viewpoint of the pilot, maintenance crews, and tactical officers the F-22 becomes more than just a list of statistics and monetary costs; the F-22 is a powerful example of technology designed for a specific purpose, taking human requirements into account.

After slightly over 100 hours of flight testing, on April 25, 1992, one of the aircraft crash landed at Edwards Air Force Base following pilot-induced oscillations. The pilot, who graduated from the Naval Academy with Dr. Durham, was apparently reassigned, and proved impossible to contact. This nonfatal impact grounded the ATF after only 70 flights, but it is being used as an antenna testbed at Rome Air Development Center, Griffis Air Force Base, New York. (Jane's 1993-94, p. 497).

General Information

The production F-22 will be an updated version of the YF-22 prototype. As stated in the March 2, 1992 issue of Aviation Week & Space Technology, "F-22 Wingspan Grows Slightly In Final Design", there have been several major changes to the airframe. The wingspan has been increased by 1 1/2 feet, improving subsonic cruise efficiency. Maneuverability and stealth capabilities have been improved by decreasing the leading edge wing sweep and perimeter edges from 48 to 42 degrees. More supersonic maneuverability, reduced weight and drag, and increased control and stability will all be features of the new aircraft. Additionally, the F-22 will have better pilot visibility, greater sensor ranges, and more stealth characteristics than the YF-22 prototype (AW&ST March 2, 1992, p. 63 and Sep. 6, 1993, p. 51).

Lockheed, Boeing, and General Dynamics are the major contributors to the F-22 project. According to their design contract, each company would build a section of the ATF, then send it to Lockheed for final aircraft assembly. After Lockheed bought out the Tactical Military Aircraft Division of General Dynamics (renamed Lockheed Fort Worth Company), they became responsible for both the forward and mid-fuselage, cockpit, avionics package, tail assembly, landing gear, environmental control system, integrated electronic warfare system, other essential flight systems, as well as the final aircraft assembly. Boeing is still accountable for the aft fuselage, engine installation, radar systems and wings (AW&ST Nov. 5, 1990, p. 90 and Sep. 6, 1993, p. 51; Jane's 1993-94 pp. 496-7).

After 1200 hours of computer-simulated air combat, Air Force Maj. Gen. Joseph Ralston stated that, "the study results show that the ATF is far more capable [than the F-15] of achieving air superiority against the evolving threat" (TR Aug./Sep. 1992, p. 46). YF-22 prototype demonstrations showed roll rates of 100 degrees per second at 138 miles per hour (120 knots), and maximum speed of Mach 1.58 without afterburners. The ATF can reach Mach 1.7 with afterburners, has a g limit of +7.9, and a ceiling of 50,000 ft. The target thrust/weight ratio of 1.4 will allow a maximum takeoff weight of 60,000 lbs., and large internal fuel tanks provide greater maximum range than the F-15. (Jane's 1993-94, pp. 497-498).

Stealth Characteristics

One of the basic considerations for the F-22 was what materials to use in building it. Initially, advanced thermoplastic composite materials were expected to be the primary radar-absorbing substance. These high pressure heated plastics could be reprocessed and reshaped for easy repairs, but were exceedingly high in cost. Advanced thermoset composites, however, cannot be reformed — once they are set, they must be replaced to be repaired (AW&ST Nov. 5, 1990, p.87).

About 22% of the weight in the F-22 will be thermoset composites, 4% will be thermoplastics, with titanium and aluminum making up 30% and 14%, respectively. This composition has been tested to withstand 30-mm. high explosive rounds (AW&ST Sep. 6, 1993, pp. 50-1).

The F-22 will be as "invisible to radar" as the F-117 stealth fighter-bomber (TR Aug./Sep. 1992, p. 44). Drain holes and access panels have been reduced in the F-22 production fighter, in order to reduce the radar-cross section (RCS). This will increase weight and reduce maintenance accessibility somewhat, but is necessary in

Preeminent warplane for the U.S. Air Force

achieving the Air Force RCS requirement. A new "electrochromic and thermalchromic" coating will also be used to reduce radar reflections and infrared detection. This coating will have a low voltage passed through it , which will help absorb radar energy and reduce heat emission (AW&ST Mar. 14, 1994, pp. 30-1 and May 16, 1994, p. 27).

Maintenance and Repairs

Despite the technological complexity of the F-22, it is expected to be the easiest fighter to maintain in the US Air Force arsenal. The Sacramento Air Logistics Center states that the advanced tactical fighter will require less than one third the maintenance time of any previous aircraft, will have a combat turnaround time of only 15 minutes, and can be transported with necessary materials in about half the space required by current fighter aircraft. This allows more combat sorties than other less sophisticated fighters, enabling the F-22 to take the role of maintaining air superiority, escorting heavier bombers, or penetrating deep into enemy territory. This leaves the less capable fighters to concentrate on precision strike missions and air defense (AW&ST Jul. 15, 1991, p. 50).

Colonel Ron Bischoff, ATF system program manager for the Air Force at Sacramento Air Logistics Center, stated that "We are not only expecting but counting on orders of magnitude of improvement in reliability of the ATF's electronics. Conceivably, some of the components might never be changed out." Since the F-15 and F-16 were built in the 1970s, vast improvements in solid-state electronics and very-large-scale integrated (VLSI) circuits will keep the F-22 running much longer than older aircraft were expected to (AW&ST Jul. 15, 1991, p. 50). Another improvement is Lockheed Sanders' use of flexible printed wiring, replacing many of the old, error-prone rigid solder boards. Although Sanders is concentrating on the video tape recorder, this technology will be used throughout the F-22 avionics system. Senior principal system engineer Jeffrey R. Millar stated that this development should cut avionics breakdowns in half, with only one-third the number of maintenance man-hours required by current fighter systems (AW&ST Dec. 6, 1993, pp. 50-1).

The F-22 will be equipped with two state-of-the-art F119 Pratt & Whitney powerplants, a "35,000-lb.-thrust class, two spool, low bypass ratio turbofan that incorporates a three-stage fan and six-stage compressor." These engines have dual-redundant third-generation full authority digital control logic, and single stage, counter-rotating high and low pressure turbines. They are highly effective, and designed to require much less maintenance and repair time than other fighter aircraft engines. Supersonic cruising speeds of Mach 1.58 will be possible without the use of inefficient afterburners, and a two-dimensional thrust vectoring nozzle will allow the F-22 to alter the direction of jet propulsion by 20 degrees. This gives firm control at lower speeds, and allow angles of attack in excess of 85 degrees (AW&ST Nov. 18, 1991, p. 34-5, 38 & Aug. 2, 1993, p. 26; Jane's 1993-94, p. 497-8).

> ***"the F-22 combines every fighter pilot's fantasies into one plane... [and will] be a full generation more advanced than existing fighters, just as the F-15 had been when it was introduced in the 1970s."***

Avionics Systems

TRW, Inc. is supplying the integrated communications, navigation and identification avionics (ICNIA) (AW&ST May 6, 1991, p. 61). Most of the copper wiring has been replaced with fiber optics, which takes up less room and transmits information faster. Fiber optics also requires less maintenance than traditional copper wiring, and a liquid cooling system will help keep the components working longer and more efficiently (AW&ST Jul. 15, 1991, p. 50). Hughes is providing the common integrated processor (CIP), which will directly control the Westinghouse radar system and store all mission-specific software for the F-22. It will be able to support data processing speeds of up to two billion instructions per second, and signal processing up to 50 billion operations per second. The flight controls, supplied by Triplex, will be a digital, "fly-by-wire" system similar to that used in F-16, with line-replaceable components that allow faster repair times and more efficient maintenance (Jane's 1993-94, p. 498).

One exceptional feature of the F-22 avionics is the benefit of "common modules." If a failure occurs in one system, another system will automatically take over the job — the entire system will be nearly as efficient, so the fighter will still be usable before the faulty system is repaired or replaced. An entire module can be replaced simply by plugging in a new unit, thus the F-22 could continue flying on a temporary module while the damaged one is being repaired. (AW&ST Jul. 15, 1991, p. 50)

An important part of the survivability of a fighter is the heads-up display (HUD), which gives the pilot all the information necessary to maintain the aircraft while engaging enemies and avoiding surface-to-air missiles (SAMs). Kaiser Electronics, located in San Jose, California, has been contracted for a new full-color display system. There will be seven active matrix, liquid crystal displays (LCDs), with no round gauge "backups" necessary. The displays include a large 8 X 8 inch, two 6 X 6 inch and two 4 X 4 inch panels. Two other small panels will be indicators for auxiliary information. The altimeter, fuel gauge, weapons status, nav-igation, radar data, etc. will all be available at a glance — Dave Ferguson, chief test pilot for the YF-22 prototype, stated, "Having colors is much better. We found we could program the displays to change the color of a parameter as a limit was ap-proached — and this was very helpful from a human factors standpoint." The brilliant displays and sharp images do not wash out in bright

See Warplane, page 20

MSE's Lu latest Sporn Award winner

by John Cole

"Dedication, caring, and efficiency are the three words I would choose to define Dr. (Guo-Quan) Lu," said Thomas Kuhr, a senior in Materials Science & Engineering, when asked to describe the newest Sporn Award winner.

Upon hearing that he had won the prestigious Sporn award, a teaching award voted on by students, Dr. Guo-Quan Lu said that he was "shocked. I can't believe that I won. There are so many good professors here."

Dr. Lu is a very modest and sincere man whose desire to go that extra mile to make sure that students are really learning and getting their money's worth out of their classes has made him much appreciated by his students. Nicodemus Reese remembers a specific incident where Dr. Lu not only continued on with a class only four people signed up for, but also made up a lab for that class, which is no small feat. According to Reese, Dr. Lu is also "extremely intelligent and knows the material and the field." Reese also noted that "his lectures are upbeat, and he is always full of energy."

Dr. Lu received his bachelors degree in 1984 from Carnegie-Mellon University with a dual major in Materials Science and Physics. His specialization was in metallurgy, the science of separating metals from their ores and preparing them for use.

He then continued on to Harvard, where he earned his masters degree in 1988 and then his doctorate in 1990 in Applied Physics/Materials Science. His thesis work was on semiconductors and how materials can have an impact on semiconductors.

From Harvard, he moved on to work for ALCOA at their technical center in Pittsburgh, where he stayed for two and a half years. He worked with ceramics and their packaging applications for electrical components. However, at that time ALCOA was staring to focus on cutting research and Dr. Lu. says that he also was "beginning to lose a feel for the fundamentals of the material (Materials Science)." Therefore, in August of 1992 Dr. Lu arrived at Virginia Tech to teach for the Materials Science & Engineering (MSE) Department.

While he is based out of the MSE department, Dr. Lu has taught Engineering Fundamentals, Solid State physics (for Electrical Engineers), and one of his present courses, Materials in Electrical Engineering. He seems to genuinely love teaching and working at a university and remarked that his is " a very fun job, I like it a lot."

Dr. Lu is a member of the Materials Research Society, the American Ceramic Society, and the International Society for Hybrid Microelectronics.

Dr. Lu does research into the processing and characterization of materials for microelectronic packaging applications such as sintering. He works a lot with the sintering of ceramics.

When Dr. Lu finds time away from teaching and research, he likes to spend time with his family (he is married and has a son) and he can also play a mean game of racquetball. He is currently involved in a tournament amongst the professors in the MSE department. EF

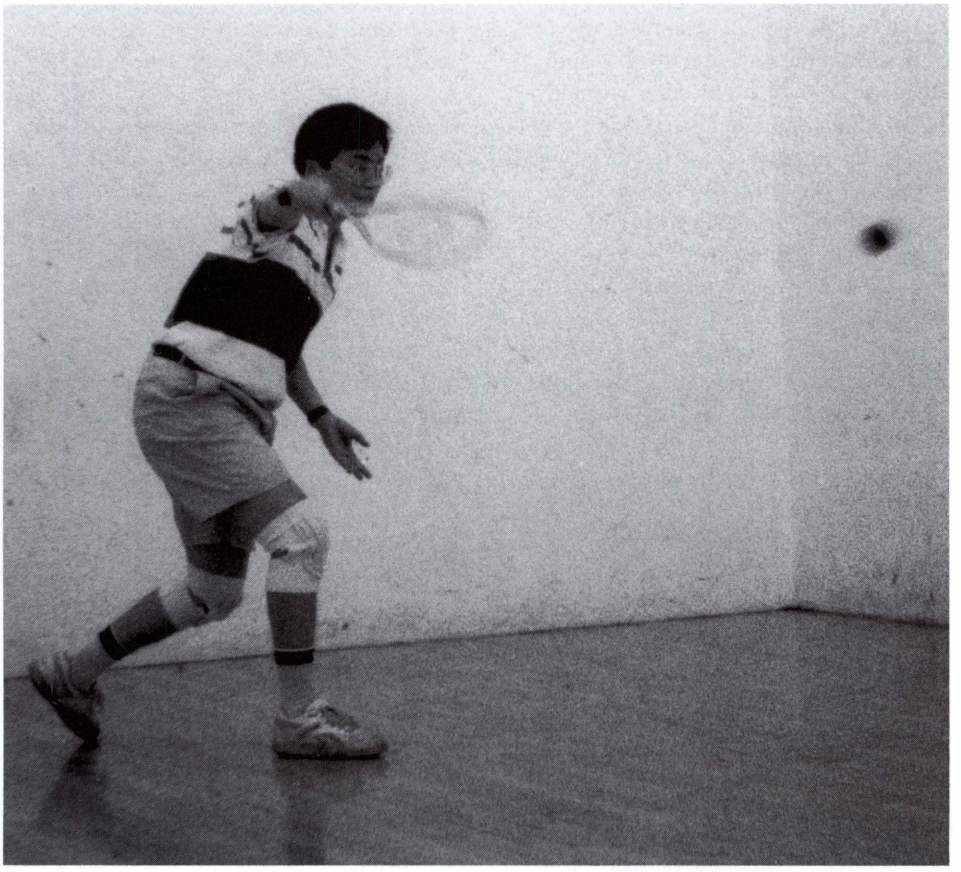

Photo by Dave Kennedy

Teacher, researcher, racquetball player: *Guo-Quan Lu makes his mark in the classroom and wins the Sporn Award for his efforts.*

Amin winner of Torgersen Leadership Scholarship

by Sneha Patel

Though most engineering curricula don't even offer classes in it, leadership has become an integral part of upward mobility in the engineering workplace. The classroom, however, is not the only place to learn about being a leader. Motivated students can find a niche as officers of various campus and national organizations.

"Never before has the need for leadership been more in the forefront of technology. As college students, I believe we are in excellent position to develop leadership skills that will help us deal with the changing face of industry," said Sneha Amin, this year's recipient of the Torgersen Leadership Scholarship. The award was established by the Student Engineers' Council ten years ago in honor of the centennial anniversary of the College of Engineering and to honor Paul E. Torgersen, current president of the university and former dean of the College of Engineering. The SEC raised $20,000 for the scholarship fund through donations from companies and alumni.

Recipients of the award are selected by the awards committee of the SEC, currently chaired by Terry Bush. The subcommittee was comprised of five voting members and two alternates, all of whom were students. A conscious effort was made by the committee to eliminate subjectivity and to ensure the group represented the various disciplines of the College of Engineering.

The application process for the award was divided into two categories. The application itself counts 35 percent and the interview counts 65 percent. The application is further broken up into five categories: leadership excellence, essay, letters of recommendation, academic achievement, and overall impression.

The winner was selected on Feb. 26, and announced at the College of Engineering Leadership Banquet on Mar. 22.

Though many well qualified students applied, Amin's communication skills, professionalism, and her ideas on leadership proved to be enough of an edge to win the award.

Photo by Dan de Moraes

Sneha Amin

A junior in chemical engineering, Amin makes a concentrated effort to stay involved in extracurricular activities despite a demanding academic schedule. She stated that she feels "the key to leadership is involvement." Indeed, Amin is currently an active committee member for the American Institute of Chemical Engineers, resides on the SEC executive board as director of relations, and is the chairperson-elect. Formerly, Amin served as hall chair for Main Eggleston Hall as well as National Engineers' Week '94 chairperson for the SEC. She stays active with other committees within the SEC and was part of the committee that chose F. William Stephenson as the new dean of the College of Engineering last year.

Asked about the qualities of a good leader, Amin stated, "It's not about you; it's about going from point A to point B and how many people you take along the way. You have to lead yourself." Amin notes the role of a leader is to develop people. In addition to making sure the job gets done, she feels that a leader must always keep "a third eye" out to look for people to replace him/her so the project does not come to a standstill. Moreover, upon finding a replacement, a leader should train and develop that person to take over without imposing his/her own views on that person. Additionally, Amin notes the importance of self-motivation and the motivation of others. She also believes that it is important to set a vision and then communicate that vision to others.

Amin feels that it's her energy and enthusiasm for the project she undertakes that sets her apart. It is this energy, she feels, that affords her with the drive not only to come up with ideas, but to make sure the ideas become reality. She sees her projects through from start to finish, and Amin feels that this, among other traits, helps her to succeed.

Though the money is nice, Amin had other reasons for applying for the $1000 award. "I feel that Dr. Torgersen is the most phenomenal professional and leader I have ever met," Amin said, "And I am just honored to have my name associated with his." EF

What happens to the engineering design equation when humans are added?

by Michelle Romanoski

In the past 50 years engineering design has become greatly complicated. The specs for the first military airplane are two pages long, while the current total specifications for the F1-11 fill a room six by six ft., 11 ft. high. Human factors engineering is the study of what happens when you add a human being to an engineering problem. Professor Paul Kemmerling, an associate professor emeritus in industrial and system engineering, recently illustrated the importance of human factors in aerospace design.

Aerospace engineering success is measured on whether the airplane will fly and continue to fly. Over the past 30 years the accident rate has greatly decreased, a marked success for the aerospace industry. The problems that occur now are more human error than mechanical.

"What do you do when you say it's human error? The answer is: What you do is nothing. You go out, scrape him off, and get another one, and try it and say 'maybe he's smarter,'" Kemmerling explains, but continues, "I maintain that human failure is inevitable, but you can design it out."

Engineering design, specifically in aerospace, has changed greatly in the past 20 years. In the past, trial and error could be used in design. Pilots could adapt to designs that were bad.

"Human beings are incredibly complex people and they are extremely good at adapting," maintains Kemmerling. But the increase in technology has surpassed human physiological systems. In high speed fighter planes, like the F-15, the gravitational forces enacted upon pilots due to increased acceleration causes gray-outs and unconsciousness. "Our world has become so complex that we can no longer afford trial and error. We have to make it right the first time," states Kemmerling.

The problem, he asserts, starts with the design paradigm. A paradigm is a set of rules or a pattern that defines how one thinks. The set of rules for engineering design often becomes the only process that engineers will follow. Kemmerling says, "The problem is when you begin to reach the point where that paradigm becomes the only paradigm you use."

"Somewhere along the line somebody has to say 'Wait a minute..., I understand that rule, but we can't use it,'" Kemmerling says. While human factors rules can be used in the design process, the ultimate test of a design is an actual human being. Some of the rules for designs were established without taking into account all possible situations. While "rules is rules," one must always watch for situations that do not match those parameters.

Another way to combat the propensity for humans to err, is to design error resistant vehicles. One way that this is currently being accomplished is through automation. The problem with automation, Professor Kemmerling asserts, is "when we automate something, we take the person out of the loop." In many cases, a human being is then unnecessary. The excep-tion occurs when a problem arises. At that point someone must be able to override the automation to fix the problem. Automation in aircraft control is not a popular option among pilots and designers alike, so some other solution needs to be found to design around human error, because human error is inevitable.

Professor Kemmerling, a certified human factors engineer, was recently honored with the University's Sporn Award for excellence in the teaching of engineering subjects. EF

> *Our choicest plans have fallen through, our airiest castles tumbled over because of lines we neatly drew and later neatly stumbled over.*
>
> — Piet Hein

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ISHM: *The world of hybrid microelectronics*

by Dave Asbell

Inside the Bradley Department of Electrical Engineering exists an organization by the name of the International Society of Hybrid Microelectronics (ISHM). ISHM is a national organization that allows undergraduate and graduate students the chance to learn more about hybrid microelectronics. The local chapter, which recently one first place at a national conference, is a student organization that allows members the chance to gain valuable knowledge and lab experience.

Hybrid microelectronics is a technique used to build electronic circuits, from very simple to complicated, on a compact scale. The technique involves taking the design of a circuit from a CAD system and shrinking it down to a smaller size. This design is then photographically placed on a screen, in much the same way as a tee shirt screen would be made. A small piece of substrate with the design etched into its surface is then used to mount the circuit. Instead of using large resistors, capacitors, and conductors as would be used in a normal circuit, the technique uses layers of paste to act as the resistors, capacitors, and conductors. These layers of paste are applied through the screen that was made from the design. By using this paste, the circuit can be made much more compact than a normal circuit, while enabling it to still be very complicated and useful.

Members of the local chapter use these techniques in the labs to design and build technical projects each year. This gives them the opportunity to learn more about the field as well as gain hands-on lab experience by building their own circuits. The society also brings in professional speakers to the university and plans plant tours throughout the year. These activities provide the students with real life knowledge and experience to further their education.

The highlight of the year for the society is their annual conference. The conference is a three day event in which the students get a chance to meet professionals, visit plants, and compete with other university chapters. This year the conference was held in Boston, Massachusetts and consisted of 200 to 250 companies and 10 student chapters from different universities. Each of the companies and student chapters prepared a display providing information on themselves. The companies gave plant tours, such as AT&T this past year, as well as student seminars. The seminars allow the students to learn more about the professional world and give them the opportunity to ask questions as to what they can expect to see in the future.

Photo courtesy Cindy Grinder

ISHM members at a recent conference.

The highlight of the conference for the student chapters of ISHM is the display competition. Each chapter prepares a display showing the activities of the organization, the technical projects, and the lab work they have been doing throughout the year. The displays are judged on their overall appearance and content. Another part of the judging are the explanations of the projects given by at least two of the members at the conference. This provides the students with practice in communication skills in a professional atmosphere.

The conference also provides some benefits to the society as a whole, as Cindy Grinder, president of the Tech chapter, puts it, "You get to see new ideas from many different universities on projects, recruiting techniques, and how they run their society. Then you can take these ideas and build on them."

An awards banquet is held on the last day of the conference to recognize the best overall displays, with awards going to the top three. This past year the Virginia Tech chapter of ISHM won first overall for their display. This continues a long tradition as the group has won first overall in seven of the last eight years.

The local Virginia Tech chapter of ISHM consists of approximately 120 members and provides many benefits to its student members here at Tech. The society allows the students the chance to learn more about hybrid microelectronics and gain valuable lab experience, that would otherwise only be available to graduate students in the field. The annual conference also provides many social and professional benefits. Grinder has noticed some of these benefits over the last few years, "ISHM allows you to get to know the faculty better on a more personal level. And the conference gives you the opportunity to get your first view of the professional world and allows you to interact with other students and professionals in a casual atmosphere."

The current membership of the local chapter consists mainly of electrical engineers along with a small number of computer engineers. The society is currently having a membership drive and is trying to expand to a wider range of students and is open to any student. Anyone interested in ISHM can contact the faculty advisor Dr. Aicha Elshabini-Riad in the Bradley Department of Electrical Engineering, or can pick up a membership packet from the ISHM bulletin board outside of Whittemore 240. EF

BSE 4126: *The real world*

by Michael Nicodemus Reese and Doug McCaskill

Experience. That's what employers want, and that's what Virginia Tech's biological systems engineering (BSE) students get. The BSE senior design project is truly a real world problem solving experience. The students are designing new machines, facilities, and systems for customers' immediate use across the world.

Robyn McGuckin, Craig Thomas, and Kathy Langdon are designing a multi-million dollar waste water treatment facility for the island of Mauritius, a small island off the West Coast of Africa. The idea for the project came from Dr. Dillaha, professor of BSE who is on sabbatical in Mauritius. McGuckin said, "I was interested in an environmentally oriented project which could be applied to a third world country." She contacted Dr. Dillaha. He told her of the island government's interest in building a waste water treatment facility to handle domestic and sugarmill waste.

The group developed a preliminary design, but decided that it was not feasible. They switched their design to an Upflow Anaerobic Sludge Blanket (UASB) facility. The basic idea is to separate toxic gases and sludge from the water so the water can be reused. The final stage of the process involves anaerobic polishing in a large pond. This pond can be used to grow and sell aquaculture, such as a small shrimp-like creatures, called prawns, for profit.

The group is working with a professor at Lincoln University in Mauritius, whose research is in UASB. The group may publish a paper describing their design.

How is the project developing them as engineers? The project is giving them good teamwork experience, McGuckin said. Each member takes a part of the design, researches the material, and reports to the group once a week. Here they work together to come up with a solution.

They are also gaining real-world experience. This group and the other groups meet with an advisor once a week. The advisor acts as a supervisor to give suggestions and check the group's progress. Dr. Haugh, professor of BSE and class instructor, makes each student keep a notebook. Also the groups communicate with him via a standard memorandum. Finally, each group gives presentations of their design throughout the semester to the class.

The BSE senior design project is more like a true engineering job than an undergraduate class.

Bill Hepler and Luke Harris are working on a project for a group much closer to Blacksburg. They are planning to design an elephant garlic clove planter which can plant through plastic mulch. Elephant garlic must be planted with a specific orientation. Existing transplanters can not be used because they cannot plant deep enough and existing transplanters that can be used with mulch are too expensive. A transplanter is a machine farmers use to plant seedlings.

Hepler said, "A grower in Virginia Beach called the department and wanted a solution (to planting elephant garlic clove)." At present he must plant the cloves by hand, a very tedious and time consuming project.

Harris said, "We are hoping to keep the cost under $2500." These students must use cost-conscious engineering, something most students don't get in their undergraduate classes.

Harris and Hepler said the project could develop into a Master's thesis, but both are looking for permanent employment.

Harris said he enjoyed the class, and Hepler said, "I think it is a good summation of the design process."

Kevin Tweedy, Chris Toms, Ryan Messier, and Adam Barlow are designing a Automatic Streamside Stage Sampler to take water samples at various depths in a stream.

The group uses past classes, such as hydraulics, energy and power train technology, and soil and water conservation engineering, to help them with their design.

The are being supported by Dr. Mostaghimi, professor of BSE, on the project. Barlow said, "He is one of the best known (individuals) in this area, and he may fund us." He also gives advice on what designs will work or not. Coming up with a design has not been easy. Toms said, "It seems a lot easier to put together in your mind." Messier added, "It's a lot harder than I thought."

During their preliminary class presentation, the group used Freelance Graphics to demonstrate how the gears, the bucket, and sampler bottles work individually and together. The next step will be to put the design together on paper. If they decide to build it, they will do so during the summer.

Some of the difficulties they encountered were finding components to lower the build time, finding time to get together, and keeping the cost under $700. To deal with problems, Tweedy said, "We've been working at least ten hours a week mostly brainstorming, calling manufacturers, and getting components."

Kim Dusterhoff and Kylie King are working with the Department of Corrections in Virginia to develop a prisoner worked farm system. Under a new state initiative, prisoners will be put to work to earn their small stipend. This means that the design plant is in the unique position of having almost free labor. The farm will contain a food processing plant to package the fresh fruits it grows. The group's goal

See BSE, page 21

Blacksburg Electronic Village

Tech's small rural community is actually a high tech prototype community for the future

by Scott Walters

The information superhighway is well on its way to connecting the entire planet. A few years ago, however, the whole concept was just breaking ground. Virginia Tech picked up on the idea early and incorporated it into a trail-blazing program of networking called the Blacksburg Electronic Village. Tech has a long tradition of being on the front lines of cutting edge technology. The project has proceeded strongly since its inception and continues to progress.

Instead of using phone lines or ethernet lines, fiber optic lines will connect each computer.

The idea for an electronic village in Blacksburg first appeared in 1990. Faculty and staff living in the town were interested in networking from their homes. A network system would easily allow them to do work at home. Tech recognized the needs of the faculty and the opportunity to experiment with a rising trend in communications. Joining forces with Bell Atlantic and the town of Blacksburg, the trio devised a plan for an experimental network. The result was the Blacksburg Electronic Village, or BEV. After a developmental period, it went on line in 1993.

The BEV is primarily an experiment. During the initial stage, the program would be fine tuned under Tech's technological supervision. The town then takes over primary control and maintenance of the BEV. One recent sign of this transferal of power is the relocation of the BEV office from the Tech campus to the Museum of Natural History on Main Street. Dr. Andrew Cohill, director of BEV, has received positive feedback from the citizens of Blacksburg about the move.

Tech and the BEV are both currently planning a number of improvements and changes. One improvement the BEV is looking into is the establishment of a private modem pool. The current system delivers speeds of 14,400 bits per second (bps). The new modem pool would deliver 28,800 bps. As student usage and demand on the servers increases, the Residential and Dining Programs at Tech is improving its networking system as well. This began with installation of ethernet ports into O'Shaughnessy, Slusher, and Payne Residence Halls. Many off-campus housing sites already have ethernet access, at a cost to the user. These ports are a direct line to the server instead of the using a modem from off campus or the digital phones currently in dorm rooms. Ethernet is much faster and more efficient than conventional modems. This change should help alleviate many of the current problems students currently experience with the servers. The only drawback is that students must purchase an ethernet card for their computers, which can be expensive. Prices for the cards have come down, however. According to Cohill, cards can now be bought for about $100.

Cohill believes that fiber optics are the future of networking. Instead of using phone lines or ethernet lines, fiber optic lines will connect each computer. These lines are designed to be extremely fast. Though the technology currently exists the cards required for fiber optic use are extremely expensive. As the prices of these card comes down, however, the availability of this technology will increase.

The future of the BEV is unlimited. According to Cohill, there are currently about a dozen other electronic villages in the country. Many of these are based on the BEV. Blacksburg's Electronic Village, however, is the largest and the only one to offer 100 percent internet access. Cohill believes that in the future everyone in Blacksburg will be connected. Judging from the support and success so far, this vision will become a reality. EF

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INVASION:
Things are never what they seem...
(Part 5)

By Rich Parish

Ria has finally arrived on Earth to keep Celone company. An effort is made to kill Forrest, Alexandra, Jim, and Ray, but unbeknownst to Shiro, they failed. After their escape, Ray dies on an electric fence, and the remaining three meet a community of people.

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"Welcome to your new home. Please, come into the living room and make yourselves comfortable."

Forrest and Jim followed the lady in white through a short passage until a wide expanse of a room opened to their left. Her arm flowed out to the side, her hand suggesting the black leather couch as a resting place for Alexandra. After putting her to rest, they took their seats in matching chairs on either side of the couch. The lady took her place in the white recliner, facing the two newcomers.

"We are always glad to have new people join our community. We would not survive if it weren't for new blood like yours. Would you like some food to eat?"

"I haven't had a good meal in over a year," Forrest responded. "Of course it hasn't been a good year, so I don't know if it deserves a good meal..." he trailed off.

"Come, Anne," the lady beckoned to one of the group near here. When she arrived, "Anne, tell Julian to go ahead and prepare our supper early. We'll be eating in the ballroom, so make sure it gets set for 33 people." She turned her attention back to her guests. "There are thirty of us living here. We all have partners, so we sleep two to a bedroom. I'll have a room cleared out for the three of you tonight. Usually we have informal meals, but we have guests tonight, as you know. I assume the girl will be joining us for dinner?"

"Well, I really don't know about that. She's been passed out cold for a couple of days now. We keep trying to get her help, but haven't yet succeeded."

"We were hoping you might be able to help," Jim added.

"Do not worry yourselves. She will be

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awake before you leave here." She spotted one of the men of the group weaving through the people towards her. "What is it, Adrien?"

"Ma'am, a room has been readied for the guests."

"Oh, good, thank you." She stood up from her seat. "If you'd like to follow me, I'll show you to your room. There is a shower there, and fresh garments will await you once you have been cleansed. One of the men will take the girl to her own room where we will will try our best to awaken her." She walked out of the room, Jim and Forrest following, almost as if allured by her presence. She walked them up three stories of a grand spiral staircase and brought them to the first room at the top of the stairs.

"You will stay here. The bathroom is two doors down the west hall on your left. There is a clock in your room; dinner will be in just short of two hours at seven p.m., I will personally come and get you five minutes early." She opened the door as Jim and Forrest walked into the room. Once safely past the threshold, she closed the door behind them, and walked back down the stairs with a smile of evil passion on her face.

••••••••••••••••••••

Shiro personally searched through the rubble of the hospital, looking for the humans as he awaited the refueling vessel's arrival. The Sonnix-A was drained of power, so none of his detection instruments worked; the only way to find results now was to labor manually. He assumed a GWV would be arriving shortly carrying troops, and Hendou would probably come along. Until then, it was his job to find the humans.

The hospital had not been that large of a building; it was only fours stories high, with two two-story wings jutting off the sides, to the back. Shiro assumed the humans had gone for one of the exits at the end of one of the wings, but after several hours of searching, nothing had turned up. He looked up, hearing a vehicle approaching, and saw the GWV walking up to him.

As it approached, it slowly came to a stop, and the legs retracted into the carrier, as it slowly sunk to the ground. Four doors opened, two on each side, and 30 troopers marched out with shovels and picks, and following them came Hendou, accompanied by Masei.

"Shiro, what happened? Where did the humans go?" Hendou asked as he walked up to Shiro.

"I don't know, Sir. I've been searching for them since I fired, but I haven't found a thing yet. It's almost as if they disappeared," Shiro explained.

"They DID disappear, Shiro! According to our sensors, there are no signs of the humans still being here."

"But Sir, if they're dead then how would the sensors find them?"

Masei pulled a little clear plastic device, with a small computer screen attached, from her pocket. "It's called an EDNA extractor. It will extract the DNA from any hair, piece of skin, whatever, and show it to you on the screen. We then take that information, plug it into the computer, and search for it. If they were dead, they'd have left blood on the rubble, leaving DNA, but we didn't find any, so they must not be here."

"But they were in the building when I fired. I'm sure of it!"

"That building had 15 exits other than the front door that they could have used. They must have already been out of the building when you fired. Meaning they're still around," Hendou explained.

"Well, if you can get my Sonnix refueled quickly then I can search after them," Shiro offered.

"No, it's too late. They're much too far away by now. But don't worry, I'm sure we will encounter them again soon. Don't worry about this, Shiro. It will not reflect that badly on your record. After all, their IQ is said to nearly equal ours. Things like this happen, and this time they happened to you. Why don't you go back to quarters and get yourself a good rest, we'll take care of the cleanup."

"Thank you, sir." Shiro sullenly walked to the GWV, which took him off into the distance, alone.

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Forrest tentatively took a bite out of the meat on his plate. They had not been told what the dinner would be, and he was still unsure about this new group of people they had found. "This is pretty good. What is it?"

"Oh, it's nothing really. Just some meat we had sitting in the freezer. Our chef, Julian, is allowed to prepare whatever he feels like, as long as he makes enough to feed the whole community," answered the lady, who had changed into a black silk gown. In fact, all the people had changed into black, except for Forrest and Jim, who were now in all white.

"Where is Alexandra?" Forrest asked.

"Oh, her, she's sleeping comfortably in her room. We were able to wake her, but she asked to sleep instead of joining us for dinner. After being passed out for a few days your body can get very tired," she answered. "Now please, don't speak. Eat your meals. It has been days, you know."

Forrest played around with his food, pushing it from one side of the plate to the other, making forts out of mashed potatoes (is that what that white thing was?) and squashing them with meat. Something just did not seem right about the whole meal, and Forrest was glad when he saw that everyone else had finished eating. "I'm sorry, I'm just not that hungry. It's been so long my stomach has shrunk a bit, I guess."

"That's completely understandable, Forrest. Why don't we retire to the study to discuss your future with us," said the lady, now in black, standing and gesturing towards the hallway.

"Just what do you mean by that? And are you ever planning to tell us your name? I feel like I already know everyone here except you; just as enigmatic as when we arrived," Jim said wryly.

"Please, just come to the study with me; I can answer all your questions in private then." The lady calmly strode out of the room, Forrest and Jim following, and weaved through several corridors in the mansion, slowly getting farther from the front entrance. "Almost there. You know, over half of this building is still not used. We're hoping that our numbers will keep growing like this, so that eventually the whole house will be in use."

"What do you mean 'like this'?" Jim asked.

"You three arrived, just wandering up

to the house; lost souls looking for a place to fester. Or roost, rather." The lady smiled, unnoticed to Forrest and Jim, at her mistake. "If we keep getting stragglers like this, then we will eventually have the entire building utilized. New people usually show up once or twice a week; most of the time they come alone, but on occasion we do get a group, like yours."

"How often do people leave?"

"Never. But that's just because no one has ever chosen to leave. Why would one want to leave a place like this? A group of friendly people living a full life together. It's much better than staying on the outside, living a life of solitude." The woman stopped and opened up a door to her left. "Here we are."

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Celone awoke to Ria's smiling face.

"After eight years, Celone, I still can't believe that you fall asleep every time!" she giggled.

"How long was I asleep?"

"Just over two hours."

"What have you been doing all that time?"

"Watching you."

"Watching me? Did I do anything interesting?"

"No, Celone, you're the most boring person I know."

"Well thank you. A young man in the infantry once said that to me. Of course, I had just finished giving a three hour lecture on ethics in the workplace." Celone laughed.

"Not one of those speeches!" Ria disgustingly exclaimed.

"Throughout the history of our planet, man has striven to be the best at what he does. Build the best transport vehicles, construct the best buildings, design the best new computers, write the best new programs. Many abilities are needed to complete any one of those tasks, but there is one factor that if absent renders the project worthless. Ethics—" Celone stopped as he noticed Ria's fake gagging. "C'mon it's not that bad!"

"But it's so boring. I can't believe you've memorized it."

"I've had to give that speech twice a year for over 10 years now. It's impossible not to."

"Well, why don't you at least change it around a bit each time, or make it more interesting?"

"I can't. I didn't write it. It was handed to me, and I was told to read it verbatim, and I have ever since."

"I hate to do this, but—"

"You're going to change the subject?" Celone guessed.

"Not exactly...I'm going to get serious. I was really looking forward to coming; it's been a long time since I last saw you, and all I wanted to do was have a good time for the few weeks I'm here."

"But?"

"But there's something wrong. Very wrong."

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"Wow, I haven't seen you in a while! What's with that spiffy white outfit?" Alexandra was sitting to the side of the room, by herself on a big leather couch. She was garbed entirely in black.

Forrest's face brightened. "Alexandra!" He walked over to her and gave her a long hug. "I'm so glad you're awake."

"Who's that other guy with you?" she whispered into his ear.

"Oh, that's Jim. I met him right after you passed out. He's been helping us the whole way." Forrest turned his attention to Jim. "Jim, this is Alexandra. Alexandra, Jim."

Jim walked over Alexandra and shook her hand. "Nice to finally meet you."

"Please take a seat," the lady instructed. She closed and locked the door, then took a seat behind a big desk in the middle of the room, facing the couch. "It's time to answer everything. Alexandra already knows what I'm going to tell you. Before I begin, would you like something to drink?"

"Sure," they all agreed.

The lady stood up and walked over to the cabinet and pulled out an ornamental pitcher and a quartet of goblets. With her back to the guests, she filled all four cups from the pitcher, and placed it back on its shelf. Turning around, she handed each guest a cup, keeping one for herself.

Forrest, Alexandra and Jim all took sips from their cups. Forrest and Jim immediately began to look sick as they looked down into the cups and realized what they were drinking.

"For starters, the people here like to call me Claudia. You three can do the same."

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"What do you mean something's wrong?"

"You talk to me about ethics and you can't tell what's wrong? This is wrong! All of it! I didn't even realize this until we started approaching the planet. Didn't you look outside your window when on the ship? Didn't you see what this place looks like?" Ria exclaimed.

"What? No, I don't have a window in my room, besides, I was preparing for the trip here, I didn't have time to look around."

"What about after you got here? During the drive to the hotel, during the many days and nights you've already spent here, haven't you noticed something wrong?!"

"No, what is it?"

Ria suddenly realized how much their age difference meant. He being only thirty-five, and she being a slight bit over fifty. A look of horror came over her face. She spoke almost in a whisper. "Oh no, I don't believe this. You're too young. You don't realize because you can't realize because you're too young! In fact, I've never told you how old I am. I don't believe we've avoided this for so long. I have to tell you a story, Celone. It's going to be long, and fantastic, and horrific, and you might not believe it, but every word of it is true. You just can't remember because you were too young. Celone, I'm 53 years old."

"What?! That's impossible, no one in our society is currently over 41 years old because of the mass suicide after The Depression of NB0982."

"That's not the reason there was a mass suicide, Celone. How I stayed alive is not important right now, though. You have to hear about everyone dying first. You have to realize what's wrong..."

To be continued... EF

State-of-the-art radar is but one feature of new local weather station

With Blacksburg's tumultuous weather patterns, one might wonder if there is any way a meteorologist can stay on top of the latest forecasts.

By Ray Easterling

It now looks as if Mother Nature's weather whims will be more readily determined.

As a part of the National Weather Services's modernization efforts, a new weather office has been located in Virginia Tech's Corporate Research Center.

"It should be a big difference in forecasting (in this area)," said Jan Jackson, meteorologist.

Included at the new weather station is a high technology Doppler radar system, the WSR-88D.

"It's a state-of-the-art radar. We can look at the activity of the storm," said John Wright, meteorologist-in-charge at the office, which gives us an advantage over the old system.

"It's quite a dramatic increase over (past systems)."

In a joint effort by the departments of Defence and Commerce and the Federal Aviation Administration, about 130 new radar sites are being installed across the nation. Nearly 20 sites have already been commissioned at this point.

"(The radar) can measure the way the atmosphere is moving. We can see a storm rotating, which can be a precursor to a tornado," Wright said. "In the past, we couldn't do this."

The radar system, which is reportedly sensitive enough to detect birds and insects, can be used to measure moisture in the air before clouds actually form, thus giving meteorologists the ability to estimate rainfall and predict flash floods.

The Blacksburg location, which came on line Feb. 1, is scheduled to be commissioned in early August.

"We can see things we couldn't before imagine to see," Wright said.

The station is currently responsible for 40 counties, spanning three states.

"That will be the full compliment of county warning responsibilities," Wright said.

Forecasts for Blacksburg and Roanoke used to come from Charleston, W.Va. and Washington, D.C., respectively, Wright said. The weather station is designed to take over the responsibilities of offices in Beckley, W.Va., Greensboro, N.C., Roanoke, Lynchburg, and Volins, Va.

The new office, complete with eight meteorologists, one hydrologist and six meteorological technicians, issues short term forecasts for the locality four or more times daily, depending on how fast the weather changes, Wright said.

Additionally, the office has begun to submit forecasts to the Weather Channel. Each forecast encompasses weather for the next six hours for the 40 counties.

Eventually, the Huntington Upper Air program will be moved to the Blacksburg site. The program, which is scheduled to begin in Blacksburg in May, involves the deployment of weather balloons twice daily.

The balloons, laden with weather instruments, soar over 100,000 feet in elevation to take measurements for the National Weather Service and National Oceanic and Atmospheric Administration.

Once the balloons reach a certain elevation, the gas expands, exploding the balloon and a parachute is deployed.

The weather service has a significant number of units returned.

"Some end up in the Atlantic Ocean, so we don't get those back," Wright said.

There are plans to bring five more meteorologists on staff during the next three years. EF

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Warplane

Continued from page 9
sunlight, unlike con-ventional cathode ray tube (CRT) monitors (AW&ST May 20, 1991, pp. 52-3).

Kaiser Electronics is also including a helmet display as an option for the F-22 pilot. This would project targeting and tracking information directly onto the pilot's visor, allowing him to see the data at all times. Of course, the pilot will be able to see through the display and find visual contacts normally. All of this detailed imagery will make the F-22 more similar to a personal computer flight simulator. The computer does a lot of the traditional pilot role of determining distance and accuracy with weapons, leaving the pilot free to maneuver the aircraft into the best position possible to ensure a kill (AW&ST May 20, 1991, pp. 52-3).

Lockheed Sanders is working on the video recorder for the F-22, which will allow pilots to see multiple views of their flight in the mission debriefing. The high resolution recorder will simultaneously capture views from the HUD and three the other multifunction displays on a single two hour tape. Weapon firings, voice transmissions, and other digitized data will also be recorded by the system. There will be an additional recorder in the tail in case of a malfunction, although neither is designed for crash survivability. The computerized debriefing station will be able to display up to four screens from two different F-22s in color, and will be time synchronized for viewing different aspects of a mission simultaneously (AW&ST Jun. 21, 1993, p. 73).

The major functions of the F-22 avionics system package are data collection and processing, and situational awareness beyond visual range. The goal is to achieve accurate identification before the target is in view, and have precise firing control at very long ranges (AW&ST Sep. 6, 1993, pp. 50-1). This "first-look, first-kill" technology allows the F-22 to engage enemies beyond the pilot's visual range (Jane's 1993-94, p. 498), and will be ef-fectively implemented with an "interflight data link" system. Coordinated tactics with several other aircraft will be possible with this link, which allows each pilot to see information on other F-22 displays (AW&ST Sep. 6, 1993, pp. 50-1). This will help wingmen get in the best position possible, and increase the overall chance of success in almost any mission.

Weapons Capability

One disadvantage of the F-22 is the weapons load — it will carry slightly less than the F-15. Of course, this should be made up by the enhanced weapons systems that almost ensure one shot-one kill capability. The F-22 will carry four Advanced Medium-Range Air-to-Air Missiles (AMRAAMs) in the under-fuselage carriage bay, one small AIM-9 Sidewinder in each underwing weapons bay, and an internal long-barrel M61A2 20-mm. gun. It will also have wing hard points for external weapons or fuel tanks — of course using these will reduce the stealth capability of the fighter. The weapons bays and external carriage will be capable of delivering air-to-ground missiles or bombs as well, including the Air-to-Ground Missile-137A Tri-Service Standoff Attack Missile (AGM-137A TSSAM) and 1000 lb. Joint Direct Attack Munition (JDAM) bomb (AW&ST Jun. 17, 1991, p. 212 and Jane's 1993-94, p. 499). It has not been re-ported whether the F-22 will be modified for carrying nuclear weapons (TBAS Jul./Aug. 1993, p. 26).

Conclusions

The F-22 has been designed specifically for maneuverability, stealth, maintenance, and survivability. According to David Callahan, author of Dangerous Capabilities: Paul Nitze and the Cold War (Harper Collins, 1990), "the F-22 combines every fighter pilot's fantasies into one plane... [and will] be a full generation more advanced than existing fighters, just as the F-15 had been when it was introduced in the 1970s." Although he is against producing the F-22 now that the Cold War is over, Callahan concedes that the warplane is a "technological marvel" (TR Aug./Sep. 1992, pp. 44-45). In the article, he argued that upgrading F-15s could match more advanced fighters pro-duced in the USSR, or French, Italian, Jap-anese or other advanced Allied aircraft sold to the Middle East and Asian devel-oping countries.

Although US aircraft numbers exceed most potential adversaries, an alliance of smaller nations or several simultaneous aggressions would stretch the current air force beyond its capabilities. The F-22 is meant to defeat large numbers of less sophisticated enemy fighters, without get-ting shot down. With greater numbers of less advanced F-15s and F-16s, there will be more US fighters destroyed in combat, costing millions or billions to replace.

The likely increase in pilot death or incapacity would add to pilot training costs, and put less experienced pilots into combat situations. Additionally, wasted missiles from less accurate firing systems, the cost of more fuel for less efficient engines, and greater repair time and maintenance expenses would use more government funds to resupply and maintain aircraft. Of course, if the US is not involved in military conflict for over twenty years, the F-22 may not be worth the cost. It is up to Congress and the Department of Defense to decide the likelihood of that.

Technological benefits from the F-22 could far outweigh the expense of this advanced tactical fighter. The data collected on the avionics systems will provide more accurate controls and sensors for other military and civilian projects, and the use of computer control in basic tasks will be implemented in almost all future technological ventures.

Noncombat tasks for the F-22 may also be used; already there are long term goals of Lockheed and the Air Force to design an F-22 reconnaissance jet, carrying a sensor package in the central weapons bay (AW&ST Sep. 19, 1994, p. 29). As pilots and maintenance crews are trained, and learn more about its capabilities, the F-22 Advanced Tactical Fighter will provide superior service well into the 21st century.

Thanks to Capt. Charles Carter (Virginia Tech ROTC Det. 875), Capt. Jay Ducharme (Wright Patterson Air Force Base System Program Officer), and Dr. Wayne Durham (Virginia Tech Aerospace Engineering department), for their assistance.

Thanks also to the public information office at Lockheed and Northrop-Grumman, and the Virginia Tech Newman and Hollins College Libraries.

BSE

Continued from page 14
is to design a plant that can produce labor intensive fruit products at a cost competitive in the state commissary.

Their biggest problem is finding cost effective machinery. Dusterhoff said, "We tell company reps that we want labor intensive machinery, and they look at us strangely."

The group will have the opportunity to present the design to the Commonwealth to determine the feasibility of utilizing prison systems in May.

Joanne Reker, John Risso, Shelby Hertzler, and Donna Keffer are developing a soil erosion control plan for Blacksburg. The group's project, "Design of a Sediment and Erosion Control Plan for Eroding Areas Near Blacksburg Ranger Station," intends to rectify the severe erosion problems near South Main Street by Ramble Ridge Apartments. The area — visible from the roadway — is severely damaged. They will work with the Town of Blacksburg to develop a plan to abate the damage incurred.

The focus of the project is to determine a Best Management Practice (BMP) that will be mostly maintenance free and cost effective. The design of this project also includes aesthetics due to the area's high visibility.

Reker expects to do similar work professionally. She said, "All towns need ways of dealing with their erosion problems; erosion control plans developed by engineers are required to remedy them." Reker says her biggest motivation for getting into the soil and water concentration of BSE was for the opportunity to work in the field and gain hands-on experience. That's exactly what she's getting.

The senior design project allows undergraduates to put their major to work. In the BSE department, the students are using their experiences to help people across the world. In the process they learn about teamwork, ethics, and business relationships — skills exemplified by successful engineers. EF

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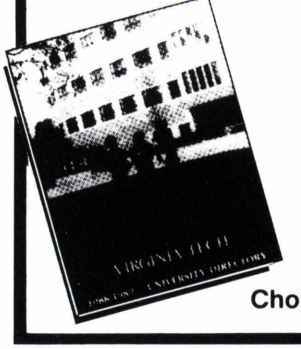

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