ILLINOIS TECHNOGRAPH

Vol 106
Issue 4
Summer 1991

Ethics in Genetics
The National Aerospace Plane
and more inside . . .

Do you have any writing skill? *If so, we can use your talent. The Technograph always has positions open for regular writers. The Technograph also accepts freelance submissions for people who only have the time for a single submission. We accept articles on most engineering and science related topics, and we encourage engineering graduate students to write about the projects they are conducting. For more information, contact John Fultz at 332-4071, or Chi-Ting Huang at 328-6808. You may also leave a message at Illini Media, 333-3733.*

ILLINOIS
TECHNOGRAPH

summer 1991

this magazine is printed on recycled paper

table of contents

Illinois Technograph
57 E. Green St.
Champaign, IL 61820
217.333.3733

Illinois Technograph (USPS 258 760)
Vol 106 Issue 4 Summer 1991
Illinois Technograph is published four times during the academic year at the University of Illinois at Urbana-Champaign. Published by the Illini Media Company, 57 E. Green St., Champaign, IL 61820. Subscriptions are available for $7.25 per academic year. The Technograph is a member of Engineering College Magazines Associated.

editor's remarks

John Fultz

Some of us just don't relish the good old days. We sometimes tend to remember the blunders of our time instead of remembering our true accomplishments. Here at the Technograph, however, we rather relish some of our past days.

The Technograph was a tradition of excellence. Soon to celebrate its 106th birthday, the Illinois Technograph was the one of the oldest and best established college engineering magazines around. Combined with the reputation behind the College of Engineering, the Technograph had no problem attracting a great pool of advertisers and good technical writers. A part of the Engineering College Magazines Associated, the Technograph was also an award winning magazine.

Due to a variety of reasons, and with no one in particular to blame, the Technograph waned over the past several years. In fact, only a couple of years ago, the magazine was struggling for its very survival. My arrival, and the arrivals of the two editors before me, were rather fortuitous, as there was no one else to take the reigns during those years.

These are the plain facts. However, the Technograph is back on the road to recovery. With a strong design and photography staff and the resources provided by our owners, Illini Media Co., we have struggled for a professional, yet pleasing, look to the magazine despite the limited budget. The College of Engineering has pledged its support for the resources it can provide.

This is not quite enough, however. To succeed, we need the help of the student body . . . you. The magazine has need of resources that only the student body can provide. There is so much that we can provide each other. Articles or other work published in the magazine are seen by nearly every prominent engineering college in the United States, as well as in nearly every high school in Illinois. Decent freelance work on science and engineering topics always has been and always will be considered for publication. The Technograph pays any student whose articles or other works are to be published. Articles need not, and should not, be highly technical in nature, as the magazine should appeal to anybody who possesses interest and a limited educational background in engineering. Finally, employers like students who can prove that they can communicate clearly and/or lead others efficiently.

I don't think I'm begging or that I need to beg, folks. The Technograph is a great experience, and I'd love to have many people share in it. So let's see if we can forget these "good old days", and move ourselves into the future.

John R. Fultz

For more information about the Technograph, call 333-3733 and leave your name and number, or write:
Illinois Technograph
Illini Media Co.
57 E. Green St.
Champaign, IL 61820

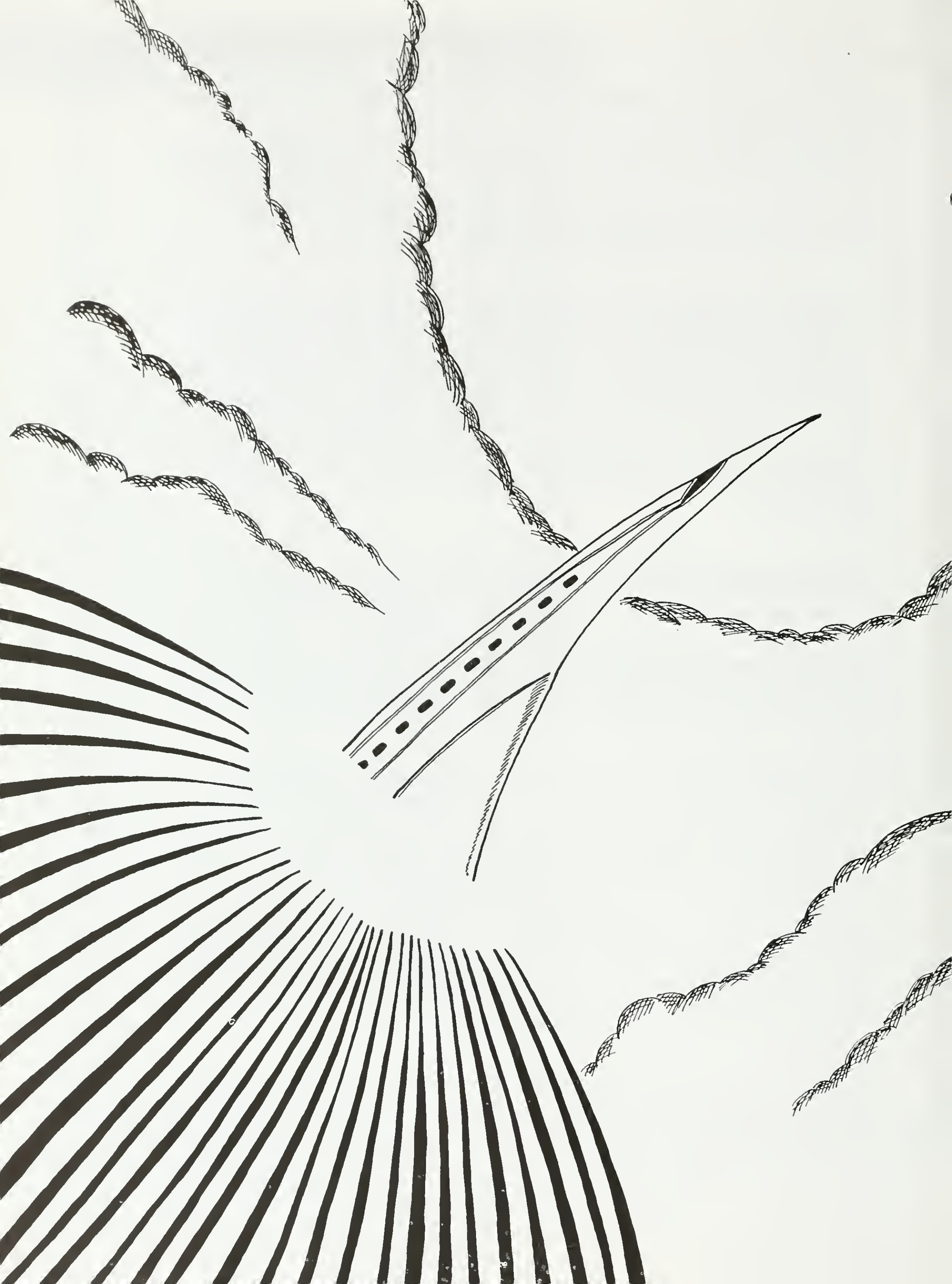
1 Joe college student is failing Professor Bob's class badly. Since Professor Bob is really a nice person at heart, he decides to give Joe a second chance. Professor Bob says, "Joe, I have two sons. The differences of the cube of their ages is a square and the difference of the square of their ages is a cube. Find their ages for me and I will consider passing you in this class." Help Joe find the answer to pass the class.

2 Joe's girlfriend Muffy is also failing Professor Bob's class. Since Professor Bob gave Joe a chance to pass the class, he must also give the same chance to Muffy. Professor Bob says, "Muffy, the number 32,547,891 multiplied by 6 (thereby using all nine digits once and only once) yields 195,287,346 (a number also containing all nine digits. I may pass you in this course if you can find another number to be multiplied by 6 to satisfy the same conditions." Joe will be very depressed if Muffy does not also pass this course; help Muffy find the answer she needs to pass Professor Bob's course.

3 A simple way to shuffle cards is to take the pack face downwards in the left hand and transfer them one by one to the right hand putting the second on top of the first, the third under, the fourth above, etc. until all of the cards are transferred. If you do this with any even number of cards and keep repeating the shuffle in the same way, the cards will eventually return to their original order. How many shuffles are necessary to return a deck of cards (52 cards) to their original order?

4 Four college students, Brian, Liz, Eric and Sheila enter a square field simultaneously at the NE, SE, SW, and NW corners respectively. All the students run at the same speed. Brian has a crush on Liz and chases her. Liz is rather fond of Eric and chases him. Eric admires Sheila and chases her. Sheila finds Brian to be quite interesting and chases him. These college students are not very bright and each always runs directly toward the person they are chasing making no attempt to head their quarry off. Obviously, the students will eventually spiral into the center of the field. If the sides of the field are 200 yards, how far will each person have to run before they all collide in the center?

Thank you for your support of this year's Tech Teasers Contests. Since this is the last issue of the academic year, the tech teasers here are strictly for fun. Look for the return of the contest next year! Answers are on pages 19 & 20.



Ken Smith

National Aerospace Plane

Converting Theories to Reality

The United States program to develop a hypersonic National Aerospace Plane (NASP) is one of the most technologically challenging endeavors the aerospace industry will face in the coming decade. Reaching speeds of 25 times the speed of sound, the NASP is an unprecedented effort to integrate several advanced technologies into a manned vehicle: propulsion, materials, aerothermodynamics, and controls. The NASP is especially attractive because it will be able to takeoff from conventional runways eliminating the need for expensive launch facilities. If successfully deployed, the NASP would accomplish full reusability, demonstrate single-stage-to-orbit (SSTO) capability, and open the space frontier to routine operations.

Previous aerospace development programs have been heavily dependent upon wind tunnel testing to offer design direction and to validate design decisions. Unfortunately, no wind tunnel facility exist today, or in the near future, that can reproduce the flight conditions of the NASP. Consequently, the NASP design is dependent upon an emerging field of fluid mechanics, Computational Fluid Dynamics (CFD). CFD researchers face the formidable task of creating computer codes that can accurately predicting the complex flowfields the NASP will encounter during Mach 25 flight.

Historical perspective

Initial investigations into the development of a SSTO hypersonic vehicle utilizing air-breathing propulsion began in the early 1960's, but were hampered by insufficient computational capacity. Performance evaluations for hypersonic designs were limited to idealized geometries for which empirical data were available. Although this approach yielded estimates of total vehicle forces, the details of the vehicle's flowfield could not be calculated. A thorough knowledge of the vehicle's flowfield is crucial to designing the NASP's air-breathing engines.

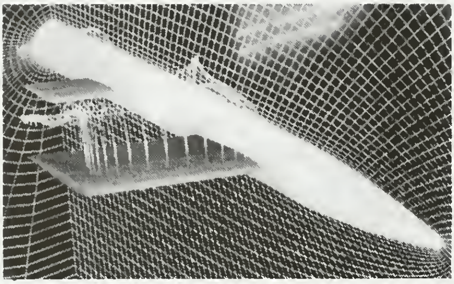
From 1970 through the mid-1980's, advancements in computer resources provided researchers with the tools to develop fundamental hypersonic fluid dynamic algorithms applicable to NASP. The recent explosion in computer speed and memory storage has permitted the incorporation of this early fundamental work into more comprehensive codes.

CFD challenges of the NASP

The solution of fluid dynamics problems are often difficult due to the mathematic complexities involved in simultaneously satisfying all the conservation equations: mass, momentum, energy, and species. Usually the governing equations can be simplified considerably by neglecting insignificant terms. But even in limiting forms, few analytical solutions exist, and then only for theoretical studies that are difficult to apply to practical engineering designs. Computational Fluid Dynamics (CFD) extends the study of fluid mechanics by developing computer codes to satisfy the governing equations. CFD codes for the NASP project are especially challenging due to the physical complexities of hypersonic flight: shock waves, chemical reactions, turbulence, and rarified flow.

When an aerospace vehicle exceeds the speed of sound, a supersonic shock wave forms so that the fluid can rapidly negotiate its way around the vehicle. One example of a shock wave is the sonic boom heard when the Space Shuttle re-enters the atmosphere. Shocks can be thought of as very thin regions in the flow where abrupt changes in the fluid properties (temperature, pressure, etc.) occur. These shocks can be difficult to "capture" within CFD simulations.

At five times the speed of sound or more, hypersonic shocks will be created that radically alter the flow's properties — even the chemistry. For example, immediately downstream of a hypersonic shock, temperatures can exceed 6000 K — sufficiently high to invalidate the ideal gas assumptions. Also, these temperatures encourage the flowfield to chemically react. The energy changes involved with these chemical reactions influence the resulting flowfield and must be included in the CFD analysis.



This graphic, designed in part by Ken Smith, illustrates a theoretical flow field for the Mach 25 spaceplane.

The flowfield over a vehicle is often described by fluid dynamicists as being laminar or turbulent. Laminar flows are stable and can be calculated in a straightforward manner using well-established equations. Turbulent flows are highly unstable and exhibit chaotic behavior. At present, no comprehensive understanding of turbulence exists; therefore, CFD researchers must use complex models to predict the motion of turbulent flows. Turbulent flow modelling is important to NASP designers because of two detrimental characteristics of turbulent flows: increased heat loading on the the vehicle, and increased aerodynamic drag. The design of adequate thermal protection and propulsion systems is dependent on the ability to model the laminar and turbulent flows over the NASP.

Finally, at normal pressures and densities, fluid flows are often treated as being a continuum. The continuum assumption asserts that the fluid molecules are very close together and that a great many molecules are present in any given volume. However, at flight altitudes of 80 kilometers or more, the flow can no longer be considered a continuum, since the NASP will encounter conditions where the atmospheric density is very low and the mean free path between the gas molecules becomes relatively large. These conditions are referred to as the rarified regime and offer distinct CFD challenges because now individual molecules are important. New constitutive relationships for rarified molecular transport processes are now being developed that can better utilize present computational facilities.

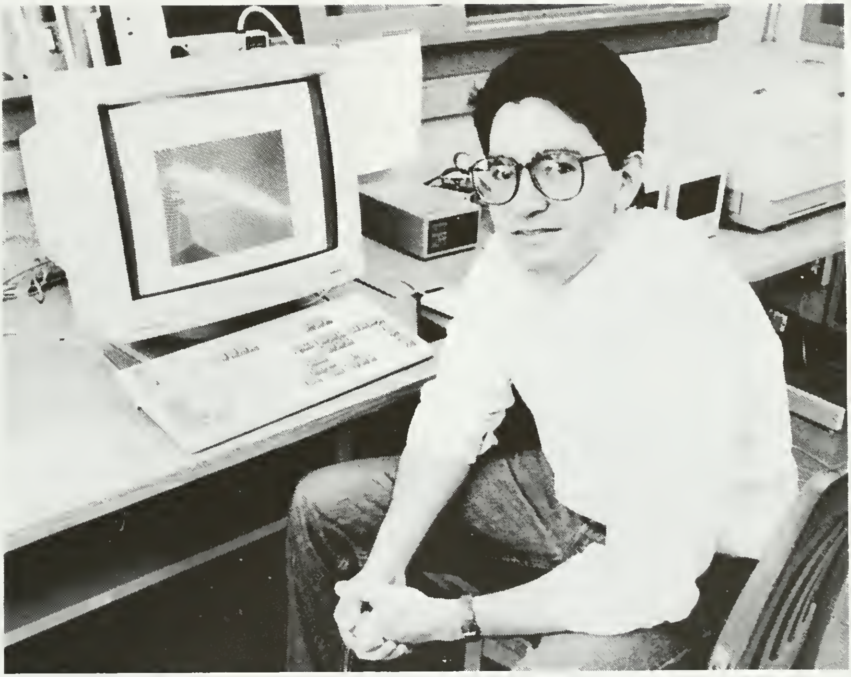
CFD progress

Initial hypersonic CFD results are encouraging. Recently, a three-dimensional solution demonstrated excellent results for a Mach 15 wind tunnel experiment; a comparison that emphasized the importance of simulating the complete tunnel flowfield. Also, a successful unsteady code compared favorably with empirical results for a two-dimensional unsteady supersonic flow. Good agreement between experimental results and computer solutions is crucial to gaining confidence in the CFD simulations.

Research into analyzing the complete vehicle has resulted in a new simulation approach utilizing the concept of a zonal-solution methodology. This supercomputer based concept involves generating a three-dimensional numerical patchwork mesh over the vehicle. The individual patches are then solved simultaneously using CFD codes specific to the flow conditions anticipated within that patch (e.g. boundary layers, inviscid freestream, unsteady, chemical kinetics, etc.). The resulting solution would be much faster and more manageable than a general all-inclusive code.

As aerospace computation models continue to develop, efficient interpretation of the CFD simulation will require advanced graphical visualization techniques. Visualization research being conducted at NASA is concentrated on using high performance graphics workstations to view, and in some cases, to animate these simulations. Connected to a supercomputer via a high-speed channel, these workstations post-process the CFD results into comprehensible three-dimensional images. Future efforts will develop interactive tracking and steering of the supercomputer solution. Tracking allows the scientist to view his/her solution so it can be stopped and restarted at will. Steering goes one step further and allows the scientist to change the parameters of the flow solver as it executes. Examples of steering include increasing the angle of attack during a pull-up and performing a flight maneuver.

The success of the United States National Aerospace Plane (NASP) program is heavily dependent on Computational Fluid Dynamics (CFD) to provide flight predictions at Mach 25 speeds. Assuming continued federal funding and research achievements, the NASP is destined to take a place in history as a tremendous technological achievement for the United States.



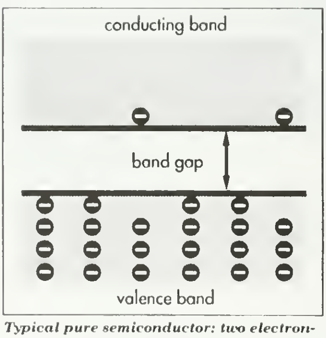
Ken Smith displays the equipment which he used to help him design the NASP flowfields.

EXCITONS IN SEMICONDUCTORS

JOHN W. SHIROKOFF

Created by photoexcited electrons and positively charged "holes" in semiconductors, excitons play a crucial role in the optical properties of semiconductors.

It has long been known from experiment and conventional wisdom that the naked eye cannot physically see electrons in nature but rather just the light given off when they change from one atomic orbital to another. As a consequence we use scientific models to describe the motion of electrons in solid matter. The interaction of light with electrons in solids is of fundamental importance to modern physics, based on the quantum mechanics of many atom systems. In a practical sense, understanding electronic motion is essential to improving the quality of opto-electronic devices and integrated circuits. Experiments involving photon-semiconductor interactions also contribute to the characterization of defects in elemental and compound semiconductor materials.



Typical pure semiconductor: two electron-hole pairs are shown (fig. 1)

First, what are "excitons" and how are they created by light in a crystal? To unravel the inner workings of semiconductor crystals, one must look at the crystal lattice in terms of its electron energy levels. Essentially, electrons in a crystal are distributed among "energy bands" in such a way as to characterize it as metallic, semiconducting, or insulating. In semiconductors at low temperatures the energy bands are either completely empty or full of electrons, and the highest filled energy band is called the "valence band". Also present is a "conduction band", which is normally empty at low temperatures, and is separated from the valence band by an energy referred to as the "band gap". Under these conditions there is little chance of electrical conductivity in a pure semiconductor. However, when some valence electrons are thermally excited up to the conduction band there can be a measurable electrical conductivity. (see fig. 1)

The absorption of a photon by a semiconductor crystal can likewise move an electron from the valence band to the conduction band. This process also leaves an empty state behind in the valence band referred to as a "hole". Once created, the electron in the conduction band and the hole in the valence band, known as an electron-hole pair, can further reduce their total energy by binding together to form an exciton. The exciton binding energy is typically quite low and the weak excitonic bond can easily be broken by thermal vibrations of the crystal even at room temperature. So in order to produce significant numbers of excitons in a semiconductor crystal, the solid must be cooled a few tens of Kelvin.

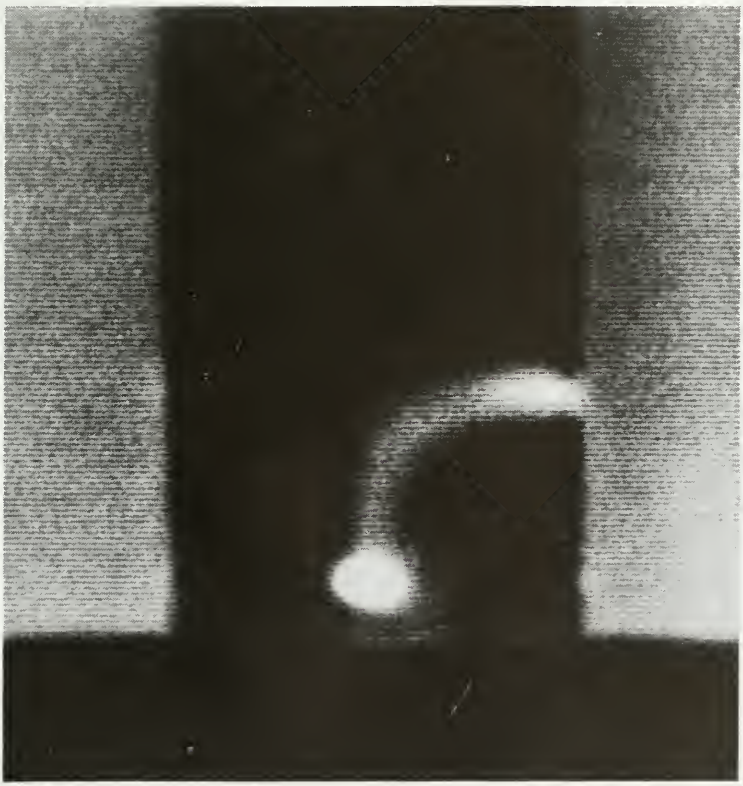
How can excitons be detected in a semiconductor crystal? Excitonic energy levels can be determined by measuring the spectrum of light transmitted through a semiconductor crystal or reflected off its surface. Information about excitons can also be obtained from the light (i.e., luminescence) they emit when the electron falls back into the hole. The lifetime for such a process is in the range of milliseconds to nanoseconds. This luminescence light can be used to determine the energy distribution of a collection of excitons, the condensation of excitons into more complex particles ("excitonic matter"), and the diffusion or mobility of excitons.

At the University of Illinois at Urbana-Champaign, research programs involving excitons in semiconductor materials can be found in both the Physics department under the direction of Professor J.P. Wolfe and the Electrical and Computer Engineering (ECE) department by Professors N. Holonyak Jr. and G.E. Stillman. Professor Wolfe's group is currently engaged in performing condensation and diffusion type experiments in semiconductors and semiconducting quantum wells, which are produced by Professor Morkoc in ECE by growing the crystals atomic layer by atomic layer (see below). Professor Stillman's group has an interest in further developing light detectors by measuring the photoluminescence of bound excitons (i.e., bound to impurities) in bulk and quantum well devices, and Professor Holonyak's group is mainly studying these materials for use as light emitters in optoelectronic applications. These groups are supported by the National Science Foundation, Department of Energy, and the Department of Defense.

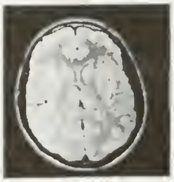
As described earlier, a compound semiconductor such as GaAs can emit light by the recombination of electrons and holes. Now if a very thin layer of GaAs were sandwiched between two layers of AlGaAs, photoexcited carriers (i.e., electrons and holes) are trapped in the GaAs layer, which forms a "2-dimensional" quantum well. Furthermore, the principal luminescence that comes from a quantum well structure is from excitons. The confinement to 2 dimensions enhances the luminescent intensity of excitons in GaAs. This is because the exciton confined to a 2-dimensional quantum well has a greater binding energy than it would in the bulk crystal. This allows the excitons to be observed even at room temperature, whereas in the bulk crystal, the weakly bound excitons are largely dissociated at room temperature.

One of the unique types of experiments performed at the University of Illinois is spatial imaging of the exciton motion. Professor Wolfe's group has developed techniques for measuring the "diffusion" of excitons in a quantum well; this is accomplished by using lasers with extremely short pulse duration and focused to micrometer spots onto the GaAs quantum well. The exciton diffusion rate depends on the temperature of the crystal and the power of the exciting laser.

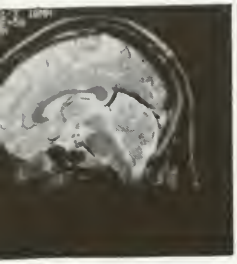
The motion of excitons was graphically demonstrated a few years ago in Professor Wolfe's laboratory, using a single crystal which was stressed to produce a region of low band gap energy to which the excitons are attracted. The accompanying photograph shows the exciton drift from their creation point on the left surface of the crystal to a "strain maximum" just below the top surface of the crystal. Further information about these kind of experiments may be found in the March 1984 issue of **Scientific American**.

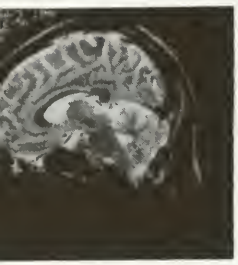


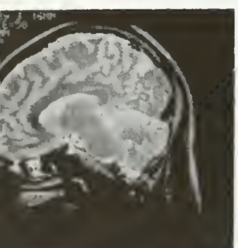
An exciton is observed in a quantum well.

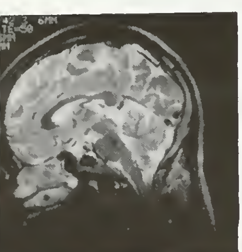


Magnetic Resonance Imaging









scan images coutesy of DIAGNOSTICS/ PENINSULA IMAGING

Magnetic resonance imaging, a technology developed mostly during the past decade, is a field exploding with opportunities. The process, which uses strong magnetic fields to examine internal structures and chemical compositions, has a myriad of uses in physics, psychology, medicine, and many other fields. The University of Illinois is playing an important part in the development of this new technology which may yet have unforeseen benefits.

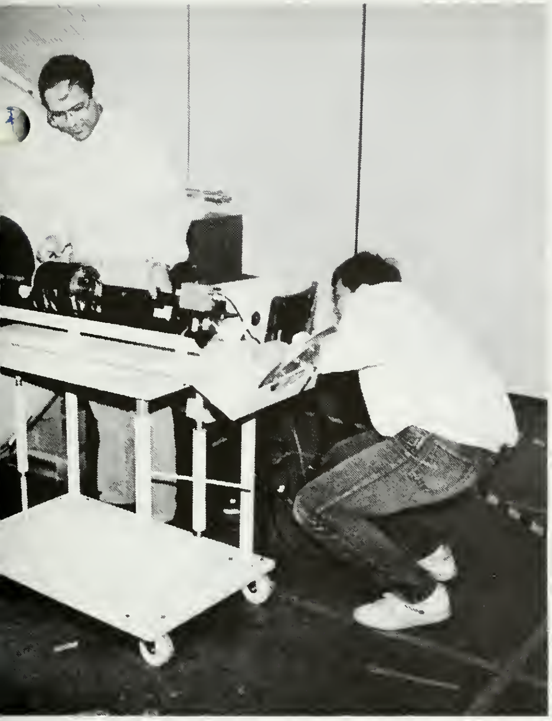
The University's current center of study is located at the Biomedical Magnetic Resonance Laboratory (BMRL) on Park Street. Professor Paul Lauterbur heads the institute's research facilities.

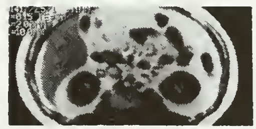
A major emphasis in medical research going on currently at the laboratory includes new applications of magnetic resonance in the field of neurobiology. The facility is also developing techniques for microscopic imaging, in which single cells may be imaged and examined. Other research areas include improving measurements of blood flow in tissues, measuring the local chemical composition of tissues, and developing new kinds of magnetic labelling.

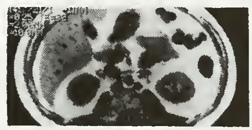
Because of the size of the imager, research is currently constricted to small animals (usually mice). However, the future looks much brighter. On March 22, a ceremony at Beckman announced a $10.6 million federal grant from the National Science Foundation and a $900,000 grant from the State of Illinois. A portion of these grants will go directly towards purchasing the world's most advanced magnetic medical imaging machine. The 4 Tesla device will be installed in the basement of Beckman, and will be used for medical imaging for humans as well as research on a grander scale than that going on at the BMRL.

The magnets for the imaging device, about three times more powerful than those typically used in hospital imaging equipment, will be built by the Texas Accelerator Center, which is also responsible for mighty supercollider project in Texas. Professor Lauterbur, highly involved with this project, is also exploring the possibility of building a 10 Tesla human imaging machine.

above: A sample is prepared to be scanned by the magnetic resonance imaging equipment. right: The computer which is used to run and process the scans is shown. far right: A BMRL staff member makes repairs on equipment.

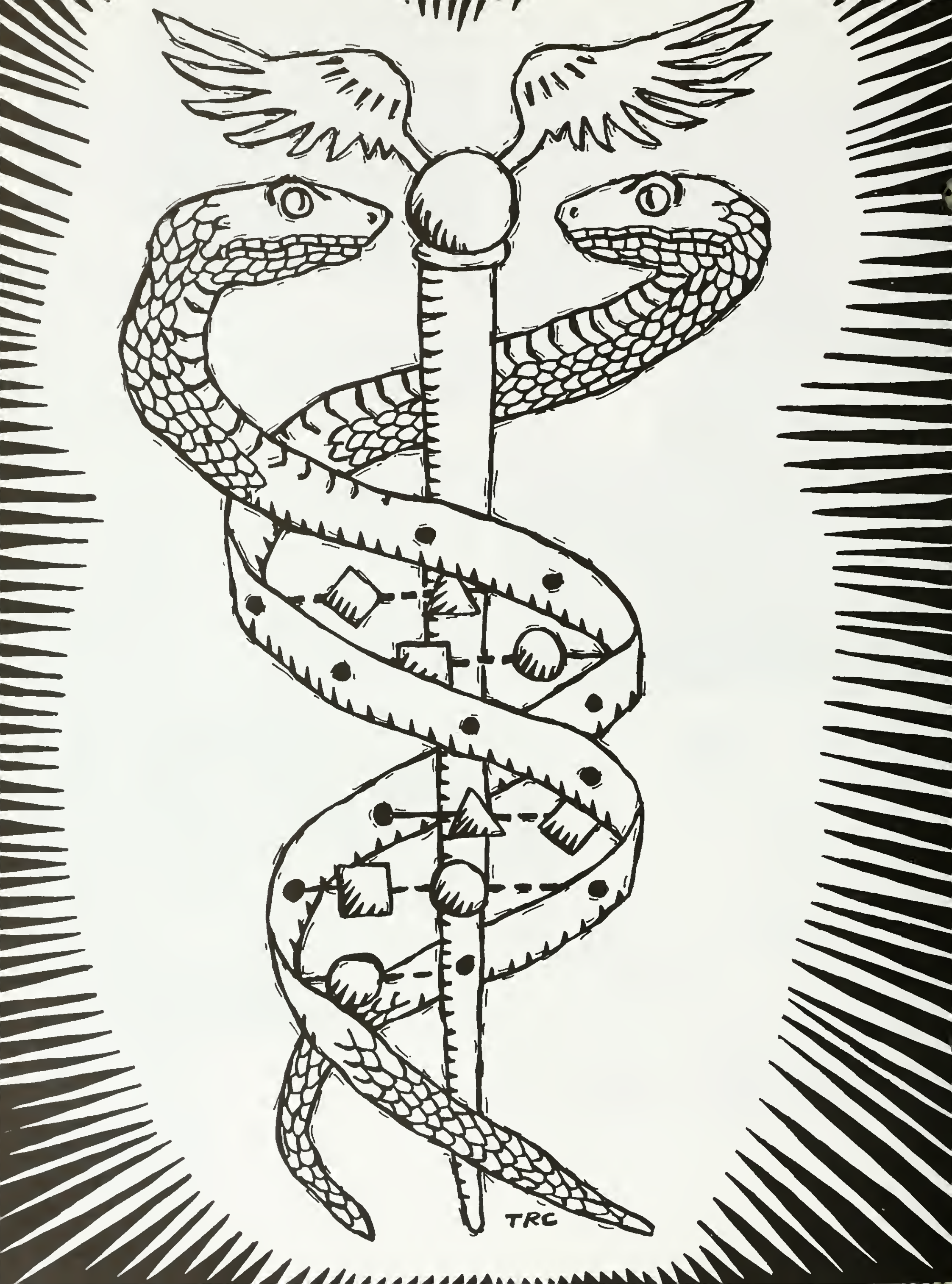






TECH VISIONS

photos by Jim Peroulas


TRC

ethics in GENETICS

why should scientists be concerned?

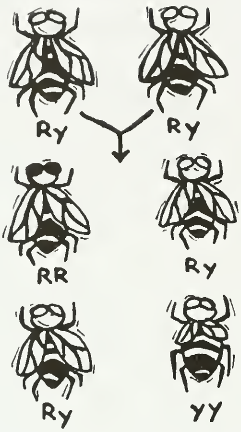
KARA FEDERMEIER

The Webster's New World dictionary defines science as "the systematized knowledge of nature and the physical world." As knowledge-seekers, scientists push back the boundaries of the unknown. By doing so, scientists not only allow humans to know more; they also allow humans to do more. It is this, aspect of science that often creates technological and moral tangles that are difficult, if not impossible, to unravel. Recent publicity for the Human Genome project, designed to completely map human gene patterns and to discover the function of each of these genes has brought to light some of the social difficulties genetic research is creating. The technologies associated with genetics research have left in their wake a whole realm of technological possibilities which the current legal, political, and moral systems of this country are not yet prepared to handle. It is important to confront these ethical issues before they present major problems in society.

A basic knowledge of genetics is necessary to fully understand the issues at hand. In brief, genes are the biological units responsible for the transmission of hereditary (determined at conception) traits. Genes are codes for polypeptide chains, proteins, and enzymes, which are the fundamental parts of biological systems. Genes usually occur in pairs (an organism usually inheriting one gene from each parent), and gene expression (how a particular gene influences a particular organism) depends, in part, upon the dominance or recessiveness of the genes in a gene pair. A dominant gene is almost always expressed; a recessive gene is expressed when no dominant genes for the same trait are present. Of course, this explanation is highly simplified, since blending a combination of genetic traits and regulation by hormones play an important role in determining how genes will be expressed in an organism. What is most important to recognize, however, is that specific genes influence specific aspects of the organism; these genes are, in turn, influenced by other biological features around them. Variations in a population occur, in part, because of differences in genetic makeups. Genetic differences often occur through mutations, changes in the chemical makeup of a gene, which can cause biological changes in the organism; such changes range from helpful to unimportant to lethal. Scientists now have the power to regulate gene flow in a population and even to chemically alter genes to create "man-made mutations." It is this technology, both advantageous and frightening, that confronts society today.

Perhaps the first genetics-related technology to confront American society was sperm donation. This process allows women with infertile husbands to conceive and carry a child through fertilization by a donor's sperm. Immediately, religious problems surfaced; members of religious groups who believe that procreation should be a natural process immediately opposed the idea, and the religious issue remains important for all the genetic technologies discussed in this article. Whether genetics technologies are "moral" from a religious standpoint remains a hotly debated issue — one that does not show signs of being resolved. But sperm donation has created legal, as well as ethical, problems such as the definition of "parent" in sperm donation cases, and the rights and/or responsibilities of the donor father and the husband of the natural mother. The present legal system does not yet have the definitions and guidelines to deal with the new concept of "father" and "mother" that genetic technology is creating.

These problems become more pronounced when another technology, that of the surrogate mother, is examined. In sperm donation, the identity of the donor can be kept from the receiver, and vice versa, so the chances of a sperm donor breaking a contract and claiming the child as his own are very slim. This is obviously not the case with surrogate motherhood. When the gestational mother is different from the "legal" mother, serious legal and religious questions can result regardless of whether or not the "legal" mother was also the donor of the egg. Questions arise such as "Should the surrogate mother be allowed to back out of the contract?", "What if the child is deformed?", "What if the surrogate mother damages the fetus during pregnancy by careless health habits", and "Should the surrogate mother be paid?" Visitation rights, complicated even for adoption, are extremely difficult to deal with in surrogate mother cases. Should the child have the right to know who his/her surrogate mother was? If egg donation is involved should the child have access to medical information about his/her surrogate mother? None of these issues has been resolved, and some have hardly been examined, yet surrogate motherhood is a technology becoming more widely used in America and abroad.



A final example is the newly developing ex utero reproduction techniques. Such techniques would allow for the development of a fetus in an artificial uterine environment for all or part of its gestation period. This idea and its implications shock even some of the less religious groups in society. Legally, the products of such technology would create problems of tremendous proportions. Not only would the concept of parents have to be redefined, but the concept of citizenship would have to be re-examined as well. What would be such a child's country of birth? Lesser problems of inheritance and marriage (defining the relatives of a child born by ex utero reproduction) arise as well. Scientific questions such as how parental bonding and the resulting mental health of the child would be affected have yet to be examined. When and where such procedures could be utilized, as well as what responsibilities society has for such children, brings humankind to the verge of a total redefinition of life and reproduction. All of mankind's "facts" about family and parenthood are being challenged by new technologies which are on the verge of being widely available and which create problems never before encountered in the history of humanity.

These are only the beginning. Such technologies put society on the verge of selective breeding and raise additional social and moral questions. Is it right to artificially manufacture a child? How will such procedures affect the human gene pool? Can such practice lead to the buying and selling of life — or at least the stuff life is made of? Who has a right to information about the genetic background and make-up of an individual?

The questions that genetic technologies raise pose a serious challenge to the structure of human society. Genetic technologies exist and will continue to develop. There is no turning back. And many don't want to turn back because these technologies, in spite of all the problems they present, offer infertile or genetically disadvantaged parents the chance to have normal children. They seem to offer everyone a chance at a healthier and, perhaps, more advantageous life. The problem is, how far and in what direction should these technologies be allowed to grow? It is this question that scientists and non-scientists alike must be prepared to address in the coming years.

Mark Maslov

TECH PROFILE

Professor Burks Oakley

Professor Burks Oakley is a faculty member in Electrical and Computer Engineering and specializes in Bioengineering. "Bioengineering is a broad field", says Oakley, "which can involve just about anything an engineer does." He explains, "Someone involved with fluid dynamics might study blood flow, while someone in engineering mechanics might study bone stresses." Professor Oakley's interest in bioengineering is really just an extension of electrical engineering. in particular, he is interested in how electrical signals flow through the nervous system.

Professor Oakley received a B.S. in Chemical Engineering from Northwestern University in 1971. While there, he became interested in bioengineering, and he went to Michigan for graduate school where he received an M.S. in 1973 and a Ph.D. in 1975 in that field. Professor Oakley went on the University of California at San Francisco to study physiology for three years to get a better background in biology. He then came back to the Midwest to work at Purdue for two years before becoming an assistant professor in the Electrical Engineering Dept. here at the University of Illinois in 1981.

For about the last five years, Professor Oakley has taught ECE 270, an introductory circuit analysis course. He says he enjoys teaching a lot of students, and, with an average of 300 students per class, ECE 270 is the largest class in the department. He likes making a contribution to undergraduate education by helping so many students get a basic ECE (electrical and computer engineering) background. He claims, "It is important for students to get off on the right foot with introductory courses."

A project Professor Oakley has been working on that relates to ECE 270 is computer-aided instruction. Oakley says that, due to the abundance of computers on campus, this is an ideal way to enhance education. So Oakley has been developing a software package that he hopes will be published for sale with the ECE 270 textbook. Undergraduate students have been helping him with the software. "It's been a lot of fun getting undergraduate students working closely with it. I'm really excited about it," he remarks.

In addition, Oakley is developing an experimental course, ECE 271, which is a combination of ECE 244, and introductory circuits lab course, and ECE 270. Oakley feels that a lab course in conjunction with a theory course gives students a better chance to apply what they learn.

Professor Oakley is currently conducting research on electrical signals produced by the retina. He is researching how the signals are produced and is characterizing signals for different conditions. He is presently working with animal models using electroretinograms, or ERG's, to measure electric signals. The goal of his research is to study how the signals can be measured, how the components of the signals can be analyzed, and what cells in the retina produce the components. Professor Oakley is anticipating that understanding this phenomenon will give insight on some visual disorders.

Professor Oakley is involved in several organizations which give him an opportunity to participate actively and give input on student problems. He serves on the Education Technologies Board which pushes to get more computers in education and develops computer-based education; and has also represented the ECE department the last four years on the University Senate. The University Senate sets policies for campus through committees, and Professor Oakley is the Chairman of the University Student Life Committee. This committee considers campus-wide issues such as alcohol abuse and racial problems. Recently the committee discussed the possibility of requiring a course in cultural diversity. For his involvement in these organizations, Professor Oakley has been honored with the 1991 Pierce Award. He reflects, "It's nice that students think so highly of what I've been doing that I get something like this."

Professor Oakley has a wife and two daughters. He says his daughters keep him busy with their sports activities. In his spare time, he likes to swim and he is also interested in computers. He and his family designed the floor plan of the house, in which they are currently living, on an Apple Macintosh. Professor Oakley certainly has a wide range of interests and takes the opportunity to actively pursue them.

A National Energy Strategy? It's up to you.

Steve Vavrik

The National Energy Strategy unveiled today by President Bush is a grab bag of missed opportunities and misplaced priorities. It's a national energy tragedy designed by the oil and nuclear industries and their allies in the White House.
–Howard Ris, Jr., Executive Director of the Union of Concerned Scientists

On February 20, the Bush Administration released the National Energy Strategy (NES). What was once eagerly awaited as a watershed policy proposal stressing energy efficiency focused rather on energy production options much to the anger of environmental and conservation groups. The NES has been introduced to legislation in the energy bill (S.341) proposed by Sen. Bennett Johnston and will undoubtedly face much debate and revision. But one conclusion is already obvious: the NES lacks any serious commitment to energy efficiency and renewable sources.

The main points of the NES concern energy production. To increase national oil reserves, the strategy suggests opening the Arctic National Wildlife Refuge (ANWR) and the Outer Continental Shelf (OCS) to drilling operations. In the transportation sector, commercial vehicle fleets will be encouraged to switch to non-gasoline hydrocarbon fuels. And in power generation, the strategy proposes streamlining the current nuclear power licensing process to a single-license procedure, mostly by reducing the number of public hearings required when construction of a reactor is complete.

What is notably absent from the NES is a call for conservation. No recommendations for increased efficiency or renewable energy measures, no increases in funds for alternative energy R&D, and no programs for science education are present. In his State of the Union address, President Bush spoke of "a comprehensive national energy strategy that calls for energy conservation and efficiency, increased development and greater use of alternate fuels." What happened in between this message and the NES?

Power of the Market

Since mid-1989 the Dept. of Energy has been developing a framework for a comprehensive energy strategy. They gathered recommendations and suggestions from 18 public hearings and solicited comments from various related groups and agencies. During the process, one message stood clear: conservation was regarded as the preferred energy option. "It was interesting for me to discover that the strongest single message that emerged from our pulse-taking for the national energy strategy was the need for increased energy efficiency. This is the case, I think, not just because energy efficiency is good for the environment, but just as importantly because it makes economic sense," commented Energy Secretary James Watkins on June 14, 1990. It looked as if all parties had agreed on efficiency as the foundation for the proposal.

But heavy fire came from the White House. Led by chief of staff John Sununu, budget director Richard Darman, and chief economic advisor Michael Boskin, the opposition contended energy efficiency measures and renewable energy initiatives constituted unacceptable government interference in the free market. Leave it to market-driven energy prices to create incentives to conserve as regulations or taxes would create inefficiencies and slow economic growth.[1]

True, the use of tax incentives and regulations to encourage and reward conservation alters the energy market. But do the present market parameters accurately reflect such externalities as environmental effects? The recent U.S. - Exxon record settlement sets a precedent for including environmental obligations in corporate/industrial responsibilities, but are disasters of the same magnitude as the Valdez spill necessary to impel such actions?

The Current NES

Regardless of market implications, the recommendations in S.341 should be reviewed. Do they match present energy requirements and form the building blocks for a long-term, sensible national energy plan? How would the opening of the ANWR and OCS specifically benefit the national energy condition? Federal government figures estimate 6.1 billion barrels of oil equivalent, approximately 3.2% of the nation's total reserves (187 billion barrels), lie within the ANWR and the OCS outside the central and western Gulf of Mexico.[2] Once obtained, these resources could only supply a small amount of the total future U.S. oil consumption. According the the U.S. Geological Survey, even if all such protected lands were opened, drilled, and exploited to full capacity, it would only supply about one year's worth of oil based on the current consumption rate. Natural Resources Defence Council attorney Ralph Cavanagh states, "We would wait seven to ten years for the first deliveries, and they emphatically would not be cheap...The drilling strategy offers at best a temporary dribble of expensive oil, helping to prolong an addiction that ultimately can be sustained only through steady increasing Persian Gulf imports."[3]

The effects of a drilling operation extend beyond the drilling site. The Dept. of Interior estimates 22 to 46 major oil spills would occur if the current OCS Five-Year Plan is continued. According to the National Academy of Sciences, drilling a single well produces 1500-2000 tons of drilling muds and cutting, much of it contaminated. The waste water from the drilling operation, contaminated by oil, grease, cadmium, benzene, lead, and other toxic organics and metals, is routinely discharged back to the surrounding well environment. In the case of the Arctic National Wildlife Refuge, the surrounding is a South Carolina-sized area of pristine wilderness. One of the world's largest strongholds for arctic wildlife, the ANWR is home to the 165,000-member Porcupine caribou herd, which shares the refuge with polar bears, grizzlies, wolves, musk oxen, and millions of migratory waterfowl and other birds.[4]

Alternatives

Fine. More oil drilling is not the ultimate solution, but are there any other attainable options? Yes, in energy efficiency. "Increases in oil costs can only be mitigated by increases in energy efficiency," says NRDC energy analyst David Goldstein. Transportation accounts for 60% of the nation's oil consumption, relies on oil for 97% of its energy requirements, and is one of the areas where efficiency measures can most readily be implemented. An increase in automobile fuel economy standards to 40 mpg could save as much as 8 to 9 billion barrels of oil by 2010. In contrast to positions by the U.S. auto industry, foreign manufactures such as Renault and Volvo have responded by creating cars with city efficiency ratings at 63 to 100 mpg, highway ratings at 81 to 146 mpg![5] In addition, carpooling and increased use of mass transit could dramatically reduce fuel consumption. Off road, home energy efficiency can be improved by fully insulating exterior walls, replacing single paned windows by multipaned insulated ones, and using compact fluorescent light bulbs which require 25% of the energy while lasting nine times longer as compared to conventional incandescent bulbs.

Improved efficiency measures can also be applied to other areas. Home appliances such as refrigerators, washers, and water heaters can have efficiency standards similar to automobiles, and some public utilities are now promoting efficiency through programs and projects. Finally, support for research and development for energy efficiency, renewable energy, and transportation alternatives should not only be continued but expanded.

Your opportunities

These policies are, of course, of national scope, and the role of the individual, let alone the typical student, seems negligible. But the individual level is where many policy programs originate and take root. Instead of driving, walk, bike, or use the MTD to get to class or across town. Recycle cans, cardboard, and glass. Use canvas or net bags rather than paper. By recycling and reusing, you eliminate the demand for the energy and resources required to replace the product. Compact fluorescent light bulbs, although relatively expensive (about $16), make creative and thoughtful gifts. Also, low flow water nozzles on your shower and sinks conserve water and reduce the energy your water heater will require.

Get involved in community groups. Volunteer some time at your local recycling center. Or, if your community does not have a center, look into what it would take to start a group. At your summer job or new career, inquire about what your company/firm is doing to conserve and investigate other efficiency options that could be implemented. Many organizations offer "rewards" for cost-saving ideas by returning to you a percentage of the actual total savings. Talk to others and inform them about efficiency measures. Consider a career in developing and manufacturing energy efficient and renewable energy technologies — the work would most certainly be exciting and quite rewarding.

Conclusion

Above all, examine the controversies surround the NES and the energy legislation debates that will certainly follow. Both emotional pleas and bottom line calculations will be widely used tools of persuasion in these argument. Should we sacrifice natural resources in order to feed a huge energy appetite? Should we let supply and demand reach equilibrium without guidance? How do we accurately evaluate the need, price, and environmental consequences of each option?

Central to the NES debate are the roles in terms of magnitude and direction of energy production and conservation. For the first time, energy conservation is being supported for reasons other than market forces. The integration of conservation *for the sense of conservation* into federal policy discussions is a milestone event. Oil leaders are not playing supply games. Rather, U.S. scientists, engineers, policymakers, and citizens are the ones promoting conservation as the better option.

Over the past two decades, conservation and environmental awareness has increasingly diffused into the mainstream attitudes to the extent that it has finally penetrated national policy construction as a legitimate consideration. The focus of global policy-making is shifting from security to environmental concerns, and a new era is beginning. As college students, we are in extraordinary positions. Standing on the fringe of this new period while surveying various career paths, we not only take to our careers and lifestyles these transferred attitudes, we carry the responsibilities of successfully implementing these attitudes, ensuring their further expansion and development, and delivering them to the next generations.

Steve Vavrik is a graduate student in mechanical engineering and newsletter editor for the Society of Scientists for the Environment.

---

[1] "Admiral Watkins's leaking energy policy," The Economist, 23 February 1991 p. 30.

[2] Dwight Holing, "America's Energy Plan: Missing in Action," The Amicus Journal (National Resources Defense Council) 13 (Winter 1991): 14.

[3] Ibid.

[4] Ibid., pp. 15-17.

[5] Ibid., pp 18-19.

1. There were several answers to the problem. The winning answer was as follows:

$$\frac{\tan\left(\frac{5\pi}{14 + (5 + 5) \times \cos\pi}\right)}{5 + 3\cos\pi} = \frac{1}{2}$$

The winning answer was submitted by Ken Smith, a graduate student in Mechanical Engineering.

2. The area of the smallest triangle is

$$1000 + \frac{1750}{\sqrt{3}}$$

or approximately 2010.36

Congratulations to Robert E. Miller, Professor of Theoretical and Applied Mechanics.

3. In order that a number be expressible as the sum of two squares, it must be a composite of the form 4n+1 which is prime. For example, (5x13x17x29) can be made into 8 different groups of two squares. The smallest number that can be expressed as the sum of two squares in twelve different ways is 160,225 (5x5x13x17x29)

Daniel Lewart, Graduate Research Assistant in Physics, was the only one to submit the correct answer.

this issue's TechTeaser solutions

1. The ages of Professor Bob's children are 6 and 10.

2. Muffy has three possible answers to choose from:

$$\begin{array}{r} 94{,}867{,}312 \\ \times\ 6 \\ \hline 569{,}143{,}872 \end{array} \qquad \begin{array}{r} 89{,}745{,}321 \\ \times\ 6 \\ \hline 538{,}471{,}926 \end{array} \qquad \begin{array}{r} 98{,}745{,}231 \\ \times\ 6 \\ \hline 592{,}471{,}386 \end{array}$$

3. Twelve shuffles are necessary.

4. Each person will travel 200 yards.

Technograph is expanding and we need your help!!

The Technograph is seeking editors for next year to cover an expanding workload. Editors will be responsible for departments or columns. Applicants should have initiative, know how to work with people, and have leadership ability. Previous editorial experience is preferred but not required. Call 333-3733 (Illini Media office), and leave your name and phone number if you are interested.