APS NEWS

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INSIDE:
PHYSICS NEWS IN 2001

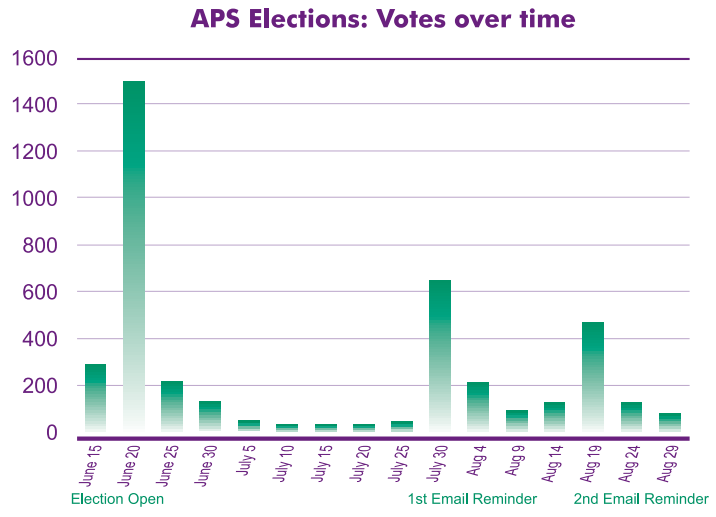
Electronic Reminders Help Boost Membership, Voting Rates

APS membership for fiscal year 2002 is up by almost 500 members compared to the same time last year. An end-of-year count shows that the total number of members now stands at 42,007, compared to 41,570 in fiscal year 2001. Trish Lettieri, APS Director of Membership, attributes the increase in part to a series of electronic renewal notices that are sent out to current members during their renewal cycle, and followed up by personal phone calls to any members who don't renew. A special half price membership offer, available to new APS members and valid through this month, also helped boost membership totals.

Lettieri reports that there was also no noticeable downward trend in renewal rates in the aftermath of the September 11th terrorist attacks in New York and Washington, DC, and that the increase is mostly due to higher retention rates for existing members. "The number of new members coming in stayed roughly the same this year," she says. "We seem to be doing better at retaining members once they join," something she ascribes to "increased communication with members and a great membership staff who are eager to respond to member inquiries."

Electronic reminder notices also proved useful in boosting the number of ballots cast in the annual APS general election. The 2001 election marked the first time the Society offered the option of online voting, and APS members showed an overwhelming preference for that option. Only 13.2% of the total ballots cast last year were in the traditional paper format, with 86.8% being cast electronically.

More importantly, the 2001 election halted a three-year trend of declining voter participation. Survey and Ballot Systems, Inc., which handles the election process, reported that response was up 24% over last year, with 23.4% of the APS membership voting, compared to 18.9% in 2000. A breakdown of votes cast from June 15th through August shows sharp spikes coinciding with electronic reminder notices sent to the entire membership, clearly demonstrating the effectiveness of the practice.



Hurricane Physics, Biofluid Mechanics Highlight 2001 DFD Meeting

The latest research results in biofluid mechanics, hurricane physics and particle simulation flows were among the papers featured at the annual meeting of the APS Division of Fluid Dynamics, held November 18- 20, 2001, in San Diego, California. The technical program featured eight invited lectures and four mini-symposia on cutting-edge research topics in fluid dynamics, as well as more than 950 contributed abstracts and the annual Gallery of Fluid Motion.

Physics of Hurricanes

Understanding the physics of the air/sea interface is a critical component of understanding hurricanes, which draw their energy from the thermodynamic disequilibrium that ordinarily exists between the tropical oceans and the atmosphere. The maximum wind velocity depends on maintaining a sensitive balance between the production of mechanical energy and frictional dissipation in the atmospheric boundary layer, which in turn depends on the fluxes of momentum and enthalpy through the sea surface. Yet little is know about such fluxes at extreme wind speeds. Kerry Emanuel of the Massachusetts Institute of Technology described recent laboratory experiments designed to better quantify flux wind speed relations and to explore possible control of

See DFD MEETING on page 5

Biophysics Workshop Planned for Fall 2002

The APS, together with its Division of Biological Physics, is organizing a topical conference entitled "Opportunities in Biology for Physicists," to be held September 27-29 2002 in Boston, Massachusetts. The conference is aimed primarily at graduate students and postdocs who are considering moving their areas of research concentration to biological topics, not at those who already work in the field of biological physics or biophysics.

Attendance will be limited to about 250 participants. Unlike the Society's more traditional meetings, this conference is not intended to be a place where scientists present their own new research. Rather, leading physicists and biologists will be asked to give broad overviews of their selected areas of expertise at the interface between physics and biology. There will also be lectures offering practical advice on how to move from physics into the physics-biology interface, and an afternoon reception for those who fund biological physics research and those who hire biological physicists to meet with the participants and to display posters or set up booths.

Five topics have been selected for emphasis: genomics and evolution, biological networks, biomolecular dynamics, high-resolution imaging of living cells, and physical devices for biological investigation. Each of these topics is an area that offers significant opportunities for the techniques and problem-solving skills of physicists.

"We hope that this workshop will help introduce young physicists to the great opportunities that exist in modern biology, and catalyze the enrichment that modern biology can bring to physics," said Robert Austin (Princeton University), who is chairing the program committee

See BIOPHYSICS *on page 7*

INSIDE THE BELTWAY: *A Washington Analysis*

European Evolution May Challenge American Science

By Michael S. Lubell, APS Director of Public Affairs

Whether the Antiballistic Missile Defense Treaty is a relic of the Cold War, as its critics charge, or a pillar of international security, as its defenders claim, President Bush, with one stroke of his pen, has ensured that it will be nothing more than an artifact of history when the United States unilaterally withdraws from the pact this spring.

To date, the debate over the Bush decision has focused heavily on the consequences for nuclear non-proliferation and arms races throughout the world. That may be appropriate for the near term, but in the long term the greater impact could well be on economic and geopolitical realignment. And that could have a profound effect on international science.

Early into the Bush Administration, White House decisions on biological weapons, the Kyoto protocols, International Monetary Fund policies, and a host of less visible foreign affairs and defense stances had most of the world convinced that the US was on an isolationist binge.

The September 11 attacks on the Twin Towers and the Pentagon temporarily altered both the perception and the reality. But suspicion of American policies remains strong, in Europe and Russia, as well as in the Islamic world.

Several weeks ago, I had the opportunity to meet Vladimir Pozner, a Moscow TV news celebrity well known for his live people-to-people talk shows with Phil Donahue during the Gorbachev era. His views on how the September 11 attacks have reshaped Russian attitudes are worth considering.

For most of its history, Pozner argues, Russia straddled the Euro-Asian divide, striking a staunchly independent course, one that was neither European nor Asian in outlook. Russian cultural and political unilateralism reached its height during the hegemony of the Soviet Union.

The collapse of Communism and the disintegration of the USSR jolted the Russian psyche and led to a reexamination of Russia's geographic identity. The 1990's, Pozner says, produced a strong Western tilt. But Western, he cautions, does not mean American.

Russia, according to Pozner, was well primed to come to the aid of the US in combatting Islamic

See BELTWAY *on page 3*

Carrying the Torch

Alicia Chang

Francis Slakey, the APS associate director of public affairs, wields his Olympic torch with pride on the steps of the US Capitol in Washington, D.C. The torch reached the DC area on December 21st before continuing on to Philadelphia on its way to its ultimate destination of Salt Lake City.

Highlights

Members in the Media

" It's relatively unlikely that bin Laden actually acquired a crude nuclear weapon, or even significant amounts of weapons- grade fissile material, but that is not a set of circumstances that engenders either confidence or complacency."
—Roger Hagengruber, Sandia National Laboratories, National Journal, December 15, 2001

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Two quotes from National Public Radio's Talk of the Nation/ Science Friday with Ira Flatow, December 14, 2001:

"We're in the midst of a scientific revolution, a major paradigm shift that corresponds to a transition from an age of reductionism —that is, that one can really find a simple description of everything— to an age of emergence."
—David Pines, Los Alamos

"We believe in the importance and the value of reductionism. It's led to many insights over the years, and we have many questions that we're trying to answer right now."
—Chris Quigg, FermiLab

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"It came as a surprise to me that this was even possible. Even leaving aside the many possible side-applications, the physics and engineering here are a very important achievement."
—Atac Imamoglu, University of California, Santa Barbara, on devices that use single photons to transmit information, UPI, December 13, 2001

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"We're about 85 to 90 percent water. So what happens is when you try to freeze a biological organism, all that water turns into ice, and since ice is 10 percent less dense than water, everything expands by 10 percent and you essentially kill the organism. But if you can make glassy water, glassy water has the same density as liquid water. You have a chance of preserving an organism without this big density change that destroys it."
—Dennis D. Klug, National Research Council of Canada, on new results about when supercooled water becomes glassy, UPI, December 13, 2001

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"I'm totally confused. Either we're supposed to compete naked with all the other people who are dressed — that is, have their infrastructure and their salaries supported — or we're not."
—Irwin Shapiro, Harvard Smithsonian Observatory, on the implications of the Bush Administration's plan to shift funding of the observatory to the NSF, New York Times, December 11, 2001

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"…a radical and imprudent departure from the current rule . . . and inconsistent with Congress's mandate."
—Victor Gilinsky, former member of the Nuclear Regulatory Commission, on the Department of Energy's proposed new rules for long-term storage of nuclear waste, New York Times, December 11, 2001

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"We don't have the full story of large-scale gravity. It's imperative that we poke with every stick we have into the details of the gravitational interaction."
—Thomas W. Murphy, University of Washington, on plans to measure the earth-moon distance to 1/25 inch, AP, December 10, 2001

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"It's not spooky, it's just counterintuitive. It's difficult to conceptualize because it's so rare that you ever interact in everyday life with these kinds of quantum effects."
—David Awschalom, University of California, Santa Barbara, on progress toward building a quantum computer, San Francisco Chronicle, December 10, 2001

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"It's definitely the strangest experimental finding since I've been in physics.It's an extremely uncomfortable result."
—Edward Witten, Institute for Advanced Study, on the fact of an accelerating universe, New York Times, January 2, 2002

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"I would say I'm responsible for the mistake. My collaborator did most of the work, but I am equally guilty of making mistakes."
—Toichiro Kinoshita, Cornell University, on a sign mistake in a calculation of the anomalous magnetic moment of the muon, National Public Radio's All Things Considered, January 1, 2002

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"UConn has made major, major damage to my career and has stigmatized me as a bully and as someone who threatens people. The last two years have been hell."
—Moshe Gai, University of Connecticut, on why he is suing UConn to prevent his dismissal from the faculty, New Haven Register, January 8, 2002

This Month in Physics History

February 1996: Deep Blue vs. Gary Kasparov

Ever since the introduction of the sentient computer HAL in Stanley Kubrick's *2001: A Space Odyssey*, the explosive advances in computing technology have begged the question: Can truly intelligent computers be constructed? Can a man-made machine ultimately out think its creators? In February of 1996, a computer known as Deep Blue, developed by IBM researchers, made history when it took on the reigning world champion of chess, Gary Kasparov, for a series of six games.

The origins of Deep Blue date back to the dawn of modern computing. The first chess program was written by Alex Bernstein of MIT in the late 1950s. When Kasparov first became World Champion in 1985 at the age of 22, solid chess playing machines were already being constructed. In the 1970s, the Machack IV computer became the first to play in a human chess tournament, and with the introduction of integrated circuits, the first chess playing computers went on the market in 1976. It wasn't until 1983 that a computer managed to triumph over a chess master in any tournament, and the Deep Thought project launched a few years later lost miserably to Kasparov in 1986.

In 1995, a Carnegie Mellon doctoral student named Feng hsiung Hsu began developing a chess playing computer called "Chiptest." After earning his PhD, Hsu joined the research staff at IBM and he and his colleague (and former classmate) Murray Campbell adapted his work on Chiptest as part of an effort to explore how to use parallel processing to solve complex computer problems. The Deep Blue project was born.

In order to build a chess playing computer capable of testing the best chess players in the world, Hsu's team sought to design a chess specific processor chip. Deep Blue had 128 processor chips running in parallel, enabling Deep Blue to calculate one billion positions per second. Yet 97% of the computer was constructed from components that could be purchased by the average consumer.

Kasparov was confident going into the match, but Deep Blue stunned the experts by winning the first game. It accomplished this by offering a pawn sacrifice early in the game to gain a lead in position: a common strategy among chess players, but risky, since the outcome is uncertain. The computer went on to recover the sacrificed pawn, ultimately winning the match. Kasparov later told *TIME* magazine that he was "stunned" by the computer's decision to sacrifice a pawn. "I had played a lot of computers, but had never experienced anything like this," he said. "I could feel a new kind of intelligence across the table."

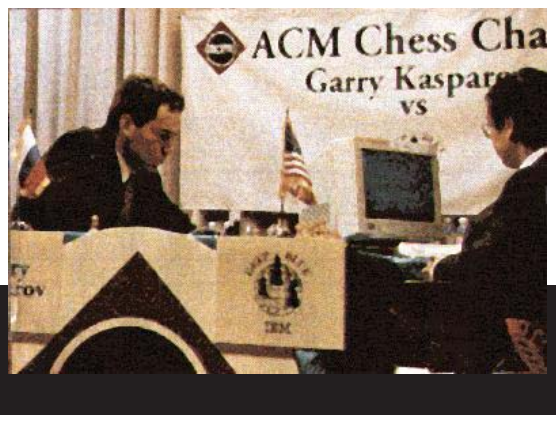
Kasparov recovered his equanimity and ended up winning the match, winning three games and playing two to a draw to collect the $400,000 prize. He later said that he eventually defeated the computer by switching strategies mid game, since the computer did not so much think, as react to its opponent's moves. "My overall thrust was to avoid giving the computer any concrete goal to calculate toward," he said. "So although I did see some signs of intelligence, it's a weird kind, an inefficient, inflexible kind that makes me think I have a few years left."

As it happened, he had about one year left. In May 1997, Kasparov faced the latest, improved iteration of Deep Blue in a rematch that made history. Early in Game 6, Kasparov made a disastrous mistake, allowing Deep Blue to sacrifice a knight and obtain an overwhelming positional advantage, going on to take Kasparov's queen in exchange for a rook and a bishop. Kasparov resigned the match after only 19 moves. It was the first time a current world champion had lost a match to a computer opponent under tournament conditions.

The biggest improvement made to Deep Blue in the year following the first match with Kasparov was speed, thanks to faster processors that gave the computer to evaluate 200,000,000 positions per second. [For comparison, Kasparov can examine approximately three positions per second.] In addition, Deep Blue's general knowledge of chess was significantly enhanced through the efforts of IBM consultant and international grandmaster Joel Benjamin, so that it could draw on vast resources of stored information, such as a database of opening games played by grandmasters over the last 100 years. The increase in computing power also allowed Deep Blue to adapt to new strategies as the game progresses a weakness cleverly exploited by Kasparov to win the first match.

Campbell and his IBM cohorts took the lessons learned from building the system and applied them to other complex and difficult problems that required a tremendous amount of computational power. Today, massively parallel computers are being applied to finance, medicine, education, and nearly every other major sector, not just in the US, but worldwide. Scientists have not yet created artificial intelligence, but systems like Deep Blue and its descendants have helped us make better use of the real thing.

For more information, see www.research.ibm.com/deepblue/home.html



[http://www.columbia.edu/cu/moment/041796/deepblue.html]

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Government Speeds Up System to Monitor Foreign Students

By Richard M. Todaro

As a result of the September 11 terrorist attacks, the federal government has put on a fast-track a comprehensive new electronic system to monitor all foreign nationals who come to the US on student and exchange visitor visas to study or do research. The Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism (USA PATRIOT) Act, signed into law in October 2001, requires that such a system be in place nationwide by January 2003.

Critics have opposed such monitoring of foreign students in the US as both unworkable and unfair in that it targets international students, a group they say is already much more closely monitored than the far larger numbers of foreign tourists who come to the US each year. But the main organization opposing such a system has dropped its public opposition in the wake of September 11.

Academic officials ranging from those overseeing international exchange programs to those involved in federal lobbying efforts have welcomed such a system provided it is created in close consultation with the academic community, and that it targets "questionable individuals" before they enter the US. They said that it is essential that the new system does not get the government involved in micromanaging specific courses studied by foreign students.

The new system is known as the Student and Exchange Visitor Program (SEVP) and its central component is a real-time database called the Student and Exchange Visitor Information System (SEVIS). It is designed to be an information collection and tracking system for individuals (and their dependents) in the US on visa categories F (student), J (exchange visitor, such as visiting scientist), or M (vocational or other non-academic student, such as cooking, theatre, or flight training school attendee).

Using SEVIS software, any institution can transmit to the Immigration and Naturalization Services (INS) and the State Department an array of electronic information on any international student or exchange visitor in the US on an F, J, or M visa. The system will employ at least two interfacing options. The first option is a "real-time interactive" method that allows users to access the SEVIS website and enter information directly. The second option is the "batch mode" in which large numbers of student records can be transferred to SEVIS in XML format.

SEVIS is based on an earlier pilot program called the Coordinated Interagency Partnership Regulating International Students (CIPRIS), implemented in June 1997 and officially concluded in October 1999. It electronically collected an assortment of information on international students and exchange visitors attending the participating schools, including current US address, visa classification and issue date, current academic or program status, and any academic disciplinary actions due to criminal convictions.

Among the 21 institutions across the Southeastern US that participated in CIPRIS were the University of Alabama (Birmingham and Tuscaloosa), Auburn University, Duke University, and Methodist College. Both the INS and officials at the participating schools dubbed it a success.

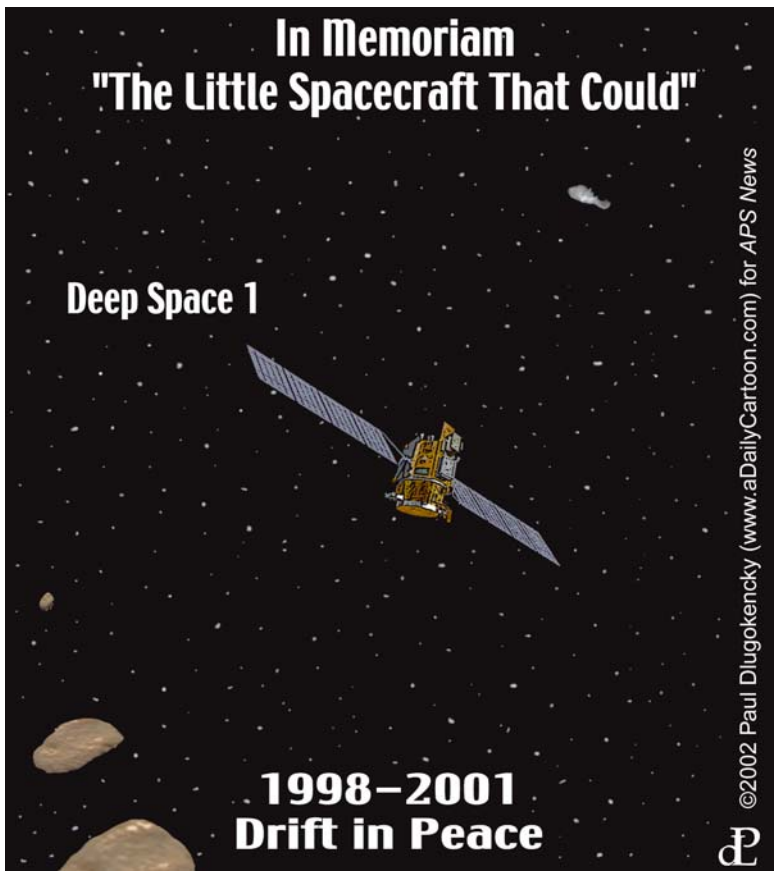
Those who participated found the pilot system to be so useful that the INS agreed to continue the system as an operational prototype, which is currently still working and will be transitioned to SEVIS in early 2002.

"Even before the tragic attacks, INS was moving forward with SEVIS and was already approaching final system testing stages," said Chase Garwood, the SEVP program coordinator. "What has occurred post-September 11 is a rapid acceleration of the INS deadline for actual deployment and availability of SEVIS to all institutions nationwide."

Echoing those sentiments was Jim Ellis, director of the Office of International Education at Auburn University, who said that while there is always the risk of misuse of the data, he has seen no indication of that at Auburn. Rather, it has made his work easier.

"As with anything, there is always the potential for uses which may or may not have been intended.

See **FOREIGN STUDENTS** *on page 5*



Viewpoint...

Dealing with Nukes and Terror

by Pervez Hoodbhoy

In the wake of the terrorist attacks of September 11, 2001, Pakistan's military government insisted that there was no danger of any of its 25 to 40 nuclear weapons being taken for a ride by some radical Islamic group. Nevertheless, it wasn't taking any chances. Several weapons were reportedly airlifted to safer, isolated locations within the country, including the northern mountainous area of Gilgit. This nervousness was not unjustified: two strongly Islamic generals of the Pakistan Army, close associates of General Musharraf, had just been removed from their positions. Dissatisfaction within the army of Pakistan's betrayal of the Taliban was (and remains) deep. Almost overnight, under intense American pressure, the Pakistani government had disowned its progeny and agreed to wage a war of annihilation against it.

Fears about Pakistan's nukes were subsequently compounded by revelations that two highly-placed members of the nuclear establishment, Syed Bashiruddin Mahmood and Chaudhury Majid, had journeyed several times into Afghanistan during the last year. Both scientists are well known to espouse radical Islamic views, and Mahmood has been photographed with Osama Bin Laden. They are currently under intensive interrogation by Pakistani and US intelligence.

It is not impossible that the two Pakistanis could have provided significant nuclear information or materials potentially useful to Al Quaeda's allies and subsidiaries in other parts of the world. If it so turns out, this will scarcely be the first instance of leakage of nuclear information. Among other examples, sympathizers of Israel working in the US nuclear establishment were instrumental in providing large quantities of uranium during the 1960s for the Israeli nuclear weapons program.

Pakistan's loose nukes underscore a global danger that may already be out of control. The fissile materials present in the thousands of ex-Soviet bombs marked for disassembly, the vast amounts of radioactive materials present in nuclear reactors and storage sites the world over, and the abundance of nuclear knowledge make it only a matter of time before some catastrophic use is made of them.

So what is the solution? Obviously tight policing and monitoring of nuclear materials and knowledge is essential. But this is far from sufficient. If nuclear weapons continue to be accepted by nuclear states as legitimate instruments of either deterrence or war, their global proliferation — whether by other states or non state actors — can only be slowed down at best. By what moral argument can others be persuaded not to follow suit? Humanity's best chance of survival lies in creating taboos against nuclear weapons, much as already exist for chemical and biological weapons, and to work rapidly toward their global elimination. The US, as the world's only remaining superpower, must take the lead.

These are difficult times to make such an argument. The White House is celebrating victory over Al Quaeda. But terrorism does not have a military solution. Soon there may be still stronger, more dramatic proof. In the modern age, technological possibilities to wreak enormous destruction are limitless, and nuclear means are one awful possibility. Anger, when intense enough, makes small stateless

See **NUKES AND TERROR** *on page 4*

Beltway, *from page 1*

terrorism, having spent much of the last decade fighting in Chechnya. But Russians, he says, continue to see themselves far more closely aligned with Europeans in their social values and political economy. The US decision to withdraw from the ABM Treaty has dramatically accentuated that leaning. And that poses significant risks for American interests.

If Russia becomes a full European partner – and Pozner says that such a reality is only a matter of time – it will free the Continent from dependence on Middle Eastern oil. From an American policy perspective, there are two obvious consequences. First, Europe will be far less tolerant of US political control over the Persian Gulf. And second, with its energy supplies more secure and the costs more predictable, Europe will challenge the US for economic world leadership.

Competition, according to free-marketeers, is what capitalism is all about. And Americans will surely rise to the challenge. But what consequences will that hold for science, where competition has meant vying for the glory of discovery, not the domination of geopolitics?

During the last decade, policymakers have increasingly equated economic growth with investments in science and technology. And with good reason. Economists of almost every stripe now agree that since the end of World War II, technology and its scientific underpinning have propelled more than half the growth in the US Gross Domestic Product, largely through gains in productivity.

Throughout this period, the US has dominated world markets, fighting off only one challenge – by Japan in the 1980's. And with American primacy seemingly assured in the international arena, federal officials have generally championed scientific cooperation.

Congressional or White House opposition to international collaboration, when it did occur, stemmed from budgetary or military security concerns, not from threats to American economic primacy. But that could change if Europe succeeds in achieving economic megapower status.

If the Euro delivers the trade and monetary benefits that its advocates believe it will and if Russian oil and natural gas become Europe's stable and affordable home-grown energy supply, the US might find international economic domination a closed chapter in its history.

An economically empowered and politically stable European Union will almost surely shift the terms of debate on science at both ends of Pennsylvania Avenue in the years to come. Proponents of greater investment in American science for American use may gain substantial political traction, while supporters of international scientific cooperation may find their cause a more difficult sell.

The sooner the American scientific community begins to grapple with the challenges posed by the European evolution, the better able it will be to help policymakers develop strategies that will secure America's economic future and, at the same time, advance global scientific knowledge.

Russian integration into the European community is not going to happen instantly. And Europe's economic challenge to the US is not a sure bet. But we should not fritter away the luxury we now have by ignoring this possibility. The time to begin the discussion is now.

LETTERS

Wu's Leadership Role Questioned

In your otherwise well-written historical piece in the December 2001 issue of *APS NEWS* about parity non-conservation, it is unfortunate that you perpetuate an injustice which seems to have become permanently embedded in the "history" books. You refer to an NBS "team led by C. S. Wu" as having done the crucial experiment.

Entirely aside from the fact that an NBS team cannot have been led by a non-NBS scientist, there was no question of any formal leadership role for Dr. Wu, to my knowledge, and the NBS scientists, specifically Eric Ambler, have repeatedly chafed at the dominant role given to her in the histories. This injustice may have happened because histories tend to be written by theorists, and she was the one who communicated with the theorists, but she appears to have made no effort to correct it. That communication may have been strengthened by the fact that Lee and Yang are also Chinese as well as by academic snobbery which was at that time alive and well at Columbia.

Philip Anderson, Princeton, New Jersey

Uncle Joe a Barrel of Laughs

Almost all the Ig Nobel Awards (December Zero Gravity) are on the mark. But why ridicule "Stalin World" while "Springtime For Hitler" is breaking box office records in New York? Perhaps the spirit of thriving and surviving with humor and daring is being celebrated.

David Markowitz, Storrs, Connecticut

Didn't It Used to Be "Throop Institute"?

Thank you for the consistently high quality of *APS News*. I look forward to receiving it every month. Recently, one minor error caught my eye in an otherwise excellent article on the 2002 Apker Award. The section of the article on Kathryn Todd identified her as a student at "CalTech". The California Institute of Technology has used the shortened form "Caltech" exclusively since World War II, eliminating from official use the variants "Cal Tech" and "CalTech". The persistence of "CalTech" is indicated both by your recent article and a nearby street sign in Pasadena, which directs motorists to campus via the sign "CalTech —>". Nevertheless, "Caltech" is the correct shortened form, and I hope that future issues of *APS News* will reflect this.

Michael Hartl, California Institute of Technology

X-Ray Pioneer At Dartmouth

Reading the "This Month in Physics History" column in the November 2001 *APS NEWS*, I was amazed to find a false statement: "By February 1896, X rays were finding their first clinical use in the US in Dartmouth, MA..." Actually, the first X ray photograph in the US of a fractured arm was taken in Reed Hall on the Dartmouth campus in Hanover, NH.

In late January 1896, Professor Crehore had his young research assistant, Frank Austin, search through the physics department's collection of Crookes tubes for one that would produce Roentgen's X rays. By the end of the week he had the Puluj tube and therefore had obtained the first X ray photograph at Dartmouth College. Then, on the evening of Saturday, February 1, 1896, Charles Emerson and Edwin Frost found time to experiment with this tube. That weekend, Frost arranged to have his brother, Dr, Gilman D. Frost, bring his patient to Reed Hall on late Monday afternoon to have his fractured arm examined using the "new photography."

We still have the original Puluj tube, Apps coil and other instruments seen in "An Early X Ray Experiment at Dartmouth College," except for the battery of seven Grove cells, in the Dartmouth College Collection of Historical Scientific Apparatus.

Allen King, Hanover, New Hampshire

SI: Imbecilic or a Modern Improvement?

Regarding the Viewpoint by Charles McCutchen ["SI"=System Imbecile, *APS News*, October 2001] and the comment thereon by Jeffrey Marque [*APS News*, December 2001]:

The discussion about the Svedberg clearly shows why the use of such units is not a good idea. The two authors disagree on its magnitude and dimension. (Where is a place to look up the definition of such obscure units? What is the quantity that is being measured in Svedbergs?).

McCutchen admits that he is getting up in age. Being myself in the mid-eighties I realize that it is difficult to keep up with changes (tricks for old dogs?). But the older generation should not let their inertia get in the way of generally accepted improvements. There is little to be gained by hanging on to special units (like angstrom) when alternatives, such as micrometer and nanometer, that fit into the general scheme are available.

Have these authors considered the effect on students and general readers? Units can help in seeing relations and checking one's calculations and concepts. The effort required for scientists to abandon a few special units is small compared to the effort for students and the general reader to be able to handle all units which some specialist might like.

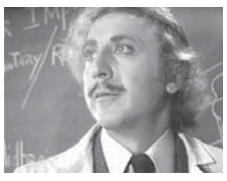
I was glad that Marque rewrites McCutchen's lengthy expression that supposedly gives some interpretation (or at least an alternative) of the Svedberg with parentheses so that it is unambiguous, as SI would require.

Mario Iona, Denver, Colorado

The confusion over the Svedberg was due to a misplaced parenthesis in APS News. Both McCutchen and Marque were correct in their definitions. We regret the error. —Ed.

zero gravity

The Lighter Side of Science



The Mad Scientist's Love Song

by Gary McGath

Do not run away as I kneel at your feet;
I come to you in supplication.
Please say that you want to be part of my life
And join me in — re-animation.

I know I should flee from your fiendish designs,
Or else I'll soon be in your power.
But life is so boring when you're not around,
So I'll go with you to your tower.

Chorus:
Come to my castle on the dark and barren hill.
Gaze into my eyes and I'll control your will.
Be my assistant in good times and in ill.
That's the mad scientist's love song.

You'll wear low-cut dresses made out of black silk.
When guests come, your warm smile will charm them.
They'll be so at ease that they'll never suspect
That we have the least wish to harm them.

The townsfolk will greet us with torches aglow;
If they're hostile, you'll stand and protect me.
And let's hear no nonsense of "death do us part."
If they kill me, then you'll resurrect me.

(Chorus)

We'll run strange experiments late in the night,
And I'll thank the stars I could win you,
For after the moon sets, we'll go off to bed
And let the "experiments" continue.

I'll learn how to work with the corpses and blood,
And never will faint when I see gore.
Forever, I swear, I'll be true to your love,
Or maybe I'll run off with Igor.

(Chorus)

Viewpoint...

Reports of Higgs Boson's Death Greatly Exaggerated

There are many excellent journalists who write about science, scattered among the newspapers, magazines and broadcast media in this country and abroad. It was therefore disappointing to discover a recent example of shoddy journalism with potentially serious consequences.

An article in the *New Scientist* appeared on December 5, under the headline "No sign of the Higgs boson". The headline was accurate, but the story strongly suggested that the Higgs doesn't exist, when in fact all that one knows from the experiments done at the LEP accelerator at CERN is that it hasn't yet been found. Toward the end of the article there were a few comments by well-known physicists, which at least alerted the reader to the fact that the non-existence of the Higgs is not a unanimous opinion.

The *New Scientist* compounded its felony in an accompanying editorial, which said "Researchers at CERN, the center for particle physics near Geneva, have ruled out most of the likely energy slots where the particle might lurk and now reckon it more probable that the Higgs is the product of an overactive imagination."

Within days several other news sources had reprinted the essence of the *New Scientist* story. None of them did any further investigating of any significance on their own. BBC News, usually a reliable source, headlined "God particle may not exist", using the name for the Higgs that appeared as the title of the 1993 book by Leon Lederman and Dick Teresi. Other headlines were: "Divine Myth: five-year quest for 'God particle' is fruitless" (Agence France Presse); "Analysis casts doubt on Higgs Boson" (UPI); and "Physicists: No sign of 'God particle'" (CNN). The headline in the Sun, the largest circulation British newspaper went straight to the bottom line: "Six billion pounds wasted on 30-year 'God' hunt." Some of these stories included the mild rebuttal that had appeared in the New Scientist; others did not, reinforcing the impression that the case was virtually closed.

With this kind of mindless reporting, there was little chance of a fair hearing for the leaders of the four major experiments at LEP, who, together with the heads of two of CERN's working groups, e-mailed a protest to the New Scientist on December 10, in which they said "…the theory makes predictions for the mass of the Higgs boson. In fact it tells us that the mass is probably lower than 200 GeV. On the other hand, from the results of our direct searches…we conclude that the mass is larger than 114 GeV, which is perfectly compatible with the above prediction—hence our dismay concerning the report that we have ruled out the existence of the Higgs boson."

These journalistic miscues are indeed cause for dismay. With Fermilab's search for the Higgs just getting into high gear, and with the LHC at CERN under construction, the misinformation propagated by these news stories can seriously jeopardize a major program of physics research. While it is possible that some members of the LEP experimental teams sought to manipulate the press by exaggerating the significance of their failure to find the Higgs, if the reporters had followed elementary principles of good journalism they would have talked to enough people to strike the proper balance and to convey the true state of affairs.

Science journalists face the often daunting task of understanding new developments in science, and transmitting the information accurately to the public. Indeed, the embargo system employed by *Science* and *Nature*, with which we have taken issue in the past (see *APS News*, August/September 2000 and March 2001), is defended by its practitioners on the grounds that it is crucial for journalists to get the story right, even if they are denied the opportunity to talk to the scientists and to report the news when they first discover it.

Whether one approves of embargoes or not, one cannot argue with the paramount importance of accuracy. Its unfortunate absence in this instance is we hope, not destined to be repeated.

—Alan Chodos

Viewpoints, Nukes and Terror, *from page 3*

groups, and even individuals, extremely dangerous.

American triumphalism must therefore give way to a more rational, long term defense of US interests and security. These ultimately lie in ameliorating conflicts and rationally dealing with complaints against its international behavior. It is time for the US to re-engage with the people of the world, especially with those it grievously harms. As a great country, possessing an admirable constitution that protects the life and liberty of its citizens, it must now extend its definition of human rights to cover all peoples of the world.

Pervez Hoodbhoy is a professor of nuclear and high energy physics at Quaid e Azam University in Islamabad, Pakistan.

DFD Meeting, *from page 1*

the fluxes by application of molecular monolayers.

Biofluid Mechanics

Dynamics in the structural hierarchies of living creatures are simplified by continuum mechanics and could be extended to support future research in biology and bioengineering, according to Y.C. Bert Fung of the University of California, San Diego, who spoke at a Tuesday morning session. And since fluid mechanics is the key determinant of stress and strain in cells, it can play an equally key role in those fields. He pointed out that every cell in the human body needs blood flow, and the dynamics of blood flow is coupled with DNA, cell function and tissue remodeling. "Significant problems of health and diseases always need a good systems analysis, and such analysis may use continuum mechanics," said Fung.

Particle Laden Flows

Martin Maxey of Brown University gave an overview of various simulation methods that could give scientists insights into the mechanisms of various types of particle-laden flows, which include turbulent combustion sprays, sedimentation of dilute suspensions, and bioparticle separation in micro-channels. Particles in such flows are dispersed by underlying turbulence, and depending on their size, their response to the turbulence can create local particle accumulations that are correlated to the flow structures. In dilute suspension flows, for example, interactions between particles via the fluid flow can have significant long-term effects, which would be masked in a more turbulent flow. Maxey illustrated the various processes with examples drawn from his experiments and simulation results.

Fluid Dynamics of Buildings

Heating and ventilating buildings account for a significant fraction of the total energy budget of cities, and one of the most pressing challenges is the design of sustainable, low-energy buildings, according to Gary Hunt of the Imperial College of Science, Technology and Medicine in London, England, one of several speakers in a Sunday afternoon mini-symposium on the fluid dynamics of buildings. Hunt believes that natural ventilation provides such a low-energy solution. Modern naturally-ventilated buildings use such innovative design solutions has glazed atria and solar chimneys to enhance the ventilation, and demand for these and other designs has far outstripped current understanding of the fluid dynamics of such buildings. Particular challenges include improving our understanding of the thermal stratification and movement of air, which often involve complex geometries.

For more information go to http://www.aps.org/meet/biology-physics/

Foreign Students, *from page 3*

Everyone should always raise questions about the security and the use of data," he said. "We have not seen any indications that the data that have been transmitted for the past number of years have been misused in any way. In fact, it has facilitated our ability to work with the students and departments [on campus]."

Not everyone is happy with such an electronic monitoring system. Opposition has come both on technical grounds and also on the philosophical grounds that cracking down on academic exchange would hurt the US intellectually and unfairly penalize a tiny minority of foreign visitors without providing any additional homeland security.

Leading the opposition has been the Association of International Educators, known by its old acronym NAFSA, a Washington D.C.-based advocacy group promoting international educational exchange among 80 nations.

"We have recognized the need for more efficient and effective reporting mechanisms, but have argued that there are better and worse ways to achieve them," according to a September 20 statement in which the group formally dropped its opposition to a foreign tracking system on the grounds of national unity following the terrorist attacks

NAFSA had opposed the monitoring system on the grounds that the new system would unfairly focus on foreign students and visitors, a group already well monitored compared to the vastly larger numbers of foreigners who visit the US each year on tourist and business visas. The organization argued that rather than enhancing homeland security, the monitoring would simply discourage the roughly half-million foreign students who come to the US each year while doing nothing to monitor the other 30 million plus foreign visitors who come to the United States annually – the majority of whom come without any visa.

"As the debate on foreign students proceeds, we must recognize that our country gains much from being their destination of choice. It also remains true that 99.99% of the foreign students enrolled in our institutions wish us no ill, cause us no problems, and seek nothing more than the best education in the world," NAFSA Executive Director and CEO Marlene M. Johnson said. "If cracking down on foreign students and scholars could really protect us against terrorism, it might be necessary to forego the benefits that they bring. But that's not the case."

The NAFSA position has met with criticism from some of its own members, including the officials at the 21 institutions who participated in the earlier pilot program, such as Auburn's Ellis.

Officials from all 21 schools signed a letter in September 2001 that went out to NAFSA members and was publicly posted on an Auburn University web site. While supporting efforts to change responsibility for fee collection, they also affirmed their strong support for the electronic monitoring program. "For the record, we continue our strong support for the removal of schools as collection agents, and for the removal of artificial deadlines in the law. Also for the record, we continue our strong support for our reporting electronically," the letter read.

Responding to NAFSA philosophical objections to such monitoring, they wrote, "No one has yet shown us how CIPRIS would have a negative effect on international exchange unless we, as international exchange professionals, make it do so. How is electronically reporting of this data evil, while posting F and J handouts and our annual statistics on our web sites considered a blessing and a service? Why is reporting CIPRIS data more malevolent than electronic transfers of transcripts, or registering for classes on line?"

Katherine Bellows, assistant dean and director of International Student and Scholar Services in the Office of International Programs at Georgetown University, thinks SEVIS is a good idea because it would provide accurate numbers on how many foreign students there are in the country. But she acknowledged that there is the incorrect perception that foreign students are the source of the terrorism threat.

She pointed to the fact that of the 19 hijackers in the September 11 attacks, only one was on a student visa to study English, while many of the others were on tourist visas. "These weren't people coming into four year colleges [but] there is still the perception, that that is where the danger is," Bellows said.

For Bellows, the success or failure of the new electronic monitoring system will be how is it designed: does it keep out "questionable" individuals ahead of time, or does it get the federal government involved trying to limit the flow of information? That is where intelligence gathering comes into play," she said. "There is a very small number of people who we are worried about having access to sensitive information. Do we focus on types of information or do we focus on types of individuals we are worried about?"

Focusing on the former, Bellows said, could create a situation where even the most innocent-seeming information becomes dangerous, with the government then attempting to "micro-manage" courses taken by foreign students. "You could go into a home economics course and take something really, really benign and do a little molecular reconfiguration and create something that was a bio-hazard. So even in the most benign courses you have danger."

Focus on Committees

Committee Oversees Publications In a Time of Rapid Change

Of all the various activities of the APS, the paramount one in terms of both human and financial resources is the publishing of the peer-reviewed research journals that carry out the organization's central mission to "diffuse the knowledge of physics." And overseeing all such research publication activities is the 11-person Publications Oversight Committee.

Last fiscal year, fully three-quarters of the entire annual APS operating budget and nearly two-thirds of all APS employees were devoted to research publication activities. According to Michael Stephens, the APS Director of Finance, research publications accounted for $27.6 million of the Society's overall fiscal 2001 budget of $37.1 million. In addition, 140 of the Society's 211 employees are employed in publication activities.

Among the 11 members of the Publications Oversight Committee (POC) are the three APS operating officers: the Executive Officer, the Treasurer, and the Editor-in-Chief. In addition, there is a POC Chair appointed by the APS President from among the remaining eight members. The POC Chair in 2001 was Mark A. Riley of Florida State University in Tallahassee. Taking over in 2002 is Beverly Berger of the National Science Foundation.

"The POC is a very important committee because it proposes guidelines for the operational philosophy of APS publications and oversees the general editorial policy," Riley says. "Publishing the finest research and review journals in physics is one of the greatest achievements of the APS and we want to keep that going."

Riley outlined two broad areas of concern before the committee, more recent electronic access and information systems issues and the long-standing journal quality issue.

Riley said an "electronic revolution" is underway that raises a range of related topics, such as submissions, reducing staff paperwork, pricing for new electronic databases, and staffing levels and salaries.

"In this electronic revolution, things can happen swiftly. APS has spearheaded the on-line systems like PROLA and many other publishers are following in our steps," he said. "One of the tasks of POC is to keep us going in those directions. One example is how do you deal with the pricing of journals in this new electronic age."

He said the move toward electronic publishing has accelerated the long-term problem of declining subscriptions for the journal hardcopies. He added that this decline has affected journals in many different fields well outside of physics, citing figures from his own university showing that subscriptions to about 2,000 separate titles have been cancelled in just the past seven years.

"We in the last year have tried to do something about this by moving to multi-tiered pricing for the journals where large institutions and research laboratories pay more for the journals than a smaller bachelors college," Riley said. "We've been very busy trying to advance that multi-tiered pricing policy. There is no doubt that it was the right thing to do and it has been well received by libraries throughout the country."

In the coming years, Riley said it is "very likely" that all APS journals will be in electronic form only because of the increased versatility this offers, while the hardcopies will be available as an "optional extra."

Echoing these sentiments is Martin Blume, APS Editor-in-Chief. "We not only have our journals online, but there are fairly elaborate things you can do with them. You can search the entire archive and references are linked. You can look at a particular PROLA article and find all articles that refer back to it, so you can trace it to the future.

Alicia Chang/APS

2002 POC Chair: Beverly Berger of the National Science Foundation (left)*; 2001 POC Chair: Mark A. Riley of Florida State University in Tallahassee*

Soon we will be linking to articles from other publishers that cite our articles," Blume said.

Blume also said that within two years, APS will have software that allows all editorial handling to be done electronically. This will end an "internal editorial process that still relies heavily on paper."

The second broad area of concern before the POC deals with the long-standing journal quality issue. "We on POC obviously are concerned about maintaining the very high standard of the *Physical Review*," Riley said. "The POC puts together committees every five years that go through APS journals and consider ways to improve them."

The review is done chiefly through survey work. "They have about a year, and it is a long, serious job, to get surveys out and try to get feedback from that particular physics community on how they feel about their particular *Physical Review* journal."

Staying on top of APS publishing activities keeps the POC very busy. "The POC meets three times a year and we've started a new policy of a two-day meeting in May, which I think was a great success [because] there are a lot of things to discuss," Riley said. "These are very interesting times for scientific publishing. While APS is sitting on the crest of a wave, we always have to be vigilant to maintain our status. It is good to discuss the future and how to do things properly."

—Richard M. Todaro

PHYSICS AND TECHNOLOGY FOREFRONTS

Strategies at the End of CMOS Scaling

by P. M. Solomon

Editors Note: This is the first of two articles on advances in electronics. "Plastic Electronics: Going Where Silicon Can't Follow?" by Hendrik Schön, Zhenan Bao, and John Rogers will appear next month.

For the last 40 years, 'Moore's Law' has ruled the growth of the semiconductor industry. This astounding exponential growth of components per chip at a compound rate of 60% per year relies on the product of higher packing densities and larger chip sizes. Higher packing densities have been achieved both by finer lithography as well as by innovations in circuit layout and in self-aligned, device structures. Feature sizes have been reduced by about 100 times during this time, and device count has increased by about 100 million times. For all of this time the silicon metal-oxide-semiconductor field effect transistor (MOSFET) has been the dominant device used in integrated logic and memory chips, and for the past twenty years complementary metal-oxide-semiconductor (CMOS) has been the dominant circuit type.

The power of CMOS lies in its versatility. The CMOS transistor is close to an ideal switch. It draws negligible gate current and can be used in series or in parallel at will. Since complementary switching types are also available, conducting paths can be cut-off in both logic states. Also, the wide band gap of silicon dioxide permits only small tunneling currents even in extremely thin oxide layers, while tunneling is suppressed in the silicon itself by silicon's indirect band gap and relatively large tunneling masses.

Everywhere the trend has been toward replacing other solutions with integrated CMOS, rather than the other way around. For instance, in the early 1990's CMOS replaced the silicon bipolar transistor for most high-end applications even though the bipolar transistor is inherently the faster switching device. III-V technology was developed rapidly in the 1980's to challenge the dominance of silicon in high end switching applications. While III-V technology has secured a niche for itself in the high frequency analog domain, and even in some specialized digital applications, it has never mounted a serious challenge to CMOS. Indeed, competition from III-V technology spurred CMOS toward more aggressive scaling leading to performance levels, integration levels, and low power usage that made it difficult to beat.

CMOS transistors become more leaky as they get smaller due to leakier gate oxides, tunneling leakage in the silicon itself, and thermal leakage over reduced barriers due to reduced gate voltage swings. The latter effect is the major leakage component today, the familiar subthreshold leakage, but the others become proportionately more important as scaling progresses. In some applications which require very low leakage, the most notably dynamic random access memory (DRAM) and flash electrically erasable programmable read-only memory (EEPROM), device channel length scaling has already effectively stopped, but density continues to increas. High-end servers, where high performance is the primary concern and power is secondary, are at the other end of the applications range. In this environment, scaling can be carried the furthest. So for bulk silicon, scaling can be carried down to ~15 nm for the high performance designs but only to ~25nm for the low power designs. At today's rate of progress and with today's design strategies, this predicament, for the lower power circuits, will be reached before 2014. This does not necessarily mean the end of all progress, since other paths can be explored to continue the performance and density improvements.

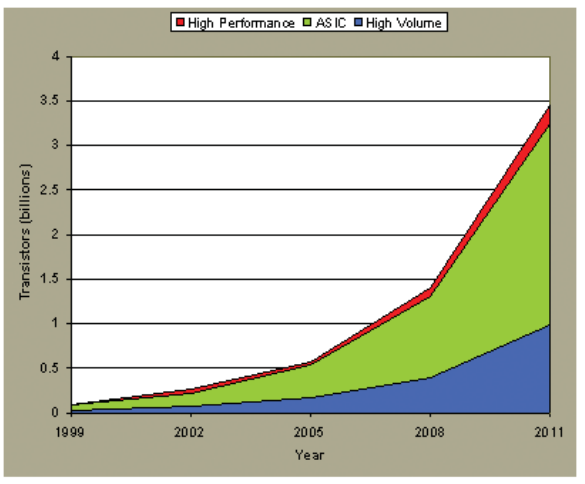


Figure 1. *Number of transistors in each type of chip (400 sq.mm.) as projected from the SIA roadmap. Reprinted with permission from IBM J. Res. Develop.*

Given that CMOS scaling is nearing the end of a long and distinguished journey, why is CMOS still looked upon, almost universally in the industry, as the technology of the future. Instead of ceding applications to other technologies, it is taking over territory. The answer lies in the sheer power of numbers and the ability of 'brute force' scaling to improve performances. Figure 1 shows the numbers of transistors available for different types of applications. It is clear that there is substantial processing power still to be wrung out of CMOS. With billions of transistors potentially available, the question revolves more around how to use them to good effect, given power constraints, rather than finding a way to increase their numbers even more.

Device Design Strategies

As the end of scaling approaches, more radical innovations are being considered, since this may be the only other way to improve performance or to extend scaling a little further. In a sense, today we are in a golden age of semiconductor device research, when radical new device designs, all in CMOS, are needed to exploit the full potential of the technology.

Performance improvements may be gained by improving the transport properties of the silicon itself. There is considerable work today on improving the mobility of silicon by applying strain. The strain induced in the silicon layer caused by accommodating the overlying Si to the larger lattice constant of the SiGe produces a transconductance improvement of about 50%.

The most important factor in scaling is suppressing the tunneling leakage current in the gate insulator. By using a higher dielectric constant material, a thicker insulator may be used for the same degree of charge control. There is much work today in search of alternate dielectrics with a high dielectric constant, yet whose bulk and interfacial electrical properties maintain the standard set by thermal oxide. While this elusive goal has not yet been met, dielectrics such as aluminum oxide and various transition metal oxides show promise.

There is also renewed interest in metal gates. The metal gate eliminates the depletion problem experienced with conventional polysilicon gates and, with suitable work function, may give improved channel mobilities by reducing channel doping. Another possible benefit is circumventing the mobility reduction that is predicted to occur in very thin oxides due to remote interactions between electrons in the channel and plasmons in the polysilicon gate. The search for a suitable work function, combined with low reactivity toward the gate dielectric, has led toward pure metals like tungsten as well as metallic compounds such as transition metal nitrides and silicides.

Improvements in scaling are predicted to occur for thin silicon-on-insulator (SOI) films, with thickness of order of 10nm or less. The thickness limit is probably about 3nm because quantum effects make the band gap (and hence threshold voltage and channel potential) very sensitive to thickness, so that slight fluctuations in thickness cause large fluctuations in potential. Experiments have thus far confirmed adequate mobilities

See END OF CMOS SCALING *on page 7*

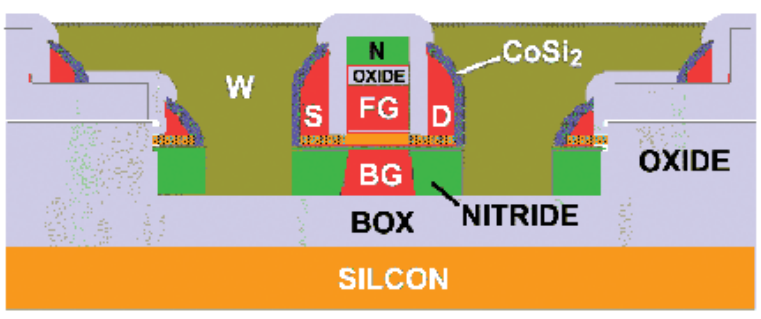


Figure 2. *Schematic cross-section of an experimental planar DGFET structure, by an IBM group, showing silicided sidewall self-aligned S/D, tungsten self-aligned S/D plugs, and isolated, undercut back gate.*

Undergraduate Changes Rescue Graduate Physics Program at U of Wyoming

by Richard M. Todaro

The University of Wyoming's Department of Physics and Astronomy has just re-instituted its graduate program following a three-year suspension that had been triggered by low enrollment in the undergraduate program. As before the suspension, the graduate program includes a doctorate in astrophysics and a masters degree in physics education.

In 1999, University officials decided to suspend the graduate program– that is, no new students were accepted into it – in order to focus on improving the undergraduate one.

"A state like Wyoming has to have an undergraduate major in physics at its only four-year institution if for no other reason but to produce physics teachers for the state," said Paul E. Johnson, the department chair for the past twenty years. "People grow up in Wyoming and they go to college here and they want to teach here. But are you going to get qualified teachers if you don't have a physics program here?"

"They decided to get rid of the graduate one since the heart of our program is the undergraduate one, and if we were having a hard time keeping both going, we needed to focus our time and energy on the undergraduate one."

Changes to the program have boosted the number of undergraduate physics majors for the current year to about 50. This satisfied university officials, who gave the green light to restart the graduate program next fall.

Among the changes Johnson cited were a range of new double-major options now being added to the undergraduate program through the department's "Physics Plus" curriculum, which according to a recent university press release is designed to combine traditional physics courses with "applications-oriented" courses. Currently, the only double option is in physics-meteorology, but additional options, physics-science journalism and physics-business project management, are being developed.

"We found that by being more open, we attract a more diverse body of students. Previously we were just another small, vanilla physics program," Johnson said. "If you look at the undergraduate population of students, they are much, much more diverse than they used to be."

Although the doctoral program traditionally focused on astrophysics, the actual degree conferred was a doctorate in physics. Regarding the distinction between physics and astrophysics, Johnson said the course work required for the two differs only in a handful of specialty courses.

The graduate program also offers a terminal masters degree in physics education that is designed to turn out high school and community college physics teachers. Johnson said that the program typically turned out one to two graduates per year, a number he called "significant" given the university's remote Rocky Mountain location.

By improving the undergraduate program, Johnson said that the graduate program benefits because it will allow graduate students to work as teaching assistants.

"Graduate students should learn how to teach," he said. And he said that because his department emphasizes astrophysics, there are more American and more female prospective students.

"I think there are a lot of kids in the US who are interested in pursuing a PhD in astrophysics or astronomy, and in fact, a lot of women," Johnson said. "It might have been in 1997 or 1998, we had an incoming class of graduate students where the number of women outnumbered the number of men by two to one."

Typical graduate enrollments at the University of Wyoming in the physics and astronomy program number around 17 students per year.

Johnson's goal for the graduate program is to attract students who graduated from small, liberal arts colleges with strong quantitative and analytical skills regardless of whether they were able to take the full array of undergraduate physics courses.

"What we are trying to do consciously now is to go after really bright students from liberal arts colleges, who because of the size of the college, haven't had a full complement of physics courses…so consequently their GRE scores in physics aren't very high, but their GPA is high and their GRE quantitative and analytical (scores) are very high. Those are the kinds of kids we are after."

ANNOUNCEMENTS

Proposed Amendment to APS Bylaws Regarding Additional Duties for the APS Audit Committee

Approved on the First Vote of the Council
November 18, 2001

The following amendment is proposed to include the additional duty of overseeing that the APS Business Continuity Plan is kept up-to-date. Approximately 2 years ago, the APS undertook a comprehensive study to look at the operations of the society and to devise a plan to deal with a number of potential disasters that could disrupt normal operations should they occur. Now that the plan has been completed and is in place, it is equally important to see that it is reviewed periodically and kept up-to-date. Such a review seems to logically fall into the area of the Audit Committee and this proposed amendment formally charges the Audit Committee with the responsibility.

ARTICLE III - STANDING COMMITTEES
A.OPERATING COMMITTEES
3. Audit Committee. - *The membership of the Audit Committee shall consist of three members of the Council, who are not members of the Executive Board or are not otherwise directly involved in the business management of the Society, elected by Council to staggered three-year terms which may extend one year beyond the term on Council. The member in his or her second year of service shall ordinarily chair the committee. Following each fiscal year, the Committee shall review the audit with the Society's auditors and submit a written report to the Executive Board and to the Council, which shall include recommendations on fiscal management issues. IN ADDITION, THE COMMITTEE WILL REVIEW THE SOCIETY'S BUSINESS CONTINUITY PLAN AND MAKE SURE THAT IT HAS BEEN RECENTLY UPDATED.*

Fellowship Nomination Deadlines

DCP: February 15, 2002

DFD: February 15, 2002

See detailed submittal information at http://www.aps.org under the fellowship button.

2002-2003 APS Member Directory

The 2002-2003 APS Member Directory will be printed in late March 2002. Check your online directory listing at http://www.aps.org/memb/enter-directory.html to confirm that APS' records are up to date. Corrections may be sent to coa@aps.org, faxed to (301) 209-0867 or phone (301) 209-3280.

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End of CMOS Scaling, *from page 6*

down to ~5nm thickness, opening a 5-10nm window for thin SOI devices. Although the configuration of a single-gate FET (SGFET) in SOI is attractive, because of its simplicity and because excellent device results have been shown by IBM and Intel at gate lengths of 33 and 50nm, the easy penetration of electric field beneath the FET when the SOI is fully depleted severely limits its scaling potential. Better scaling is obtained with a double-gate FET (DGFET) in which there is a gate on both sides of a thin silicon layer. Then, when using the higher dielectric constant insulators, mentioned earlier, the reduction in scaling length might approach a factor of two. The two gates of the DGFET augment this advantage since they may be controlled independently, offering advantages of extra functionality.

Research into DGFETs has picked up pace in universities such as Berkeley and MIT, and in the industry such as at IBM and Lucent. Fig. 2 shows a cross-section of an experimental self-aligned planar DGFET, realized at IBM, where the source and drain regions are etched away to leave sidewalls and to allow the back gate to be under-cut.

Power Management.

Of all the issues that confront scaled integrated circuits, power dissipation is the most serious. Though the power per function continues to decrease, more and more functions are crammed onto ever larger and denser chips. There is also an increasing conflict between the demands for low dynamic power, which requires low power supply voltages, and low standby power that needs higher threshold voltages to turn the transistors off. This trade-off leads to power supply optimization and device design according to application.

Power management technology is still in its early stages of development, since until recently voltage reduction, improvements in cooling technology, and improvements in system architecture have kept the problem within bounds. But within the domain of device design, several approaches could result in a better static versus dynamic power trade-off, such as multiple threshold voltages; multiple oxide thicknesses and power supplies; dynamically adjustable threshold voltages and block switching.

Of these, block switching, in which the power supply to a circuit block or even an entire processor is gated, is the more radical approach. If the gating switch consists of a high threshold voltage, thick gate oxide FET, both the sub-threshold and gate leakage components of the standby power may be greatly reduced. At issue are the size, speed and power needed to switch the switching transistor but detailed analysis shows its practicality and the plausibility of its increased use in future chip-systems.

Redundancy

A premise of many of the power management schemes is that devices are cheap but power is expensive in future chip-systems. At issue is whether devices are used to implement large numbers of processors on a chip, many of them idle because of power constraints, or whether the transistors are better used with fewer processors and a very large cache memory. Most likely a particular balance will be struck depending on the application, but the availability of 10 billion transistors in 'end of roadmap' chips allows for placement of hundreds of processors, and innovations like embedded DRAM (or other dense on-chip memory technology), might mean that there is adequate chip area to support large numbers of processors, each accompanied by a large cache.

Redundancy is now an essential part of memory design, including error detection and correction. Without it memory could never achieve the integration levels available today. It is not an unwarranted speculation to assume that it will be equally important for future chip-systems. The increased susceptibility of scaled devices and circuits to soft errors, increasing parameter spreads caused by material fluctuations, and increasing numbers of devices point to the need for such techniques, while the increased on-chip computing power gives an increased capability of implementing them. Redundancy techniques have long been applied to fault tolerant and highly reliable computing systems and have been implemented in hardware and software and at high and low levels. This is an important area for research and a possible key for exploiting future systems to the full.

The data processing potential of future CMOS chips is tremendous. Even as we push up against ultimate limits, device designers will exploit structural possibilities to the utmost, continuing density and performance improvements for many generations to come. Indeed, the ultimate MOSFET is truly a 'nano-transistor', competitive with other nano-challengers. A device scaling approaches its logical conclusion, the future of the VLSI revolution will be even more in the hands of the chip architect.

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BIOPHYSICS, *from page 1*

for the conference.

In genomics and evolution there are two main avenues that offer opportunities for the techniques and problem solving skills of physicists: unraveling the evolutionary history of life by comparative genomic studies of sequenced organisms, and utilizing bioinformatics to unravel the much more complex process of the selective expression of the genome. Biological networks incorporate features that are familiar to the physicist, including feedback, amplification, error correction and coincidence detection.

In biomolecular dynamics most significant challenges will come from trying to understand how the dynamical interactions between molecules can allow for the creation of much of the complex machinery of the cell, ranging from genetic regulatory networks to signal transduction cascades to active control of cell shape and rigidity. High resolution imaging of single cells will enable scientist to determine the exact three-dimensional arrangement of the cellular components and is tremendously important, as are the time-dependent changes in this arrangement during the cell cycle and upon interaction with a variety of cell activators (hormones, growth factors, etc.).

Finally, there is the "classical" area of physical probes in biology. In X-ray diffraction to magnetic resonance imaging, physicists played key roles in developing so many powerful tools. "We don't believe that the biology of the future will be able to grow and flourish without further parallel development of technologies from physics," says Austin. "Even now as we see the explosive growth of the gene chip array technology, it is important to realize that many aspects of this technology came from physics," specifically optical lithography.

Physicists have made enormous strides in the past 20 years in developing new nanotechnologies, new imaging technologies, massively parallel data acquisition and storage techniques, and new ways of assembling matter including quantum dot lasers and superconducting interference devices. "We are just beginning to see the applications of these ideas to biology, and if history is any guide, then we will see enormous impacts in biology," says Austin.

THE BACK PAGE

A Few Modest Prescriptions for Widening the Path to Politics

by Daniel S. Greenberg

Science finds advantage and claims virtue in its detachment and aloofness from politics. But politics is the medium through which a society decides upon and implements its values and its choices. That the political system frequently goes awry and fails to work to its full potential of beneficial effects is a reason for increased involvement, not withdrawal. And this is especially so for an enterprise that draws heavily on the public purse and radiates powerful effects in all directions and on all things — while denying responsibility for the consequences of its work.

In its retreat into political isolation, science cannot detach itself from relations with the outside world. But increasingly, these relations are with industry seeking profits from academe's scientific strength and prestige, distressingly often to the detriment of scientific integrity and public well-being. Science is too powerful, too potent in its effects on society, and too arcane, to be entrusted to the expanding alliance between a profession that has retreated into a ghetto and the commercial sector, with their shared focus on making money. While this relationship flourishes, a deadening complacency has settled over the institutions that should be protecting and advancing the public interest in science. With rare exceptions the public is satisfied to leave science to the scientists. Politicians put hands on science mainly to get a share for their voters. None of the professional sectors concerned with science are inclined to push for change on their own, and there is little expectation that the necessary correctives to the scientific enterprise will come from within.

But coming from several directions, small impulses for change can reverberate through the various sectors with energizing effects beyond their original strength. The goal should be more involvement of science with politics, rather than less, because more would benefit society by opening science to public view and controversy. More involvement with politics would surely be uncomfortable for science, because it would threaten the reigning combination of support without scrutiny or responsibility. But it would be beneficial for society in its dependence on science, and possibly even helpful for science itself. The aim is to dislodge science from its comfortable ghetto and move it into the rough waters of the political mainstream.

The dearth of scientists in elective public offices is in large part explained by the monastic nature of scientific training and career progress. But it also comes from a scientific culture that derides politics as unclean and debased, ethically distant from the ideals of science. For inspirational purposes, the concept of the role model is central to the culture of science, but in elective politics, role models with scientific credentials are few. The professional societies of science should advance beyond clichés and act on the recognition that participation in the nation's political life is a virtuous activity, good for the nation and good for science — and well worth the support of scientists. The fellowship programs that bring scientists and engineers to staff positions in Congress and elsewhere in Washington are useful but insufficient. Politics would benefit from more office-holding scientists; science would benefit, too.

> *"The prevailing anti-political culture of science encourages the field to stick to the ghetto, and perhaps even to strengthen its walls."*

With that understanding as a starting point, the scientific enterprise should extend help to scientists who dare a plunge into politics. Physicians, lawyers, and schoolteachers apply collective strength to politics through political action committees and other organized efforts. Why not scientists? Latent scientific support for scientists in politics was brought forth by scientists rallying to finance the congressional candidacy of physicist Rush Holt in 1998 and 2000.

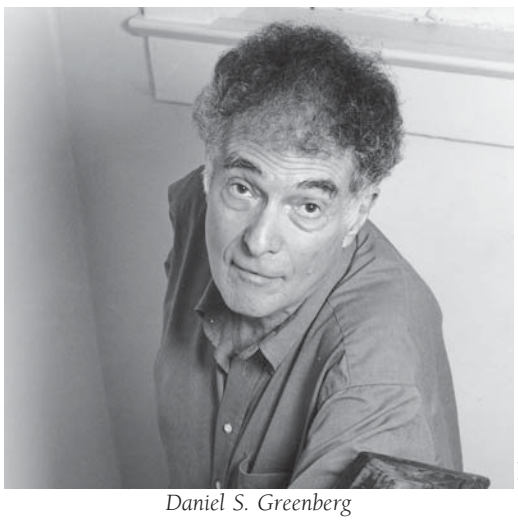
In modern America, participation in elective politics is measured in money and efforts to mobilize votes — activities largely shunned by science ever since its one-time, 1964 venture into big-league politics, under the banner of the ad hoc organization Scientists and Engineers for Johnson-Humphrey. Antiseptic aloofness from elective politics contributes to the marginalized role of scientists in public affairs, as evidenced by their frustrations with the State Department and the compartmentalized presence of scientists in the White House. With the prestige and glamour of presidential staff appointments, the White House scientists serve the presidency. But no one in the know in political Washington is fooled. The president's scientists are peripheral to the political structure of the presidency because science has made itself peripheral to politics.

No amount of sermonizing can compel a flood of mathematicians, physicists and biochemists into seeking elective office. The laboratory is a poor launching pad for politics. However, the prevailing anti-political culture of science encourages the field to stick to the ghetto, and perhaps even to strengthen its walls. In 2000, over half a million holders of PhDs in the natural and physical sciences and in engineering were employed in the US. Only four were members of Congress.

The isolation of science from politics is furthered by traditions that have become entombed in bureaucratic concrete. Consider a small but revealing item, the anachronistic title of the venerable National Science Foundation, an organization whose historic and spiritual significance for science transcends its money-giving capacity. The NSF long ago acquired responsibilities beyond science, expanding into engineering and elementary and high school science education. However, the mandarins of academic basic research scramble to the ramparts at the hint of a title expansion that would accurately reflect the work of the NSF. Their friends in Congress, with little interest in this obscure sectarian strife, find it simplest to leave the name unchanged. Meanwhile, the managers and beneficiaries of NSF express puzzlement and disappointment over the failure of politics to provide the agency with funds that match its expanded responsibilities. On good grounds, they contend that the foundation's entire budget, over $4.5 billion in 2001, could be well spent in any one of the three sectors: science, engineering, or education. By monopolizing the title, the scientists assert a symbolic claim over NSF, but at the cost of truth in labeling and the potential for broadening public and political recognition and the financial fortunes of the foundation.

In the senior echelons of academic science, political vision is blurred by reverence for basic research and outdated anxieties over its political support. The self-designated legatees of Vannevar Bush ominously chant that applied research drives out basic research. But through good times and bad, both the White House and Congress have strongly supported basic research, even during those periodic bouts of political infatuation with technology.

For purposes of prodding science out of its isolation and broadening political and popular support for science, wonders might be achieved through an even more expansive name change: why not make it the National Science, Engineering and Humanities Foundation, with perhaps a nonscientist at its head? The chieftains of science will gag on that proposal as a denial of their place in the sun. Congressional barons, sensitive about maintaining their jurisdictions, will resist loss of authority. The long-deprived humanists will probably fear a trick by the politically suave scientists and their political compatriots. But let's not file away that suggestion in hopes someday of a more favorable environment for reshaping the science wing of the US government.



Chad Evans Wyatt

Daniel S. Greenberg

A first step would be to recognize the beneficial potential of housing science and the humanities under the roof of a single government source of financial support. Nothing is certain in these matters, but the merger might contribute to the intellectual enrichment of both the sciences and the humanities. We might recognize, too, that separate bankrolls do not advance the goal of bringing together the two cultures.

Another beneficial step would be removal of the physical sciences from the chronically dysfunctional Department of Energy, and their resettlement into an independent agency or the well-run NSF. As for the National Institutes of Health, with an annual budget that exceeds $20 billion and continues to rise, the problem is bureaucratic elephantiasis in a government agency that holds a near-monopoly on finance for the biomedical sciences. A breakup of the NIH into several separate government philanthropies for the medical sciences would introduce the vigor of competition into a sector that constantly flagellates itself for scientific conservatism and operational sloth — without correcting either.

These suggested changes would contribute to opening the politics of science to public view and — horror of horrors — political scrutiny and contention. The object isn't more money or less money, though more could conceivably result from bringing science into the political mainstream. The object is to encourage science to bear its responsibilities in a new millennium dominated by the works of science. For over 50 years, the political instincts and talents of science have been heavily focused on a single goal: more money. Now it is time for the people and institutions of science to justify that confidence by stepping out into the unruly world of politics.

Daniel S. Greenberg is a Washington-based journalist and the author of ***Science, Money and Politics****, published in 2001 by the University of Chicago Press. The above is excerpted by permission of the author.*

Physicist Jumps Into Texas Senate Race

APS Fellow Lawrence Cranberg has yet to read Daniel Greenberg's book *Science, Money and Politics,* the source of this month's Back Page, but he is answering the call to public service nonetheless. Cranberg is seeking the 2002 Republican nomination to fill the seat of retiring Texas Senator Phil Gramm. As a political outsider Cranberg casts a much lower media profile than his opponent for the nomination, Texas Attorney General John Cronyn, not to mention a field of veteran politicos battling for the state's Democratic nomination. But if his bid is successful, Cranberg will be the first PhD physicist ever to join the Senate ranks.

Although he is new to the campaign trail, Cranberg is no stranger to political activism. He was a technical advisor for the US delegation to the First International Conference on the Peaceful Uses of Atomic Energy in 1955. While teaching at the University of Virginia (UVA), Cranberg also served as chair of the Central Virginia American Civil Liberties Union (ACLU), and helped the ACLU file a case that opened UVA to women students in 1970.

Readers of *Physics Today, APS News,* and other publications may know Cranberg, 84, as a tireless, and sometimes brusque, letter writer who takes editors to task over issues ranging from age-based bias to educational policy to some of the finer points in recent science history. Education and science policy are pivotal points in Cranberg's campaign, but his role as a scientist among politicians may be his most distinguishings characteristic. "What does America need more in the Senate," Cranberg asked during a recent interview, "a fifty-fourth lawyer, or the first physicist member?"

For more information about Lawrence Cranberg's political aspirations, visit www.LawrenceCranberg.org.