FAS
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Budget Priorities for 2006

Henry Kelly

If you wanted to mark the moment the United States decided that it no longer cared to be at the forefront of world science, you might choose February 2005, when the administration presented its proposed FY 2006 budget to an apparently compliant Congress.

The U.S. economy is being battered by sophisticated foreign producers. U.S. students are below world standards in mathematics and science. We face challenges in energy, the environment, security, health care and other areas that can only be met with major innovations. And the scientific community is facing an extraordinary array of challenges, questions, and mysteries. It would seem that this is precisely the time for a renewed national commitment to maintaining U.S. preeminence in science and technology. Yet the funding for science and technology would be cut by more than 3% in constant dollars. The cuts are greater than 4% if the National Aeronautics and Space Administration's (NASA) "exploration missions" aimed at manned missions to the moon and Mars are not counted.

Research budgets are likely to continue to fall in future years as the Congress struggles to find ways to avoid catastrophic budget deficits without increasing taxes. Details are not available since, in a break with decades of precedent, the administration declined to show any budget detail beyond 2006. But the American Association for the Advancement of Science (AAAS) estimates that by FY2009 the National Science Foundation (NSF) budget would decline by 4%, The National Institutes of Health (NIH) by 5.8% and science in the U.S. Department of Energy (DOE) by 9.5%.

The depth of the cuts for science is masked by two additional factors: (1)

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Hans A. Bethe – The Supreme Problem Solver of the 20th Century

Hans Albrecht Bethe, 98, a leading Manhattan Project scientist who was active with the FAS, died March 7 at his home in Ithaca, New York. He inspired a generation of scientists by showing how scientific expertise can help to shape sensible U.S. policy on nuclear weapons and many other areas.

According to nuclear historian Robert S. Norris, Bethe was "the almost perfect expression" of the scientist-activist, driven by a sense of responsibility for his own atomic breakthroughs and those of his physicist colleagues. "He saw his role as to educate the public and the policy-makers about the new dangers and to help figure out ways to control them," Norris said in the New York Times' obituary March 8.

Photo: Charles Harrington/ Cornell University Photography

Richard Rhodes, who wrote about Bethe in his 1986 history of the U.S. atomic bomb, said Bethe "more than any other leading figure of the Manhattan Project, agonized over his participation, first in the bomb itself and then in thermonuclear research" to see if a hydrogen bomb was possible.

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Journal of the Federation of American Scientists

In This Issue

About FAS
The Federation of American Scientists (FAS), founded October 31, 1945 as the Federation of Atomic Scientists by Manhattan Project scientists, works to ensure that advances in science are used to build a secure, rewarding, environmentally sustainable future for all people by conducting research and advocacy on science public policy issues. Current weapons nonproliferation issues range from nuclear disarmament to biological and chemical weapons control to monitoring conventional arms sales and space policy. FAS also promotes learning technologies and limits on government secrecy. FAS is a tax-exempt, tax-deductible 501(c)3 organization.

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Phone 202.546.3300
Fax 202.675.1010
E-mail fas@fas.org.

EDITORIAL STAFF
Editor: Henry Kelly
Managing Editor: Monica A. Amarelo

FAS in the News

December 17. A letter by FAS vice president Kay Howell appeared in **The Washington Post.** Howell disagreed with two post pieces stressing the negative aspect of video games. "The future of learning could be well-served by video games" because young people "are in the habit of concentrated play for hours" and are motivated "to master ever harder challenges" to get to the next level. "Teachers would love to tap into these qualities for academic subjects," she wrote.

January 3. Marketplace Radio interviewed Ivan Oelrich and Jaime Yassif on the problem of cleaning up after a dirty bomb attack.

January 19. FAS' "foam home" housing design was examined in a shake-table test in the Trentec laboratory in Cincinnati. Local media coverage included **WPCO TV** and **The Cincinnati Inquirer.**

January 27. The Christian Science Monitor quoted FAS President Henry Kelly, "These inexpensive composite panels can be used to build homes that are safer, less expensive to build and operate, and more comfortable than conventional home construction."

January 27. A CH 53E Super Stallion Marine helicopter crashed in Iraq, killing all 31 aboard in one of the deadliest days for Americans in Iraq. **The New York Times** quoted Ivan Oelrich on the difficulties helicopters have ''in a dusty, desert environment" where they have to fly low and slow and are vulnerable to ground fire.

February 14. Time quoted Ivan Oelrich in a cover story on nuclear proliferation. Oelrich said the wide availability of raw material and scientific expertise made "the simplest nuclear bomb" possible.

February 15. Henry Kelly was quoted in **Nature** concerning the poor state of science advice.

The **Hartford Courant** (Connecticut) was among the papers using an FAS editorial advisory with reasons papers should oppose the Administration's request for new nuclear weapons in the FY 2006 budget. The advisory went out with the release of Nuclear Missions after the Cold War.

February 18. The Discovery Channel aired a segment on the housing shake test.

February 20. National Geographic broadcast a one-hour special, "Inside Shock and Awe," about how precise was the bombing of Baghdad in the 2003 Iraq war. Ivan Oelrich was quoted on the evolution of precision weapons. Another expert was PIR author Stephen Biddle and author of "Military Power" (Public Interest Report Fall 2004). (http://www.nationalgeographic.com/channel/explorer/)

February 16. The Congressional Quarterly covered a breakfast with Senator Chris Dodd (D-Conn) to describe the Digital Opportunity Investment Trust legislation and new economic studies.

February 17. A column by Marcella Sanchez in **The Washington Post** reported that Richard G. Lugar (R.-Ind.), chair of the Senate Foreign Relations Committee, may introduced a Conventional Arms Threat Reduction Act, or CATRA. In 1991, Lugar co-sponsored the Nuclear Threat Reduction Act which helped deactivate more than 6,500 nuclear weapons in the former Soviet Union. Sanchez wrote if CATRA is similar, it "couldn't be timelier for Latin America." Homicides from firearms are "five times higher in the region than in the rest of the world." The column quoted Matthew Schroeder, FAS Arms Sales Monitoring Project Manager.

February 20. Ivan Oelrich and Matthew Schroeder appeared on a one-hour program, "The Deadliest Weapon," aired on **The History Channel's Modern Marvels.**

March 15. Government Executive, a monthly publication for government officials, Congress and the media, ran a feature on the "deficit" in federal support of science. An accompanying article focused on the recommendations of *Flying Blind,* FAS' report on the poor state of science advice.

March 26. Has Pakistan configured the U.S. F-16s it obtained in the 1980s to carry nuclear weapons? When the Bush Administration announced plans to sell F-16s to Pakistan, a previously little-known report obtained by the FAS Government Secrecy Project under FOIA, revealed that U.S. intelligence had told the White House, which told Congress in 1992, that Pakistan had possibly altered the planes for this purpose. A number of publications picked up the item as debate began over the proposed F-16 sale.

We are at the End of a Long Process of Having Conventional Weapons Displace Nuclear Weapons…"

Ivan Oelrich

Excerpts from Ivan Oelrich's "Missions for Nuclear Weapons After the Cold War," an FAS Occasional Paper No. 3, published January 2005.

Nuclear weapons are instruments of immense military and political power. Their existence affected every aspect of the Cold War. The appropriate roles of nuclear weapons are less clear now that the Cold War is over and much of the current U.S. nuclear force posture is extrapolated from the past. In spite of great changes in the strategic environment, the United States and Russia still maintain arsenals of over seven thousand nuclear weapons, most with explosive force equivalent to hundreds of thousands of tons of TNT, and most ready to launch within minutes…Even when the United States and Russia move toward the two thousand or so weapons envisioned by the SORT Moscow Treaty, the U.S. nuclear force structure will be a scaled down version of its Cold War arsenal.*

In addition, the United States, and probably Russia, are exploring new missions for nuclear weapons…

Soon after the collapse of the Soviet Union, there were suggestions to seize the moment and try for large reductions in nuclear forces. Other voices urged caution, pointing out that…changes in …Russia could be quickly…reversed. This reasoning led the first Bush and the Clinton Administration toward a strategy of "hedging," by deliberately allowing force reductions to lag behind international political changes until the changes were irreversible…

The current Administration developed a nuclear strategy that purports to leave Cold War thinking behind entirely and start with a clean slate; yet the resulting force structure is remarkably close to what would be required to achieve the Cold War mission of a disarming first strike against Russia…

The Administration has explicitly decoupled nuclear missions from specific threats and has focused on nuclear *capabilities*…[O]ne could imagine that in five years every potential nuclear threat from Iraq, Libya, Iran, and North Korea could disappear but, using the Administration's approach, U.S. nuclear requirements would not change…

"Using only the Administration's four goals, it is difficult to evaluate how nuclear weapons might undermine U.S. security, that is, it is difficult to evaluate nuclear missions' costs that can then be compared to benefits…In fact, using the goals and presumptions presented in the NPR never gets us on any path leading to a world where nuclear weapons are substantially de emphasized or de-legitimized…

[But in Oelrich's mission-by-mission assessment] A nuclear mission that actually encourages proliferation will get a negative "dissuasion" score. A mission that contributes to first strike instability will get a negative deterrent score…

This report's analysis finds that nuclear weapons can fulfill most (but not all) of the missions set out for them…The question therefore is not their effectiveness, but how useful they are compared to alternatives and what are the consequences of their development, deployment and use?

In most missions, the marginal improvement in effectiveness [of nuclear weapons] compared to modern precision guided munitions, is small…The marginal costs, whether measured along strategic, proliferation, or moral dimensions, are potentially huge. For the vast majority of missions considered for nuclear weapons today, they are not the weapon of choice…

Our examination of fifteen missions for nuclear weapons makes clear that some advocates of nuclear weapons have a tool and are looking for uses for it…

Of the fifteen missions evaluated here, only five demand nuclear weapons. [Overawe, virtual power and war termination missions] could depend on specifically nuclear use. [If China or North Korea used nuclear weapons against the United States he US we also might respond with nuclear weapons. But none of these four require the size and structure of the present force. Only] "the need to maintain a disarming first strike [against Russian forces] seems to drive the size, structure and deployment of U.S. nuclear force. This is also the mission that most tightly binds US force requirements to the size of the Russian arsenal.

If *and only if,* the United States and Russia can find some way to forgo this mission, most likely through agreed reductions and changes in the characteristics of their delivery systems, are further major reductions in the world's nuclear arsenals possible.

All of the remaining missions are potential nuclear weapons but conventional weapons can also fulfill each. We are at the end of a long process of having conventional weapons displace nuclear weapons."

* The Moscow Treaty (SORT) requires each side to reduce to "1,700 to 2,200" by YEAR from 5,968 strategic warheads today "accountable" to the US force 5,000 are counted in the Russian strategic force, though many are reported to be inoperable. Yet after the proposed reductions, Oelrich writes, "the U.S. nuclear force structure will be a scaled down version of its Cold War arsenal." We will be "left with weapons far beyond the numbers needed to destroy either country, so the treaty is of less practical effect than the numbers alone would suggest."

"Advocates of greater consideration of nuclear use do not want profligate nuclear bombing. Oelrich writes. "The central debate is between those who want it to be rare, and those who want it to be very, very rare. "Therefore the issue is whether the United States should maintain, or develop, nuclear weapons" for the few special cases where they seem advantageous, on the chance these extraordinary circumstances would arise?" (p. 8)

Why this situation persists – *fear of it being part of the landscape?*

"[F]ears of nuclear dangers have lost much of their political urgency. Many follow the easiest political and bureaucratic course,

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FAS Publishes National Survey of First Responder Training

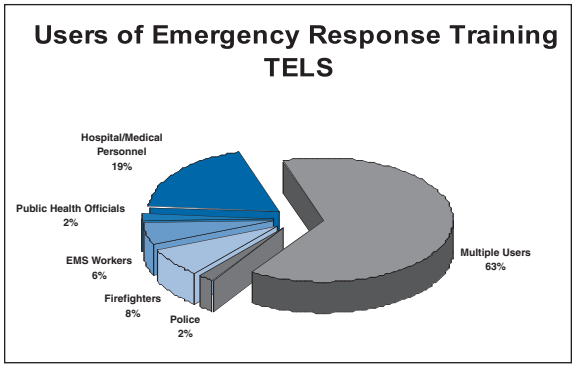
Adam Burrowbridge

Three years and $8 billion after the call for increased funding for emergency preparedness, there is little documentation on progress our nation has made to address this call, particularly in the area of training first responders. Numerous new federal training programs are being funded or are under active consideration, but absent better coordination and approaches to the dissemination of training materials, much of the investment is likely to be wasted and decades could pass before our first responders' training needs are met.

FAS is advocating a coherent national approach to mass casualty incident responder training to ensure training materials are peer-reviewed and certified and that investments stimulate development of affordable training systems that transfer into high levels of performance in an actual emergency. In February, FAS' Learning Federation (LF) published a survey of technology-enabled learning systems, or TELS, for first responder training. TELS include multi-media computer-based training (CBT), web-based training (WBT), and newer training technologies, including intelligent, individualized coaching, computer-based simulations, performance assessment, and feedback capabilities that have been demonstrated to help trainees build expertise that can be used quickly and efficiently in the case of a real emergency. *Emergency Training Systems – A Survey,* by LF Research Assistant Becky Sullivan, examines the features typical of current training products to assess progress in implementing these advanced approaches to training.[1]

According to William O. Jenkins, Jr., Director of the Homeland Security and Justice Issues at the Government Accountability Office (GAO), "The federal government has allocated between $6 and $8 billion since 9-11 to enhance emergency preparedness nationwide… But the GAO does not know how much has gone for planning, training, and exercises. And GAO does not know how much has gone specifically to train first responders because the largest grants, such as the State Homeland Security Grants, can generally be used for planning, equipment purchases, training, and exercises, at the discretion of the grant recipient."[2]

For our survey, we first identified several hundred emergency training products through Internet searches. From this initial set of training products, we selected 54 for further study based on descriptions of training features, the product release date (we selected those with the most recent release dates), and the target markets (we selected products targeted at first responders to mass casualty incidents).



Source: Emergency Training Systems – A Survey, Becky Sullivan, FAS Learning Federation

Who is developing emergency responder TELS? Private companies developed 73% of the TELS surveyed. Which user groups are targeted? We found 19% are aimed specifically at hospital personnel, while 8% are focused on firefighters. We found 63% of the TELS surveyed aim to meet the need of multiple audiences.

What features characterize these TELS? The survey looked at the following areas: assessment, question asking and answering, motivational strategies, interactivity and standards to promote certification and re-use.

Sophisticated assessments can be used to tailor instruction to the needs of individual learners and evaluate the capabilities and preparation of individuals, teams, and units. Yet, for more than half of the TELS sampled we were unable to determine the method of assessment. We found 20% of the TELs surveyed provide evaluative feedback at the end of the training session and only 19% assess performance after each learning objective.

Use of simulations in training can immerse trainees in situations like the ones for which they are being prepared, using techniques ranging from simulated equipment operation to role playing. Our survey found that only 31% of the TELS sample employ simulation capabilities and only 6% utilize virtual reality technology. Motivation has been found to have a direct effect on learning outcomes, affecting the amount of time people are willing to devote to learning and practice, yet only 25% of the TELS surveyed use motivational strategies.

The survey illustrates that very few of today's training systems implement training methods that have been demonstrated to produce substantial improvements in instructional effectiveness. This is alarming because our MCI first responder training needs are dramatically larger in scope and more complex than anything the nation has faced before. This conclusion echoes the DHS's ODP. The ODP office issued voluntary guidelines to guide developers of these training products. It also stated that "a more distributed and flexible model is needed to guide future efforts. The training model must be agile enough to address dynamic requirements quickly."iii However, these voluntary guidelines are insufficient. Given the importance of ensuring well-trained first responders, DHS should include learning science and technology R&D as a critical component of its S&T portfolio.

The FAS Learning Federation supports these goals. We continue to research how to make TELS more engaging, effective and accessible to many kinds of learners, including emergency responders. These TELS can be cost effective for emergency response training by being reusable; they can also be quickly modified to reflect new information or threats. Our Learning Science and Technology R&D Roadmaps show how future TELS can help the nation achieve key education and training needs.

Adam Burrowbridge is Learning Technologies Research Assistant at FAS.

Of Red Parakeets and Dragon Fire: The Nonproliferation Case for Maintaining the EU Arms Embargo on China

Matthew Schroeder

Despite remarkably strong opposition from the United States, momentum is growing within the European Union to lift its 15-year-old embargo on arms sales to China. In January, U.K. Foreign Secretary Jack Straw said that it was "more likely than not" that the embargo would be lifted by July. Responding to international concerns that lifting the embargo would loosen controls of arms sales to China, Straw was quick to add that changes to the European Code of Conduct on Arms Sales would offset the effects of ending the embargo. "If it is lifted we will end up with as effective arms controls in relation to China as we have now," he promised.[1]

But even if Straw can deliver on that promise – a big "if" – lifting the embargo is still problematic and begs the question, why now? Beijing's human rights record – the original raison d'etre for the embargo – is still poor, and China if anything seems closer to a military confrontation with Taiwan.[2] Equally alarming is China's arms export record, which remains flawed despite constant goading by the United States.

In recent years, the Chinese government has taken steps towards complying with international nonproliferation norms and reining in its arms manufacturers. In 2002 for example, China published a comprehensive export control list of missile-related items that Assistant Secretary Paula DeSutter praised as "a significant and welcome step."[3] Such steps should be applauded and in some cases rewarded, but not with additional military hardware. The Chinese still have a lot of work to do.

The U.S. intelligence community has long tagged China as a prominent proliferator of dangerous military technologies. In 1997 the Central Intelligence Agency identified China as "the most significant supplier of WMD-related goods and technology to foreign countries" during the last half of 1996.[4] Beijing's efforts to stem these exports have yielded some results, but Chinese firms continue to engage in problematic transfers. In March 2004 the Director of Central Intelligence George Tenet testified that "Chinese firms continue to be a leading source of relevant [ballistic missile] technology and continue to work with other countries on ballistic missile-related projects."[5]

Indeed, troubling transfers of Chinese military and dual-use equipment are numerous. In 1996, an 16-month Federal sting dubbed "Dragon Fire" culminated in the confiscation of 2,000 fully automatic Chinese AK-47 assault rifles that had been illegally imported into the United States from China. Massive arms shipments interdicted on U.S. soil are usually en route to Latin American guerrillas or drug cartels. Not this time. According to customs officials, the dealer (a Chinese immigrant reportedly working with two large Chinese defense firms) thought the ultimate recipients were "gang bangers" in the United States. The dealer also reportedly offered 60 mm mortars, rocket launchers, and "Red Parakeet" shoulder-fired surface-to-air missiles to undercover agents, who told him that they would be sold to right wing radicals in the U.S. and terrorists in Ireland and Latin America.[6]

During the investigation, the dealer repeated that the "Chinese government knew exactly what was going on."[7] This claim has not been substantiated, but court documents indicate that officials from two large, state-controlled Chinese companies were involved in the deal. Commenting on role of China North Industries Corporation (NORINCO), the Department of Justice stated that "[t]he shipment of weapons from the Dalian plant of NORINCO involved the active participation of that firm's PRC-based vice president, export manager and other officials."[8]

NORINCO has come under fire for other transfers, including the sale of missile technology to Iran. In May 2003 the Bush administration slapped a two-year ban on NORINCO imports as punishment for engaging in "missile technology proliferation activities." The ban reportedly cost NORINCO $100 million a year in lost U.S. sales.9 DeSutter, the Assistant Secretary of State for Verification and Compliance, has described NORINCO as a "serial proliferator" that escapes punishment from Beijing despite the exasperated pleas of U.S. officials. "For some time, we have been alerting the Chinese Government to our concerns about the activities of NORINCO," Sutter testified in July 2003. "Nonetheless, the Chinese government has taken no action to halt NORINCO's proliferant behavior."[10]

As mentioned earlier, the Chinese have adjusted their arms export policies and practices in several significant ways. Too often, however, these improvements come only after the U.S. brandishes the stick of economic sanctions. The EU embargo is a crucial diplomatic tool for prompting long-term reform. China resents being lumped together with international pariahs like Burma and Zimbawe, both of which are also under European arms embargos, and is anxious to shed the stigma associated with the embargo.[11] Lifting it before China makes necessary changes to its arms export practices needlessly eliminates a key incentive for doing so.

Until China's track record on arms exports improves dramatically and consistently, the embargo should be maintained.

Matthew Schroeder is the Manager of the Arms Sales Monitoring Project at FAS.

[1] Stephen Fidler, George Parker and Frederick Studemann, "UK Expects Brussels to Lift China Arms Ban," *Financial Times,* 13 January 2005.

[2] In December 2004, China released a defense white paper that reportedly threatened to "thoroughly crush" a Taiwanese move toward formal independence "at any cost." Caroline Cluck and Richard McGregor, "China 'Will Crush Taiwan Independence Moves'," Financial Times, 28 December 2004.

[3] China's Record of Proliferation Activities," testimony of Paula DeSutter, Assistant Secretary for Verification and Compliance, before the U.S.-China Commission, 108th Congress, 24 July 2003. See also Jonathan Davis, *Export Controls in the People's Republic of China: 2005,* Center for International Trade and Security, University of Georgia, 13 January 2005.

[4] Director of Central Intelligence, "The Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions July – December 1996," June 1997, available at http://www.fas.org/irp/cia/wmd.htm.

[5] "The Worldwide Threat 2004: Challenges in a Changing Global Context," testimony of George J. Tenet, Director of Central Intelligence, before the Senate Armed Services Committee, 108th Congress, 9 March 2004.

[6] Richard Cole, *Associated Press,* 24 May 1996.

[7] "Massive Seizure of New Automatic Weapons Illegally Smuggled by PRC Weapons Producers," Press Release, United States Attorney, Northern District of California, U.S. Department of Justice, 23 May 1996, available at ttp://www.courttv.com/archive/legaldocs/misc/smuggle.html.

[8] Ibid.

[9] Shirley A. Khan, "China and the Proliferation of Weapons of Mass Destruction," *Congressional Research Service,* 20 May 2004.

[10] DeSutter, "China's Record of Proliferation Activities."

[11] Rana Forhoohar, "Arms Embargo: No Lift in Sales," *Newsweek,* 7 March 2005.

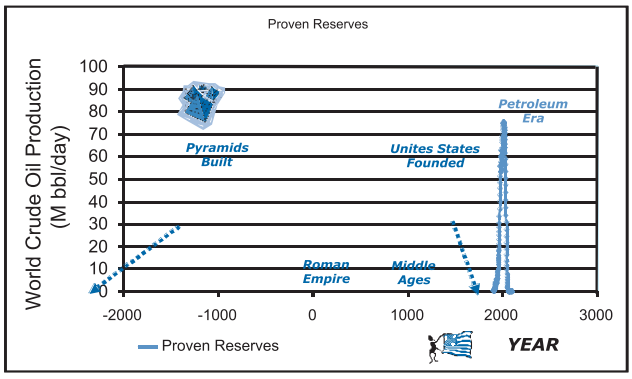
Options and Implications for Future Automotive Fuels

Charles L. Gray, Jr.

This article contains a condensed summary of the remarks made by Charles L. Gray, Jr., Director of the U.S. Environmental Protection Agency's Clean Automotive Technology program, at the Congressional R&D Caucus meeting on January 28, 2005.

Crude oil consumption and production capacity are among the most important topics today in the United States and in the world. The developed countries are obviously dependent on crude oil for fueling their industries and transportation systems. As developing countries advance, they too become more dependent on petroleum for quick energy to fuel their emerging economies. China, for example, is experiencing phenomenal growth and doubling its crude oil consumption every eight years. Some estimates predict that by 2030 China will consume as much petroleum as the United States.

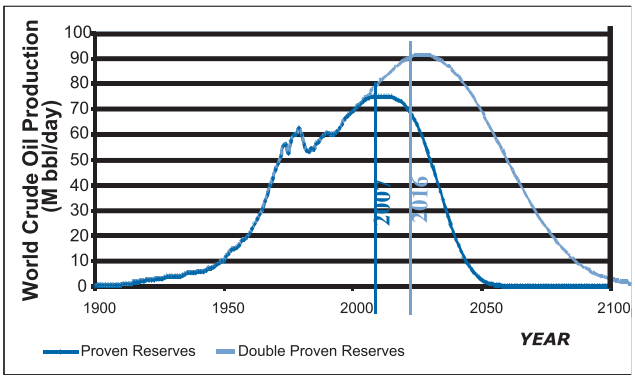
The timeline in Figure 1 puts a historical perspective on world wide petroleum consumption. The petroleum era will be seen as a very short portion of world history, where nearly all of the crude oil resources were consumed. When, not if, world petroleum consumption exceeds production capacity, transportation and economic growth around the world, as well as life as we have known it, will change.



Source: EIA - Department of Energy

Figure 1: Timeline for World Crude Oil Production and Consumption.

Zooming in for a closer look in figure 2 at the oil consumption peak reveals that the peak of world oil production could arrive as soon as 2007 (the red curve). Using a sensitivity analysis, we doubled today's proven reserves (the green curve) – assuming we could somehow find twice as much oil world wide than we know exists today – to see how much more time we would have available for, if you will, a transition period. It is quite sobering to realize that this does not move the peak much further away, around 2016 – 11 years from now!



Source: EIA - Department of Energy

Figure 2: Timeline for planning for post Petroleum-Era Fuels.

This does not mean we will run out immediately when we reach the peak, but prices *will* go up around the world when oil production can just meet consumption needs. This will be a global phenomenon because most countries import oil. Countries that have money will pay more for the oil, and the poorer countries will have even more difficulties economically as they struggle to grow their economies into prosperity. Eventually, as prices continue to rise, we'll begin to see crude oil consumption reduce because the world will not have enough petroleum to meet unlimited demand.

It is extremely important to begin planning for some kind of transition with a sense of urgency, first, because the production/consumption peak is almost certain to occur in the foreseeable future, and second, because it takes so long to make changes in vehicle technology and fuel infrastructure. It will take a long lead time to switch to different kinds of vehicles that have high efficiency and use different kinds of fuel.

Obviously, there are a lot of implications due to the global use of oil – climate change, green house gas emissions, as well as other obvious direct environmental consequences. As with all energy consumption, our use of oil consumes the commodity and yields no long-term value or equity for the expenditure. This consequence has huge economic implications, as the world's massive oil consumption results in almost unimaginable transfers of capital to purchase the crude oil from supplier countries. The economic implications are clearly seen by simply examining the U.S. trade deficit and seeing its link to U.S. dependency on imported oil.

The US is experiencing an ever increasing negative trade deficient, with the 2004 total deficit being close to $600 billion dollars away from our economy. Imported petroleum products constitute nearly 25% of our trade deficit. With the current price of petroleum near $50 per barrel, it should not be surprising to see 2005's trade deficit for imported oil to be over $200 billion dollars. We need to understand that the US is continuing to increase its dependence on imported oil, and the economic consequences of this situation will only get worse with time.

Future Fuels

Having examined the economic situations that will certainly drive changes in transportation, we must look forward in our search for the technology opportunities that exist for future advanced *fuels, engines* and *drivetrains.* First we will examine the options and choices for advanced transportation fuels, and then later examine advanced engines and drivetrains.

But before beginning, I would like to highlight that EPA's experience has shown that it is most often best to set performance standards for new technologies, rather than try to pick specific successful technologies in advance. Unless one can

Future Fuels

Bio-diesel, which has received a fair amount of attention, is a good diesel fuel. The big question with bio-diesel is cost and total quantity that can be provided from its base resource.

Fischer-Tropsch Diesel is basically a high-quality diesel fuel that can be made from any organic material such as coal, natural gas, or municipal waste because it's made through a gasification process. We believe that gas-to-liquid or other gasification-based transportation fuels, even if the gas may have started out as coal, are likely to be the primary source fuels for the post petroleum-era transportation system. There is a substantial amount of diesel made world-wide now by gasification and catalytic processes using coal or natural gas.

Dimethyl Ether (DME) is another good diesel fuel that can be made from the same gas-to-liquid process, made by reacting methanol.

Methanol is also a very good transportation fuel, and from our analysis is the lowest cost of the above options.

Ethanol is not as likely to be a fuel derived from coal or natural gas, but is likely to continue to play a role being derived from corn and cellulose bio-mass.

Natural Gas, as well as LPG and propane, will continue to be used in vehicles, but the US does not have a large amount of excess natural gas available to meet the full appetite of the transportation system.

Hydrogen is a potential fuel that can be made from the gasification of natural gas, coal, etc.

Electricity is also a potential transportation fuel since we can potentially burn any base chemical energy feedstock to produce electricity and store it in batteries to run any electric vehicle. Electric vehicles have not turned out to be as cost-effective as we have hoped they would be, but potential technical improvements continue to be explored.

perfectly guess what the market place will ultimately find as the most cost-effective solution, we are always better off focusing on performance goals we want to achieve and allowing the natural market selection process to select the best solution.

Today, we see the primary transportation fuels are clean low sulfur gasoline and diesel (derived from petroleum), which are currently required in the United States for environmental reasons. There are quite a number of other transportation fuels that are being used in vehicles to some extent somewhere in the U.S, some of more promising which are described in the *Future Fuels* inset.

Natural Resource/Energy Feedstocks

The United States holds about 24% of the world energy reserves. The problem is the U.S. does not have much oil or natural gas. However, we hold about 25% of the world's coal reserves, and from a domestic stand point most of our energy is in the form of coal. Consequently, on a long-term perspective we need to be thinking about what transportation fuels are compatible with coal. We need to re-evaluate our position of continuing to import energy over the long haul and its effects on our capital base.

Gas-to-Liquid Processing

The gas-to-liquids (GTL) process takes natural gas, primarily methane, and essentially adds oxygen to it when it is passed through a particular catalyst. The product is hydrogen and carbon monoxide known as SYNGAS. These basic chemical energy carriers in SYNGAS are then reacted across different catalysts to produce various fuels shown in the insert.

Price of Non-Petroleum Fuels

These projections came from an in-house study where we looked at how different transportation fuels could be generated from various feedstocks including municipal waste. It shows the gasoline equivalent pump price of various transportation fuels including CNG, ethanol, methanol (which could also include Fischer-Tropsch diesel and DME), and electricity

World Natural Resource/Energy Reserves

Coal (61% of World energy reserves – 25% is in the US)

Most of the world energy is in the form of coal; The US as an individual country has the second largest amount of coal.

Oil (15% of World energy reserves – 2% is in the US)

Natural Gas (15% of World energy reserves – 3% is in the US)

There is a lot of natural gas with significant energy content, but much of it is "remote gas" that can't be easily transported to cities for use in home heating and factories. Natural gas will be in competition with coal as the next major energy source as we start running short on oil.

- We hear a lot about liquefied natural gas (LNG), which is natural gas chilled to –260 degrees Fahrenheit. Shipping liquid natural gas requires specially designed ships to keep LNG in its liquid form.
- Remote gas can also be converted on-site to a liquid like Fischer-Tropsch diesel, DME, or methanol and can be transported very cost-effectively to market.

Oil Shale (9% of the World's energy reserves – 90% is in the US):

The U.S. has a fair amount of oil shale, and there are also tar sands in Alberta, Canada along with a few other places.

Viable Transportation Fuels from GTL Processing

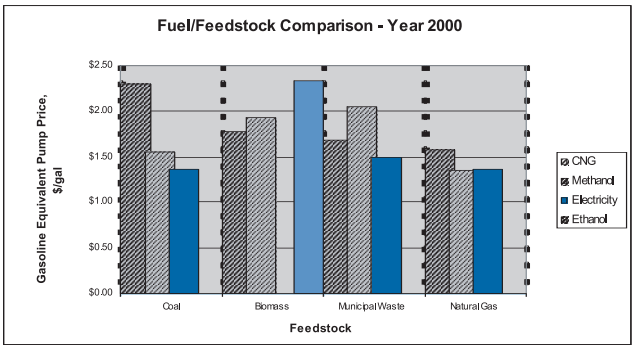
Methanol – is simply methane with one oxygen atom – which turns the gas into a liquid. Methanol is an extremely good fuel. Methanol is also being made in large quantities by the GTL process. MTBE, commonly used as a gasoline additive, is made from methanol.

Dimethyl Ether (DME) – the next most complicated molecule that can be synthesized from these building blocks is dimethyl ether, a very good diesel fuel.

Fischer-Tropsch Diesel – a fuel that is directly compatible with conventional diesel fuel and the current distribution system. Quite a bit of diesel fuel is already being made world-wide from this process.

that can be produced from a number of domestically available feedstocks.

The figure 3 reveals that the average pump price (including taxes) of these non-petroleum fuels made from these different feedstocks would be quite competitive to what we are paying at the pump today for petroleum based fuels. It shows that cost-effective options for domestically based transportation fuels are quite possible, if we can just plan and manage a successful transition.



Source: 1991 in-house staff study updated to 2000 dollars.

Figure 3: Price estimate of non-petroleum fuels form different feedstocks.

Economics of GTL Processing

In 2000 at an Energy Frontiers International conference, BP - the petroleum company, presented an interesting analysis showing very attractive business case economics for GTL processing (http://www.energyfrontiers.org/presentations/tftec1000.pdf). The BP presentation analyzed return-on-investment, cost of the energy feedstock, operating expenses, capital investments with an emphasis showing the manufacturing costs with four different profit margin scenarios, each producing a barrel of non-petroleum fuel at costs very compatible to today's cost of petroleum.

Non-Petroleum Highway Fuel U.S. Production Potential

(billion gallons, gasolineequivalent)

	2008		2010		2012	
	Low	High	Low	High	Low	High
Ethanol / Methanol	3.1	5.1	3.7	8.0	4.5	12.5
Biodiesel	.1	.24	.14	.6	.22	1.5
CNG/LPG	.2	.25	.22	.31	.24	.37
FT-Diesel	1.7	4.7	5.1	10.3	10.3	15.4
TOTAL	5.1	10.3	9.2	19.2	15.3	29.8
Hwy Fuel Demand	189		195		201	

Source: In-house staff sensitivity projections.

Note: From non- coal/shale feedstocks

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When comparing the cost of fuels made from a Gas-to-Liquids process, the BP presentation indicates that you can make a good return on investment making Fischer-Tropsch diesel from natural gas at a price comparable to a barrel of oil, *provided* you can be assured that oil prices would remain above $20 per barrel. In the past companies couldn't be assured that oil prices would remain above $20 per a barrel, so they did not want to risk building significant infrastructure to process high volumes of gas-to-liquids. However, at the point where there is sufficient certainty that oil prices will remain above $20 per barrel, we will begin to see a lot more investment in gas-to-liquids plants.

GTL Production Scenarios

The U.S. already produces a fair amount of ethanol fuel used for transportation from corn and this in-house analysis tried to realistically estimate what could be done to produce other fuels with serious investments in processing plants. The analysis looked at how much alternative fuel could be produced under two investment scenarios (one low and one high) – considering the availability of US energy resources/feedstocks (CNG, bio-mass, etc.), investment potential, etc. to arrive at these estimates.

The figure 4 shows that because of the tremendous amount of oil consumed every day, it would take a long time for us develop enough production capacity to make a significant supply of alternative fuels. The Fischer-Tropsch diesel was assumed to be derived from North Slope Alaska gas and transported through the excess capacity in the Alaska pipeline to Valdez. In the longer term, much larger quantities of transportation fuels could be produced from U.S. coal.

It's possible with the right kind of incentives we could see non-petroleum fuels representing 5-10% of transportation fuel demand in less than 10 years. Now this is not a lot, but it is so much more than we will have if we do not start soon. 2005 to 2012 gives us seven years to develop some alternative fuels in sufficient quantities to understand with some depth of experience the processes of making non-petroleum fuels for transportation. There must be a sense of urgency – today – if we are to be marginally prepared for the transition from petroleum to petroleum plus other alternative fuels for transportation.

Advanced Automotive Powertrains

While there are numerous options for feedstock and chemical forms of future transportation fuels including several attractive options for U.S. based resources, *it is still true that the lowest cost fuel and the fuel with the lowest environmental impact is the fuel we do not waste* through continue use of conventional inefficient vehicle powertrains.

The typical American uses less than 1% of the chemical energy in fuel to actually to move themselves (i.e., their weight) around in today's vehicles. *We waste an incredible amount of the chemical energy meeting our personal transportation needs.* If we are truly concerned about world energy consumption, then it is extremely important that we improve this situation and create much more efficient engines and drivetrains. If we double the efficiency, we cut in half the amount of petroleum consumption.

Clean and Efficient Engines

Today's big vehicles and bigger engines do not operate very efficiently. We have to think about designs that treat the fuel, engine and drivetrain as a system. The engine/powertrain converts the chemical energy in the fuel to useful work, and the transmission/drivetrain delivers that useful work to the wheels of the vehicle to transport us from place to place.

Clean and Efficient Drivetrains

Future drivetrains are being designed to improve vehicle efficiency. These drivetrains include Continuously Variable Transmissions (CVT), as well as Electric Hybrids and Hydraulic Hybrids. All of these drivetrains allow further optimization of the operation of the engine, and hybrids also provide the ability to recover braking energy. The inset shows two configurations for hybrids – parallel and series.

Advanced Engine Technologies

Clean Diesel Engines are the most efficient engines we have today, but in the past they were not as clean as gasoline engines. However, the new light-duty Tier2 and heavy-duty 2007/2010 emission standards require all engines, diesel or otherwise, to be as clean as gasoline engines. To meet these emissions standards, a new generation of diesel engines is being developed, holding great promise as a future powertrain technology. EPA has recently demonstrated a very clean and cost-effective way to burn diesel fuel called Clean Diesel Combustion (CDC). The engine-out emissions from CDC engines are clean enough to avoid the need for any NOx aftertreatment to meet EPA's HD 2010 NOx standards. In May 2004, International announced their partnership with EPA to explore the application of CDC to their V6 and V8 family of engines. Just this past January 2005, Ford and EPA announced their success in demonstrating CDC technology in Ford's Galaxy mini-van, where they met the critical Tier2 bin 5 emissions levels while maintaining the high fuel economy from of the diesel engine.

Methanol and Ethanol Engines dedicated to burning alcohol fuels have been proven to be much more efficient than those burning gasoline. EPA demonstrated engines which get diesel like efficiency (40+ %) with extremely clean combustion running with methanol and ethanol fuels. EPA believes that methanol engines could compete with diesel engines to greatly improve the vehicle efficiency over gasoline engines, while being extremely clean.

Variable Displacement Engines allow "re-sizing" a vehicle's engine to meet the power required as the driver's needs change. As an example, for normal urban driving operation only half the engine's cylinders are used so the vehicle fuel economy is more like one equipped with a small engine. But when there is a need for more acceleration or towing capability, the other half of the engine is available to provide the extra power. EPA has a unique concept for variable displacement engines that is different than today's cylinder deactivation systems. This engine has two crankshafts, essentially packaging two engines in one engine block. Each half of the engine is independently operated, so when one half of the engine's cylinders shut off the other half is stopped and does not generate friction or load. This approach improves the vehicle fuel economy by as much as 15%, far greater than displacement on demand designs.

Variable Compression Engines vary a key (conventionally fixed) engine parameter, the compression ratio, to meet the instantaneous optimum engine condition. When an engine is operated at light loads, the compression ratio is set higher to get high efficiency, and the compression ratio is set lower to enable high engine power when desired. By adding a supercharger to boost the engine, variable compression allows extension of power to even higher levels. A description of EPA's unique variable compression concept can be found in a technology report at www.epa.gov/otaq/technology.

Direct Injection Gasoline Engines are used in Europe and Japan to improve the efficiency of conventional gasoline engines. This technology is not broadly available in the U.S. because it has a problem meeting Tier 2 emissions standards.

Gasoline HCCI Engines (**H**omogeneous **C**harge **C**ompression **I**gnition) are run by introducing the fuel with the intake air and auto-igniting it from the compression stroke of the engine. Gasoline HCCI combustion is a nearer-term engine technology that produces extremely low emissions and very high fuel efficiency – competitive to the diesel. EPA has recently demonstrated an HCCI engine in a full series hybrid truck platform that achieved Tier2-bin2 NOx and virtually no PM emissions. There is a great deal of optimism surrounding this ultra clean engine technology, particularly when coupled with use in hybrid drivetrains.

Fuel Cell powertrain technologies are evolving, requiring hydrogen fuel to produce almost nothing but water as emissions. Currently, the fuel cell costs and an adequate hydrogen infrastructure are constraints. As we consider longer term options, future advanced engines versus fuel cells should provide some exciting competition in future vehicles. EPA is part of the California Fuel Cell Partnership and is partnered with UPS' fuel cell demonstrations by supporting hydrogen refueling at our Ann Arbor, MI laboratory.

Free Piston Engine technology provides an exciting glimpse to the future, where unique and new types of powertrain engines are enabled by series hybrid drivetrains. A **F**ree **P**iston **E**ngine ("FPE") is an exciting new kind of engine that doesn't have a crankshaft. EPA's FPE produces hydraulic power directly from the linear motion of the combustion piston without going through a crankshaft or hydraulic pump, making it an extremely efficient power plant for a future hybrid. EPA has successfully operated the first multi-cylinder four stroke free-piston engine in our laboratory.

HyTEC (**H**ybrid **T**hermal **E**nergy **C**onverters) describe a field of novel energy recovery systems capable of capturing and reusing some of an engine's waste energy normally rejected as heat in the coolant and exhaust (nearly 60% in a typical engine). A HyTEC device returns some of the recovered energy (30%-40%) as power to the engine's output shaft, typically working best with engines that mostly operate at continuous loads, such as long haul trucks. HyTEC technology development points toward engines that compete with fuel cells in terms of pollution & energy efficiency at a fraction of the fuel cell cost.

Hybrid Configurations

Parallel Hybrids retain a driveshaft connection between the vehicle wheels and the engine. In this concept, you add an electric or hydraulic motor to the drive shaft to add or remove power from the vehicle, storing and consuming energy to\from batteries or hydraulic accumulators. The Toyota Prius is a parallel system.

Series Hybrids remove the rotating driveshaft connection between the vehicle wheels and the engine. In a Series Hybrid, there is no conventional transmission or traditional driveshaft connected to the wheels. The engine transfers its power through electric generators or hydraulic pumps, and electric motors or hydraulic motors drive the wheels. Batteries or hydraulic accumulators are placed in the system to compensate for energy mis-matches between the engine and the wheel. In these vehicles, the engine operation can be optimized independent of the speed of the vehicle. This is the kind of drive system that can be most cost-effective, with the highest efficiency and the lowest cost.

Figure 5: Series hydraulic hybrid in a large car test chassis.

EPA summarized its hybrid concept work for large SUVs and passenger cars in a 200-page technology report comparing the efficiency, cost and consumer payback of: parallel verses series hydraulic hybrids; with gasoline verses diesel engines – with or without variable displacement. The report is available on EPA's web site (www.epa.gov/otaq/technology). One key point made in the report is that there are many highly efficient and cost-effective configurations of hydraulic hybrid SUVs, with low enough cost and high enough efficiency to offer the consumer payback in the range of 1–3 years. The following is a summary of hydraulic hybrid work being done at EPA's National Vehicle and Fuel Emissions laboratory in Ann Arbor, Michigan.

Figure 6: Full series hydraulic hybrid in a Ford Expedition.

Hydraulic Hybrid Test Chassis – Figure 5 shows our full series hydraulic hybrid test chassis (circa 2000), developed in conjunction with the PNGV program. This chassis represents a "large car" platform, like a Taurus or Impala. This chassis demonstrated over 85 MPG without any weight reductions from a baseline standard vehicle, or any loss in acceleration performance time. This demonstration vehicle led to several cooperative R&D partnerships, as well as licensing agreements with industry wanting to explore adapting this cost-effective technology to the market.

Hydraulic Hybrid Sport Utility Vehicle – Figure 6 shows our current work on a full series hydraulic hybrid Sport Utility Vehicle which we announced publicly at the 2004 SAE World Congress. The purpose of this vehicle is to demonstrate the synergies available from combining full series hydraulic hybrids with a diesel engine. In fact, we choose a small 1.9 liter diesel engine to show the performance of one-half of a larger diesel engine in urban driving (demonstrating part of the twin crank variable displacement concept). This vehicle is capable of improving the fuel economy of a typical large gasoline SUV by 85% (combined city/highway driving). During city only drive cycles, it is capable of 125% improvement in fuel economy over the baseline vehicle. This is all possible with a 1 to 3 year payback to the consumer.

Figure 7: Full series hydraulic hybrid system in a UPS truck.

Hydraulic Hybrid Urban Delivery Vehicle – Figure 7 shows another hydraulic hybrid project EPA is working on for heavy duty trucks. Urban delivery vehicles like a UPS truck operate on a heavy stop-go duty cycle and are very well suited for a hydraulic hybrid configuration. In February 2005 we announced our latest partnership involving International Truck and Engine Corporation (the largest U.S. truck manufacturer), Eaton (the largest U.S. based hydraulics supplier), UPS (a large fleet operator who wants to see how well these cost-effective hybrids will operate in the real world), and the U.S. Army (interested in hydraulic hybrid technology for military trucks). The partnership is building hydraulic hybrid vehicles to demonstrate a projected 60-70% improvement in fuel economy in an urban environment. This mpg improvement will provide fleet owners payback in 2–3 years.

Summary

Clearly, crude oil consumption and production capacity are among the most important issues today – not only in the United States, but throughout the world. Dependence on foreign crude oil stresses our environment and the U.S. economy, as well as that of other developed and developing nations. As the world reaches limits of crude oil production capacity, there will be both struggles and real economic incentives forcing change in transportation fuels, as well as in engine and drivetrain technologies. Fortunately, there are many choices which can actually make things better environmentally and economically. Unfortunately, the best clean, efficient and cost-effective choice is not yet clear. Today, we need to provide the right (performance based) kinds of strategic incentives, so the inevitable transition occurs on our terms, rather than waiting until we are desperate and forced to make changes quickly. The choice is ours to make.

Budget Priorities for 2006 *(Continued from pg. 1)*

sharp increases for presidential "visions" that bear no relation to the priorities of the serious science community, and (2) new security-related research funded in civilian agencies.

Setting Priorities

The budget provides no clear justification for the decision to cut back on research spending. Instead of the 12 pages or so that the budget usually devotes to describing the goals of research in health, energy, and basic science, this year's budget provides only two pages – most of which are devoted to explaining how well research programs are being managed. John Marberger, the President's Science Advisor, asked the House Science Committee to look on the bright side; research budgets were not cut as extensively as other domestic programs therefore the ratio of research to domestic spending has gone up. It's hard to take much comfort from this.

It is true that the budget documents are filled with rhetoric that would seem to point to tough-minded analysis of research priorities that would focus research funds where it would have the greatest potential impact. This year's budget texts are punctuated with terms like "management rigor," "focused, prioritized requirements," "corporate focus," and "spiral transformation." Yet somehow

Continued on next page

this process results in a budget that cuts funding for energy efficiency research and increases funding for planning a manned flight to Mars. And on the critical point of whether research is a higher value use of federal tax money than say sugar subsidies, the documents are completely silent.

Visions

The President's State of the Union address scarcely mentioned the subject of innovation. The speech mentioned science only twice: once to describe science that will not be supported (stem cells) and once to state that "my budget provides strong funding for leading-edge technology—from hydrogen-fueled cars, to clean coal, to renewable sources such as ethanol."

This presidential "vision" for hydrogen energy does get a $35 million increase—including an $11 million increase in the "nuclear hydrogen initiative." But growth of funding for hydrogen is more than offset by cuts in other energy research. Fossil energy research is cut by nearly 16%, and funding for solar, wind, hydro and geothermal energy research by $4 million. Biomass energy research, which includes ethanol, would be cut by nearly 40%. Energy conservation – including funding for energy efficient automobiles – would be cut nearly $21 million. It's difficult to reconcile these priorities with many recent reviews of priorities in energy research. Most suggest that research in hydrogen should be a part of a balanced portfolio of research and strategies creating incentives for new efficiency and energy supply technologies. But it's hard to find analytical reasons for cutting research in developing efficient vehicles, buildings, and a range of new energy supply technologies in order to fund the hydrogen program – let alone "nuclear hydrogen."

The second presidential "vision" referenced in the budget involves a commitment to return men to the moon and Mars. Strangely this didn't make it into the State of the Union, but it did make it into the budget with a serious amount of money attached. This vision is surprisingly close to the one developed in George H.W. Bush's administration, when Vice President Dan Quayle was instructed to find a new mission for NASA. But this time funding for many critical NASA research programs is being cut to make way for the new vision. It is unthinkable that any group of scholars asked to develop a set of research investments, most likely to yield important results, would have set such priorities. As in the late 1980s, the administration couldn't muster the courage to talk about the astronomical sums actually needed to put a person on Mars. Instead, the budget seems suspiciously consistent with one that would simply maintain the hugely expensive infrastructure of manned space flight.

If nothing else these "visions" put the high-flying rhetoric about sound management to an interesting test. First NASA somehow has been given a core mission that focuses on means and not scientific ends – a curious management objective. And while other research programs are held to tough measures of performance, the manned flight program has been made an investment priority in spite of the fact the program has never come close to meeting its program objectives since the Apollo program. The space shuttle was given a goal of achieving 50 flights a year but the fleet has made only 113 flights in 24 years – and lost 14 astronauts in the process. The space station lumbers along with apparently no apologies for the fact that it has never made a significant scientific achievement. Funding for the Viking and the Hubble rescue mission were eliminated in spite of their stunning record of discovery.

Security

A letter from 758 infectious disease researchers created uproar last month. It complained that the $1.8 billion being spent on biosecurity in NIH each year is unnecessary and diverts funds from higher priority research. I disagree with their contention that biosecurity funds are not needed, and believe that we should be pleased that the funds are being spent by NIH. But there is real reason to be concerned that these new programs mask the fact that traditional civilian research in NIH is being cut. Without the additional biosecurity spending and the goal of doubling the NIH budget would not have been met.

A similar pattern is threatening science at other agencies. It is tautological that the research in agencies such as Agriculture, NSF, EPA, Commerce, and others are cut, if they are asked to increase security-related research without a proportionate increase in funding. Yet that is precisely what is happening. The real cuts in federal domestic research would be much larger if adjusted to reflect the $2.7 billion in homeland security research that non-security agencies are being asked to do.

Looking Forward or Looking Back

The most troubling feature of the disastrous research proposals in this year's budget is that they don't seem to have created much concern. We drive to work in cars designed abroad and eagerly buy inexpensive cell phones using chips designed abroad. Much of this work is based on fundamental research funded by the U.S. over the years. Yet we somehow believe that Americans can continue to enjoy incomes five times higher than the world average without making the investments needed to stay ahead in critical areas of science and technology. It's difficult to avoid a sense that America has somehow shifted from a nation focused on the limitless promise of discovery to a place confident that all important truth has already been revealed.

The cuts in research are not the result of some natural disaster; they are the result of a conscious decision by federal leaders to cut taxes and cut research. The extreme right have made it clear that they want to ensure that taxes are set at levels that will "starve the beast." Apparently they are comfortable that research is part of "the beast" that must be starved.

Sources:

Federal Science and Technology Budget, Analytical Perspectives, Budget of the United States, 2006 (www.whitehouse.gov/omb/budget/fy2006/pdf/spec.pdf) and budgets for individual agencies AAAS R&D Budget and Policy Program (www.aaas.org/spp/rd/)

Shuttle Promise Unfulfilled, *Houston Chronicle.* 7/21/03 (http://www.chron.com/cs/CDA/ssistory.mpl/space/2003630)

"Sustainable" House Holds Up Through Strongest Earthquakes in Live Test

The "sustainable" house design being studied by the FAS Housing Technology Project will stay intact even when it is shaken by forces larger than the strongest known earthquake. This was the result of a live shake table test held on January 19 at the Trentec laboratory in Cincinnati, Ohio.

Coming soon after the devastating December 26 tsunami that swept across South Asia, the successful test aroused wide interest in this new technology. The design has already been shown to be cost-effective and safe in fire and wind. It is also environmentally friendly because it uses no wood. FAS considers it could provide earthquake-resistant, energy-efficient housing at very low cost to millions living in seismically active regions such as Indonesia and Afghanistan. (FAS Public Interest Report, Fall 2004 p.10)

The two-story model unit stayed fully intact through the strongest earthquake-like shaking in three dimensions.

The *Discovery Channel* was on hand shooting live. The test team was interviewed as the forces were made stronger. Rachel Jagoda, FAS Housing Technology Project Manager, H.H. "Hoot" Haddock of Thermasave Corporation of Florence Alabama, and Gary Chapman of Trentec, waited to see if it would fail – or at least bend – on the next round. FAS co-sponsored the test with Thermasave, which supplied the panels and the novel construction system.

Even though it uses no braces or framing, the structure remained fully intact to the delight of the test team. Jagoda said afterwards, it "showed that a home built from these materials would have survived the most severe earthquake ever recorded. It demonstrates that homes can meet the most rigorous seismic standards without increasing cost. In fact the structure is less expensive to build than standard 2'×4' framed construction and much more energy efficient."

"This test is the last of a series proving that these inexpensive composite panels can be used to build homes that are safer, less expensive to build and operate and more comfortable than conventional home construction," said Henry Kelly, FAS president. The system has been certified by the International Code Council and can be used for homes in the United States. FAS will use the technology to build an elegant home in Houston this summer, demonstrating that it is compatible with the highest standards of U.S. architecture.

Sustainable house is intact after shakeup simulating Earth's strongest earthquake
Two-story test house on the shake table at the Trentec Inc. laboratory in Cincinnati, Ohio. The house walls, floor and roof are made from expanded polystyrene panels cladded with cement board, which fit together without wood framing or braces. The house remained fully intact after being shaken up harder than the strongest recorded earthquake, in a test on January 19, 2005. This housing system is certified for building in the United States, where a number of structures have been built. Since the system is also cheap and energy efficient, the Federation of American Scientists (FAS) is researching its use in earthquake prone regions like Afghanistan. The non-profit FAS will have a demo home built in Houston, Texas, this summer to get this cheap, energy efficient technology better known. *Photo Credit:* Rachel Jagoda

For high resolution image go to www.fas.org. Select "Sustainable house" item and click on "Housing Technology Image Gallery."

For more information, call Henry Kelly at the **Federation of American Scientists,** 202-546-3300. For background on the project go to www.fas.org. On left of page select "Housing Technology."

Discovery's segment ran on "Daily Planet" on February 18 (link is at www.fas.org). *The Christian Science Monitor* wrote "now, a group of scientists hope to convince poor residents of seismologically active areas to replace their mud huts with foam homes."

The *Cincinnati Enquirer* noted that the first test was "equivalent to the San Francisco earthquake of 1989." In the last test "the simulator shook the house with a force of 5Gs (or five times the force of gravity) in three directions simultaneously." The paper quoted Trentec's Chapman saying: "After 1 G it's like throwing the house up in the air. We were basically trying to make it fly, and it held together. That's good stuff."

Haddock has refined the expanded polystyrene panel system for two decades. Afterwards he told the *Enquirer:* "There was no damage and we just simulated an earthquake beyond any in the history of the world. So I'd say I'm quite happy. It's taken me 20 years to get to this point."

More on the test and the FAS Housing Technology project is at (http://www.fas.org/main/content.jsp?formAction=325&projectId=17)

FOSEP – A Model Student-led Group Linking Science and Society

In early 2004, a small group of biomedical graduate students at the University of Washington began holding weekly meetings to discuss how they could create thoughtful dialogue on the social and ethical effects of their research. They felt that they had too few opportunities to address the implications of their work and that they were not encouraged or trained to communicate about the broader context of science in society. Our society has an unmet need, they believed, for scientists to communicate effectively with colleagues, the public and the policymakers who support their research.

To meet this need, the students formed a new organization, the Forum on Science Ethics and Policy (FOSEP). In its first year, FOSEP has organized public forums, meetings with policymakers, and lectures. This unique organization has captured national interest and was highlighted in Nature magazine.[2]

FOSEP reached out to key university leaders for support. The university's Office of Research graciously offered to 'host' the organization by providing some funding, administrative support and mentorship, while leaving FOSEP's agenda solely in the hands of its student leaders. Dr. Malcolm Parks, Associate Vice Provost for Research, became the group's most active mentor. Besides his office, more than a dozen other departments and programs at the University of Washington and Fred Hutchinson Cancer Research Center have made financial contributions to the group.

In April 2004, the directors began planning its first annual public forum: "Stem Cells: The Science, Policy, and Possibilities." The topic was chosen, in part, because the University of Washington is home to one of three federally-funded exploratory centers for human embryonic stem cells.[3]

Furthermore, in early 2004, the Washington House and Senate had introduced bills to allow and regulate human embryonic stem cell research and therapeutic cloning in Washington state. FOSEP members attended a public hearing for the House bill and were dismayed that no scientists testified at this hearing or had been consulted on the bill. When FOSEP selected this topic for the forum in early 2004, it did not anticipate that stem cell research policy would explode as a national issue in the presidential campaign.

On October 18, 2004 more than 750 Puget Sound area citizens packed the largest auditorium on the University of Washington campus to learn from an expert panel about stem cell science, ethics, and policy options and to share their views. In addition, earlier on the same day, FOSEP convened a stakeholders' meeting to connect scientists, physicians, elected state and national officials from both parties, ethicists, and business leaders to discuss state stem cell policy. This was the first time that many of the participating scientists had met with their state legislators; it sparked greater scientific participation in the state's development of stem cell research policy.

A group of graduate students at the University of Washington felt that they had too few opportunities to address the implications of their work and that they were not encouraged to communicate about science in society.

In 2005 scientists were involved in redrafting stem cell legislation (HB 1268) and in committee discussions and public testimony. The scientists discussed the potential impacts of this new bill on stem cell research in their laboratories and institutions and revised some of the scientific terms in. They corrected inaccurate statements made by non-scientists about stem cell science and got their expert opinions into the official record. HB 1268 passed 59-36 in the Washington House of Representatives March 15. The Senate voted for a companion bill the next day.

With the success of the first public forum and the wide interest in FOSEP's activities within the university, the four public forum organizers, who are senior graduate students, decided to expand the group and create a sustainable organization. Now a team of five directors lead a larger group of 30 members – graduate students and post-doctoral fellows – representing 15 departments, including biomedical sciences, atmospheric sciences, law, chemistry, and medical ethics.

Since its expansion, FOSEP has been organizing monthly academic seminars and small focus groups. The seminars feature national experts who give the academic community—particularly scientists—an overview of "hot topics," such as genetically modified foods, open access publishing, and the politicization of science.

The goal of the seminars is to encourage discussion of the topics among scientists and to teach scientists to communicate effectively with the public and policymakers. Thus far, the seminars have drawn 200-400 attendees each from more than 30 departments.

FOSEP also organizes small discussions with local experts to help its members and other students stay current on emerging issues and to practice communicating about them. Plans are underway for another public forum in the autumn of 2005. At present it is slated to focus on the development and regulation of pharmaceuticals.

Today FOSEP is creating this culture of awareness as the first step toward bridging the communication gap between scientists and local and national communities. The challenge faced by FOSEP and like-minded scientists elsewhere will be sustaining such efforts.

Funding is a particular challenge. First, FOSEP's broad-reaching, multidisciplinary scope does not map well with the specialized subject areas of academic departments. Furthermore, while there is foundation and other funding for training in responsible conduct of research issues such as authorship rules and informed consent, there is less support for examining scientific "macroethics" and science policy. FOSEP would like to see a comprehensive professional ethics training program for early-career scientists that

Continued on next page

FOSEP – A Model Student-led Group Linking Science and Society *(Continued from pg. 13)*

integrates micro- and macroethics topics to shape young scientists into effective communicators and to get them in the habit of considering the broad implications of their work, in their laboratories and in society.

Malcolm Parks captured FOSEP's mission when he wrote in a letter of support: "By enlisting students and early career professionals, FOSEP involves fresh and often critical voices in discussions of ethics and policy in science. It will provide a model for civic involvement in the scientific community that will benefit us all for years to come."

More information is at www.fosep.org. Send correspondence and comments to fosep@u.washington.edu.

[1] From the graduate programs in Microbiology (Benki), Epidemiology (Chubak), Molecular and Cellular Biology (Mitchell), Neurobiology and Behavior (Roberts), and Bioengineering (Robey).

[2] Nature, September 23, 2004.

[3] Two of FOSEP's directors work in laboratories that study the federally-approved stem cell lines.

Hans A. Bethe – The Supreme Problem Solver of 20th Century *(Continued from pg. 1)*

Born in 1906 in Alsace-Lorraine, Bethe fled to England in 1933 and came to the United States two years later. He became an immediate star of U.S. physics and was recruited in 1942 to assist the Manhattan Project at Los Alamos.

Bethe later did not regret his role in creating the atomic bomb because of the Nazi threat at the time. But the destruction of Hiroshima and Nagasaki caused him and other atomic scientists, in an unprecedented wave, to argue publicly for nuclear restraint to Congress and the press. The FAS was founded in October 1945 as the Federation of Atomic Scientists and became a key vehicle for these concerns.

Bethe's advice to the President in 1956 led to the pathbreaking 1963 Limited Test Ban Treaty. In a tireless career of activism, Bethe called on scientists to renounce research on nuclear arms. He hoped nations would cut their nuclear arsenals to a few hundred weapons or less. Throughout his life he advocated nuclear power as an answer to fossil fuel shortages. Aside from his star power, Bethe remained one of Cornell's most stimulating faculty members until his death.

We are at the End of a Long Process of Having Conventional Weapons Displace Nuclear Weapons…" *(Continued from pg. 3)*

which is to keep what we have, so the nuclear force structure remains in place. Moreover, reductions in nuclear forces would not reduce costs much within the overall defense budget; so there is little financial pressure for reductions that could counter the present institutional inertia."

"Nuclear weapons are unique…Recent debate has tended to make nuclear weapons seem ordinary. An example is the controversy over "small" nuclear weapons, ones with explosive yields less than the equivalent of ten million pounds of TNT, or one-third the size of the nuclear bomb that destroyed Hiroshima and thousands of times larger than the conventional explosive Oklahoma City bomb. The recent promiscuous use of the term "weapons of mass destruction," to fold together nuclear explosives with far less destructive weapons, is also a source of confusion. The uniqueness of nuclear weapons means that their roles should be assigned sparingly. There are risks associated with use of nuclear weapons and nuclear proliferation that are qualitatively different from any other type of weapon. When we calculate potential advantages of using nuclear weapons, we must balance them against these special risks."

Nuclear Missions

1. Survive and fire back after nuclear attack against homeland (for retaliation/deterrence)
2. Survive and fire back after nuclear attack against allies (for retaliation/deterrence/assurance)
3. Survive and fire back after chem/bio attack against homeland (for retaliation/deterrence)
4. Survive and fire back after chem/bio attack against allies (for assurance/retaliation/deterrence)
5. Survive and fire back after CBW use in military theater
6. Deploying nuclear weapons to attack enemy nuclear weapons to increase their vulnerability, decreasing their value (to discourage their development in the first place)
7. Deploying nuclear weapons to attack enemy chem/bio weapons to increase thir vulnerability, decreasing their value (to discourage their development in the first place)
8. Damage limitation attacks against nuclear weapons in military theater
8. Damage limitation attacks against CB weapons in military theater
10. Damage limitation attacks against Russian/Chinese central systems
11. Ready to inflict damage after regional conventional attacks (or to deter such attacks)
12. Overawe potential rivals
13. Provide virtual power
14. Fight regional wars
15. Apply shock to terminate a regional conventional war.

From: Missions for Nuclear Weapons after the Cold War

FAS Votes

On May 11, 2005 FAS members voted to amend Article Four of the FAS Articles of Incorporation. The change eliminates the requirement that half the Board be elected by the membership. This change will assure that the process of attracting and selecting FAS board members is more easily accomplished and more cost-effective.

FAS has done well financially over the past few years, but sustaining this growth will require flexibility and a dynamic Board able to provide ideas about the organization's direction, help in finding resources, and help in communicating our message.

The change will make it easier for FAS to create new classes of members and attract and hold the kind of Board FAS needs to do good work and to ensure that our work has impact.

"It is an important decision that will help guarantee that FAS will move into the future with the agility necessary to be successful in a difficult political environment. We have a bright future because of your commitment to our work," said Board Chair Tara O'Toole.

Melba Phillips, FAS Co-founder

Physicist Melba Phillips, among the last of a vanishing generation of activist scientists who founded the Federation of American Scientists and fought the political battles of the early cold war, died in November.

A 1947 policy statement on "military secrecy and security" that she co-authored for the FAS leadership complained that the personnel security practices of the Atomic Energy Commission were "extra-legal, arbitrary, and often subversive of every right of the individual in a democracy" (quoted by Jessica Wang, American Science in an Age of Anxiety, p. 157).

FAS in its early years was sharply divided between liberal anticommunists, who eventually became dominant, and popular front liberals. Dr. Phillips was among the latter.

In 1952, she was summoned to testify before the Senate Judiciary Committee's subcommittee on internal security, but she refused to answer questions. She was subsequently fired from her teaching position at Brooklyn College. In 1987, the College formally apologized to her for its actions. *(From FAS Secrecy News)*

FAS Staff Expands

FAS is renting additional office space and hiring to be able to carry out recently funded projects. Meanwhile, we have said good-bye to a few staff and welcomed more.

Arrivals

Scott Drewes is a new Senior Research Associate at FAS. He earned his bachelors' degree from Johns Hopkins University and his doctoral degree from the University of California at San Diego. Both were in physics. His PhD thesis was titled "Monte Carlo Studied of Charging Effects in Ultra-Small Tunnel Junctions." His research has been published in *Physical Review Letters and Physical Review B.* He previously worked at a biotechnology company, Prediction Sciences.

Zeynep Gueven joined as Administrative Assistant with special responsibility for membership. She is a 2004 graduate of George Washington University majoring in International Affairs. She has had internships at the United Nations, American-Turkish Council, The Turkish Embassy, and America-Abroad Media.

Blake Purnell joined FAS as Research Assistant in the Strategic Security Project. He holds a masters degree in physics from University of California at Santa Barbara.

Gartrell White joined FAS as a Strategic Security Research Assistant in Biosecurity. Gartrell is a native of North Carolina, with a B.S. in Biology from the University of North Carolina at Chapel Hill. Previously Gartrell worked as a research technician/assistant at the Lineberger Comprehensive Cancer Center at UNC-CH and at the Lombardi Comprehensive Cancer Center at Georgetown University.

Departures

Josh Kellar departed as Research Assistant in the Strategic Studies Project for graduate study in physics at Northwestern University. He plans to continue working with FAS on space issues and nanotechnology.

Christine Palumbo left as FAS Administrative Assistant to move to her family's home on Long Island. She is preparing to return to graduate school where she hopes to pursue a Masters of Education degree.

Benn Tannenbaum left his job as FAS Senior Research Analyst to become Senior Program Associate at the Center for Science, Technology & Security Policy at the American Association for the Advancement of Science.

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