Statement of:

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To:
Subcommittee on Energy and Environment
Committee on Science and Technology
U.S. House of Representatives

Regarding An Academic Viewpoint
Of
The Department of Energy, Office of Science, Basic Energy Science Program

September 10, 2008

Statement:

I am in the unique position of having received support as an individual investigator from the Department of Energy, Office of Science, Basic Energy Science for the past 25 years both as an industrial scientist and as an academician. I have served on the Committee of Visitors who reviewed the research portfolio that the Office of Science, Basic Energy Science, supports and the processes used to make funding decisions. In addition, I have also been involved with the national synchrotron and neutron facilities that the Department of Energy stewards, as a user, as a member of research team efforts, as a member of proposal review panels, and as a member of advisory boards for the facilities. I have also served on panels that have mapped out the course of x-ray and neutron sciences in the United States. While I have actively used the facilities within the United States, I have also used facilities in Europe and in Asia and am in position to assess the performance of the Department of Energy in the operation of these facilities in comparison to other countries.

Research Portfolio

The research portfolio of the Department of Energy, Office of Science, Basic Energy Science encompasses and exceptionally large range of topics. Due to the breadth of the programs that span from soft to hard materials including synthetic and natural (biological) materials as well as a suite of national user facilities, it is truly a daunting task to cover every research area in sufficient detail with the budget limitations that are common to any funding agency. Infinite resources would, of course, solve all problems. However, due to the limitations in the budget, it is reasonable, in fact mandatory, to ask the question as to whether BES is allocating its resources properly. Guidance for research directions, in general, are established via reports from workshops wherein expertise from around the world are brought together to review the current state of affairs in a particular area and where the future directions of a field lay. The results of these studies are balanced with the potential impact that a given area will have on society and American Competitiveness.

One such study group led to five grand challenges in basic science. These grand scientific challenges strike at the essence of the fundamental science stifling advances in many disciplines Take, for example, the topic of non-equilibrium phenomena. Everyday we are exposed to and use materials that are in a state that is very far removed from their most preferred or, in other words, lowest energy state. Virtually processes that industry uses generates materials that are trapped in a non-equilibrium state. Yet, processes have been developed, more often than not by trial and error, to produce materials that the meet end-user (consumer) needs. However, if we really understood exactly how the materials got to their final state, then we would have predictive capabilities in being able to optimize the structure and properties of a material. While this may seem like an obvious example, glassy materials, glass that is used for windows and drinking or grains of sand or powder passing through a funnel or rush hour traffic are situations where materials are tapped in a state far removed from equilibrium. Each of these examples represents objects that are really fluid-like in nature but are jammed or trapped in state where they are essentially frozen. Yet, can we control the state of these jammed materials or even develop routes by which the materials can be unfrozen without leading to catastrophic events. Think, for example, of mud slides or earth quakes where systems are trapped and the sudden release of the snag restraining the system and event that is highly desirable (as in traffic of in powder flow through a constriction) or highly undesirable (as in mudslides or earthquakes). As of yet, we still do not have a fundamental understanding of systems that are trapped in these highly non-equilibrium states.

The five grand challenges that have been put forth by a panel of renowned scientists represent a superb platform that BES will use to guide future funding directions. These are challenges that transcend any one discipline but will have far reaching consequence to society and American Competitiveness. How different disciplines will address all or some of these challenges will be discipline-dependent, yet these challenges provide BES with excellent guidance for resource allocations. Does this mean that all research must fall under one of these grand challenges? Absolutely not! This raises another aspect of BES program managers that is critical. As a member of the Committee of Visitors reviewing the process by which funds were allocated, in general, the peer-review process was adhered to. Proposals from researchers in academia, industry and laboratories were reviewed and the program officer would make decisions based on these recommendations. However, there were instances where the program officer would fund a risky proposal. In most cases, these risks paid off, leading to new areas of science that clearly advance American technology. One case in point is combinatorial chemistry which led to start-up companies like Affymax, Affymetrics and Symyx Technologies where libraries of materials, generated by performing literally thousands of reactions in parallel, are used to uncover materials with unique properties or drugs with exceptional response. This flexibility is, in my opinion, extremely valuable and it has been used effectively, albeit with discretion and care.

Is there evidence that the decision to fund basic science leads to true advances in American technology? This is the age-old question of whether there has any value in supporting basic research. Are there concrete examples where the funding of basic science has led to technological developments? To address this question, I would like to provide a brief description of the funding of my own research by BES. When I was at the IBM Almaden Research Center I had submitted a proposal to examine the behavior of polymers (plastics) at the interface with another polymer. From IBM’s perspective, this research was of importance, since it addressed issues of delamination, where two adjoining layers of materials separate. If this occurs, this would lead to a failure of the device or chip or, in the least, degradation in the performance of a material. From a basic science point of view, fundamental questions concerning the behavior of a polymer molecule at an interface were never asked. These studies led to the development of processes and materials to control such delamination problems while using non-propriety materials and processes to uncover the fundamental science.

One type of material that was intensively studies was block copolymers, two different polymers that are tied together at one end. These materials are like soap, where you have two components that simply do not mix and separate from each other. In the case of soap, there is a part that is oily or hydrophobic and one part that will dissolve in water or hydrophilic. Now polymers are about 10 nm in size. So, if I have a copolymers, we have two parts that are about 10 nm in size that want to separate from each other and, like in the case of soap, the size of the molecule and the fact that they are tied together limits how far apart the sections can get from each other. The consequence of this is that these molecules form domains that are tens of nanometer or less in size. The basic research that BES supported allowed us the opportunity to develop routes to control how these domains are arranged in thin films that can be generated by routine spin-coating processes that the microelectronics industry using every day. In addition, we learned how to remove one of the domains, producing films that had nanoscopic holes. This seemingly simple process has had a tremendous impact on the microelectronics industry already and, soon, in the magnetic storage industry.

By using these films with the nanoscopic holes, silicon can be evaporated in the holes and, with subsequent processing, tiny islands of silicon can be produced where each of the islands are separate from each other by either the remaining polymer or the polymer can be replaced with an electrically insulating material, like silicon oxide. Researchers at IBM used this very simple technology to increase the lifetimes of flash memory devices (memory sticks), since a critical component in the device is a floating gate where electrons are stored. However, the process of transferring electron from a source to the gate is destructive over time. So, if one has a single piece of silicon acting as the gate, with time the source will short-out with the gate. However, by using the copolymer technology describe above, the gate is broken up into a large number of smaller pieces that are insulated from each other and, if one of these pieces shorts-out, it does not cause a failure of the device, since we have a large number of smaller pieces left. The figure shows a side view of one of these gates where the copolymer templating process has resulted in a significant increase in the longevity of the device.

This simple concept of copolymer templating has led to yet another technological breakthrough. In a microelectronic circuit the speed that the electrons travel in the circuit depends on the dielectric constant of the materials surround this wires. Ideally, you would like to have the wires suspended in air, but this, of course, is impossible, since the elements of the circuit must be solid to support a multi-layered structure. If, though, you use the polymer film with nanoscopic holes, as described above, and you place this on the existing insulating material between the wires on the circuit, then you can use the film with holes as a template to etch or drill into the insulating materials. Subsequently, you can

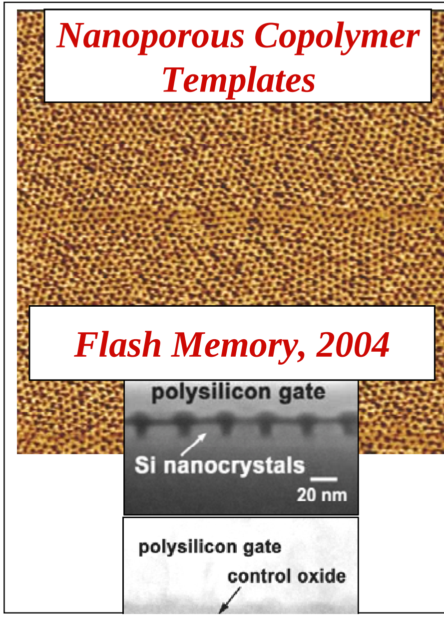
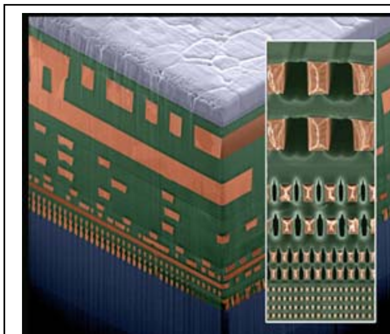


Figure 1. Floating gate technology



This permits chips to run faster and use less energy….significant advance in exploiting nanotechnology…enhances the competitiveness of US companies in this critical industry. According to Dr. John Kelly, IBM's senior vice president of research and development, "To our knowledge, this is the first time anyone has used nanoscale self-assembled materials to build things that machines aren't capable of doing."

Figure 2. IBM’s air gap technology

cover the tops of the holes in the insulator, trapping air pockets in the insulator. The consequence of this is that the dielectric constant is significantly decreased, allowing faster and more efficient transport of electrons through the device. An example of a multilayered circuit is shown in the figure and IBM is adopting this strategy in the manufacture of devices beginning in 2009.

We can go even one step further. Let's consider this polymer film with the nanoscopic holes. Any of a variety of standard processes can be used to fill the holes with a material that is magnetic. If we could address each of these magnetic elements and force the spin of each tiny magnet to be up or down (this is a typical process that is used for magnetic storage in current computers) and, if we could read each of these tiny elements, then we could far exceed the predictions of Moore's law that governs the magnetic storage industry. Now with the copolymers, we can control the size and separation distance between each of these elements by controlling the size of the molecule. Recently, laboratories across the United States wave learned how to control the ordering of arrays of these elements and, in the no-to-distant future, we will be able to produce storage media that is so dense that we could put 100 DVD or a disc that is the size of a quarter! An example of an array of elements produced by this copolymer templating technology is shown in the figure. Here, each of the little holes is ~8 nm, about 100,000 times smaller than a human hair! This will represent an incredible breakthrough in the storage dense, far exceed that predicted by Moore's Law, and will revolutionize everything magnetic storage and, I dare to say, the life of the average American. In addition, this storage density will impact numerous technologies and significantly impact American Competiveness.

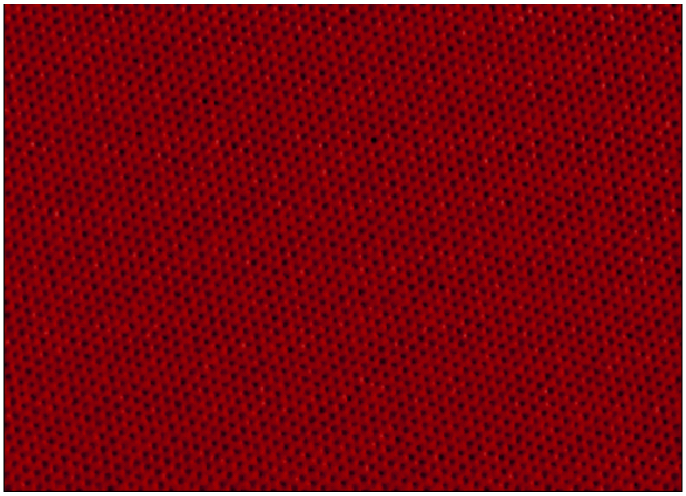


Figure 3. Bock copolymer template with long-range lateral order with 15 nm pores that can be use for a one terabit magnetic data storage. This technology will lead to 10 Tbit capable of a 100 DVDs on disc the size of a quarter.

There are other applications where these simple templates are having impact in the biological arena, as for example in the separation of virus particles or in the generation of surfaces that can promote or retard cell proliferation. However, the developments that have been made using copolymer templates are extensive. This represents just one particular project that BES had supported where the objective was a fundamental scientific question, i.e. basic research, that have had significant impact on technology and, by default, American Competitiveness. It should be noted that the time scale over which the current technological advances are being made is on the 5-10 year time frame. For all intents and purposes, this time scale was fairly rapid. Another additional factor that has direct impact on the "turn-around" time is that the processes that are required for the copolymer templating processes are non-disruptive, i.e. these materials could be integrated into the existing fabrication processes. If an entire new process was required to enable the use of these templates, the chance of them seeing the light-of-day in an industrial process would be slim or, at least, delayed by another 5-10 years. Fabrication lines are simply so expensive to build, that introducing new processes is getting progressively harder.

Facilities

The Office of Science, BES, is the steward of the national user facilities located at national laboratories across the country which includes synchrotron x-ray facilities, reactor-based neutron sources, spallation neutron sources, electron microscopy facilities and ignition laboratories. I am most familiar with the x-ray and neutron facilities constitute essential tools for the execution of my research. I have also been a member of the Kohn Panel, which documented the state of neutron sources and made recommendations to BES to ensure the vibrancy of neutron science in the United States, and the Birgenau Panel, which documented the state of synchrotron x-ray facilities (both hard and soft x-rays) and made recommendations to BES on the operation and future directions for national x-ray sources in the United States. In addition, I also chaired two panels to establish the design and operation criteria for the spallation neutron source. When I was a member of the Basic Energy Science Advisory Committee, neutron and x-ray facilities were undergoing major revamping, the Advanced Neutron Source (a reactor source) was put on indefinite hold (essentially cancelled due to extensive costs), the foundations were laid for the construction of the Spallation Neutron Source, now operational at the Oak Ridge National Laboratories, and the Advanced Photon Source was just being commissioned. As a general statement, these facilities should be considered as jewels of the national laboratories that provide an invaluable resource to science and technological advances in the United States and hold significant promise for the future.

Does the Department of Energy manage these facilities well? With the resources available to BES, I feel that the DOE BES does an exceptional job. While these facilities have required substantial investment to design, construct and operate, BES has made every effort to ensure that the facilities operate in a manner where the reliability and availability of the sources exceed the criteria established by the Kohn panel. This requires that the facilities operate in a dedicated "user-facility" mode, not being parasitic to other sources. The Stanford Synchrotron Radiation Laboratory and the Los Alamos Neutron Scattering Center were, at one time, parasitic to the Stanford Linear Accelerator Center and the Los Alamos Meson Production Facility. When operated in this mode, the ability for a user to perform experiments was impaired. However, at present time, all the x-ray and neutron scattering facilities are dedicated to the users. In addition, the ability to use these sources relies on a peer-review process where the highest ranked proposals are granted appropriate levels of time to execute the proposed studies. This means that both small, individual investigator efforts can be accommodated, along with much larger efforts. At the National Synchrotron Light Source at the Brookhaven National Laboratory and the Advanced Photon Source at Argonne National Laboratory, Private Research Team and Collaborative Access Team efforts were introduced where teams of investigators could propose, plan, finance and commission a specific beamline. In return for this investment, these investigators were guaranteed a certain percentage of the beam time, while the remainder was made available to outside users.

These were novel concepts to instrument these facilities allowing researchers to secure funding from government or industrial sources to establish a particular capability in x-ray science. Neutron sources have not implemented this mode of operation due, primarily, to the limited number of beam lines that can be accommodated by the sources.

Whether the beam lines are provided by the DOE BES or via the PRT or CAT routes, the operation of the facilities has been excellent and have provided routes by which industrial, academic and government laboratory scientists could perform research that they were not capable of doing in there own laboratory. For industrial scientists, if the research is proprietary in nature, a full cost recovery of the operation of the beam line during the experiments is required and this, in my opinion, is as it should be. Proprietary research cannot be reviewed in a peer-review manner and, as such, the investment the industrial laboratory is required to make to do the experiments is appropriate to circumvent the normal review process and, in a sense, is akin to a review process, since this investment would not be made unless it was cost effective. As an academic scientist and as a former industrial scientist interested in performing basic research, the allocation of beam time have been and is done in an objective and effective manner.

Does this mean that the operation of the facilities cannot be improved? Absolutely not! Perhaps the major problem that I see with the operation of the facilities is the insufficient number of staff scientists or beam line scientists. These facilities operate 24/7 and it is virtually impossible for three scientists to operate in this manner. This is not an unusual level of staff support. Yet, these scientists are expected to accommodate the user community, maintain the operation of the beam line and maintain an active, independent research effort. .In addition, the staff scientists tend to get burned-out and it is most difficult to attract and retain first-class researchers to these positions. I feel that this problem could be alleviated with a higher level of personnel support. Nonetheless, the beam line scientists perform an extraordinary service to the scientific community by interacting with seasoned users and those users who are new to either x-ray or neutron science.

Are there too many facilities? In the United States there are three BES-maintained neutron sources currently operational: the Spallation Neutron Source and the High Flux Isotope Reactor at the Oak Ridge national Laboratory, and the Los Alamos Neutron Scattering Center at the Los Alamos National Laboratory. In addition, there is the Center for Neutron Research at the National Institute of Standards and Technology that is operated by the Department of Commerce. The Intense Pulsed Neutron Source at the Argonne National Laboratory is scheduled for closure. In comparison to European or Asian scientists, the availability of neutrons in the United States falls far behind. As an academician, this means that the competition for beam time at these facilities is stiff. There are three hard x-ray synchrotron sources: the Stanford Synchrotron Radiation Laboratory, the National Synchrotron Light Source and the Advanced Photon Source. Geographically, these sources are located on the western, eastern and central United States. Consequently, these facilities have taken on a regional character with many of the users coming from the respective parts of the United States. There is not question that there is overlap in the capabilities for the facilities, yet each facility offers unique capabilities that are used by scientists across the country. From the soft x-ray perspective, there are source at the National Synchrotron Light Source and the Lawrence Berkeley Laboratory and, as such, the user-base is far less regional in character. These facilities are operated 24/7 and it is still difficult to get time on the instruments. Should there be more sources made available? While one can easily give a quick response based on the full-time use, I would only concur with this after an in-depth study, since the demand-surpassing-the-supply situation ensures that only the highest quality science is performed on these invaluable resources. The cost for the design, construction and operation of a single facility demands that the scientific or technological case be solidly made before considering taking this step.

Do these facilities contribute to American Competiveness? The example that I cited about on the use of copolymers a templates for insulating and gate materials in microelectronics and the generation of ultrahigh density magnetic storage media represent on a small number of examples where these sources were key in understanding the fundamental science underpinning the processes used to generate these structures. Numerous other examples can be cited where these facilities have been essential in enabling a scientific advance that, in turn, led to a technological breakthrough or development. One example where these sources will be key to American Competiveness lies in the unique ability of these sources to characterize materials on the nanoscopic level over macroscopic distances. To understand this, in Figure 3 is an array of nanoscopic dots that are present over the entire surface of a disc that may be several centimeters in diameter. To be suitable as a magnetic storage medium we must know the exact position of each of the elements to within a nanometer. Industry is current pushing to a goal of 10 Terabit or 10^{13} magnetic elements per square inch. If we could read one element in a nanosecond, it would take us three hours to scan (which we cannot with any accuracy) a one-inch square just to characterize the surface. X-ray scattering, though, has the ability to sample an entire surface at one and provide information on the nanometer to sub-nanometer level in seconds. Consequently, I feel that these intense x-ray sources will play a key role in establishing metrics to characterize nanostructured materials with any degree of certainty. Such capabilities will be essential as the size of structures get smaller and smaller.

Aside from the scientific importance of the experiments that can be done on these facilities, they also provide an important tool for educating young scientists, not just in terms of the science that underpins the technique but, also, in the science that forms the basis their own research and the research of others. At these facilities there are numerous scientists performing experiments on different beam lines and it is difficult not to interact with others during the course of the experiments. These facilities provide a beautiful setting in which the next generation of scientists can receive a basic education in their own discipline but, also, a fertile ground in which science, over a much larger spectrum, can be learned. This is, in my opinion, vital to the future of science and technology in the United States. I must, also, add that many of the facilities offer short courses where students from across the country travel to a particular source and receive a practical training on the theory and use of these facilities. I have personally sent numerous students to attend these courses where travel and accommodations are covered by the hosting facility. These short courses have been invaluable and beautifully augment the formal training that the students receive in the classroom.

Frontier Energy Research Centers

The single-most important problem facing the United States and mankind in general is the identification of a reliable energy source that will, at some point, overcome our dependency on fossil fuel. Fossil fuel resources are finite in nature and where the resources will exhausted in 20years or one hundred years, the "writing is on the wall". A reliable, cost-effective energy source or sources must be found before we, as a nation, or as a species are forced in to a corner. I will not argue whether solar is better than hydrogen, hydroelectric or wind. Regardless of the method, a solution must be found. This is one of the DOE BES grand challenges. Last year, the DOE BES had a call for single to multiple investigator proposals that addressed this critical energy need. Even though hundreds of proposals were submitted, only a handful was supported. This was not a result of the quality of the proposals. On the contrary, based on peer review, many more proposals should have been funded but the funding cutbacks precluded supporting many of these proposals. This year we are faced with a similar situation. The DOE Bes had been allowed to proceed with a call for Frontier Energy Centers with a proposed total budget of $100M. The scientific community was very pleasantly surprised by this call, given the events of the previous year. These EFRCs are intended to support multi-investigator and/or multi-institutional efforts that bring together scientists from different disciplines to attack this energy problem in a novel manner. The EFRCs are similar in ilk to the Materials Research Science and Engineering Center and will provide a beautiful framework in which significant advances can be made in resolving the impending energy crisis.

The academic community is now faced with a possible repeat scenario of last year that must, in my opinion and in the opinion of many academic scientists across the country, be corrected! The academic community received the news of this call with great enthusiasm. It is very clear that the academic community, in general, must be involved, in some manner, in addressing the energy crisis. While national laboratories, like the National Renewable Energy Laboratory or the Lawrence Berkeley Laboratory, have established track records in energy science and some industrial laboratories have expertise in designing and fabricating energy devices, I can cite the recent developments at the University of Virginia where scientists succeeded in making a photovoltaic device with 50% efficiency. This is a tremendous advance in the field and demonstrates the key roe that academic laboratories can play in this area of critical need. Currently, the Senate has removed this item from the budget of DOE BES, transferring it to EERE. This was done after the House of Representatives left the EFRCs in as a line item in the budget. The reasoning behind this is not obvious. Nonetheless, the person power that academic laboratories can bring to bear on this problem and the diversity in the research portfolio of the Department of Energy forces us to the conclusion that a peer-reviewed proposal process for EFRCs that is open to academic and industrial scientists and where expertise at the DOE-supported national laboratories is the logical route to follow. Not only will this lead to advances in resolving this critical problem but it will also serve to educate the next generation of scientists in problems associated with energy which, in turn, will ensure a retention of expertise and competitiveness of the United States in energy.

Ramifications of Budget Reductions

Perhaps the most frustrating experiences that I have had with both facilities, specifically neutron sources, and the energy initiatives are budget reductions. Sometimes these reductions are known in advance and other times they occur rather rapidly. I fully realize that these reductions are outside the control of BES but that does not make them any less frustrating. For example, last year (2007) BES had a major initiative on renewable energy, soliciting proposal across the entire spectrum, ranging from hydrogen storage to photovoltaics. The rezones of the community was overwhelming, with over 300 proposal submitted. I happened to involved in several of these proposals as a co-principal investigator. These proposals were peer reviewed and, in fact, the priorities for funding were established. After a significant delay, a continuing resolution was established for the federal budget with the funds promised to support this initiative, never materializing. The sum and substance of this was a massive waste of time. I assure you that most of the individuals involved in these proposals are under severe time constraints and I can also assure you that there were many investigators who were less than pleased. Aside from the investigators proposing research, the peer review process itself consumes a significant amount of time on the part of the referees. We can add to that the significant amount of time that was expended by the program managers at BES. It was also not an easy task to turn to the investigators and to the scientific community in general and announce that the funding to support research in the most important problem facing the United States, although promised, was not going to be there. This budget shortfall dumbfounded, surprised frustrated and irked everyone involved in this effort.

With the EFRCs we are again faced with a similar situation that we must, in any way possible, prevent from happening again. Specifically, there was a call for EFRCs that was to be supported by $100M enabling the establishment of 20-40 EFRCs across the United States in academic, industrial and government laboratories. The House of Representatives approved this initiative while the Senate removed this from the BES budget, transferring the funds to EERE. This will essentially place the funds in the hands of NREL and/or industrial laboratories. While superb research can be done at these laboratories, as I mentioned above, engaging the entire scientific community, as BES is quite capable of doing, is essential. So, now we have a situation where the call for EFRCs has a proposal deadline of October 1. Putting together a competitive proposal for an EFRC that will involve multiple institutions will require several months of effort. With the recommendation made by the Senate and the budget being debated in committee the inevitable question arises as to whether one should write an EFRC proposal? Putting these proposals together is a massive effort. Not writing the proposal ensures losing an opportunity to bring your expertise to bear on a scientific engaging, societally important ad technologically challenging topic. Yet, there are absolutely no guarantees that if a proposal is written that there will be funds to support the effort. Do you take the chance that the funds will appear? Don't forget that the deadline is October 1 and proposals simply do not materialize out of thin air. I have decided to take this chance and I am gambling on the wisdom of our Congress to re-instate thee funds to the BES budget.

Let's move to the neutron facilities, both the reactor-based and accelerator-based (spallation) neutron sources. In the United States there are two reactors currently operational as user facilities: the Oak Ridge High Flux Isotope Reactor (DOE supported) and the Cold

Neutron Research Facility at NIST (DOC supported). Both are superb instruments where researchers (faculty member, students, post-doctoral fellows, industrial scientists and government laboratory scientists) can perform experiments on a peer review basis. Reactor sources, particularly cold neutron sources which these facilities are, enable experiment on large objects (approaching microns in size) which is essential for the stud of biological systems, plastics, colloids and metals. Through a combination of safety issues, budget reductions and bad publicity, the High Flux Brookhaven Reactor was decommissioned and the Advanced Neutron Source never materialized. Losing two facilities may not seem to be a major disaster. However, the paucity of neutrons has resulted in a loss in the number of scientists who have expertise with neutrons. This has deleteriously impacted nearly every scientific discipline and, therefore, technological advances that would have been enable by studies using neutrons. Academicians were simply fearful of having doctoral theses reliant on the availability of neutrons. Funding agencies were reluctant to support research that relied on the availability of neutron Loss of funding for individual PI grants translates in to a further reduction in the number of students and so we go spiraling down. So many opportunities were lost by American scientists during this time. Even though an idea may have theoretically emanated from research in the United States, American scientists simply had to sit back while their European counterparts executed the studies. I experienced this aguish on several occasions, but there was imply nothing that could be done, so you move on.

The situation with accelerator-based (spallation) sources was not that much better. At the time, the Intense Pulsed Neutron Source at the Argonne National Laboratory was operating like the Every Bunny (it kept on going and going). However, despite its name IPNS was not a high flux facility and only through the innovative and creative efforts of scientists at the IPNS were scientific and technological advances possible. Indeed, given the flux of the facility, it is amazing to see the number of outstanding contributions made by IPNS scientists. The Los Alamos Neutron Scattering Center, while being much more intense than IPNS, had seemingly incurable problems with availability and reliability of neutrons. As a result, the user base at Los Alamos deteriorated and, as an academic, I was reticent in establishing a research effort where students' theses relied on experiments at Los Alamos. As an industrial scientist, I was content to take my chances at Los Alamos, though there were numerous experiments that never occurred due to the unreliability of this facility. I do want you to appreciate the fact that to do experiments at these facilities id far more than the actual time you are at the facility. Sample preparation begins weeks to months ahead of the scheduled beam time. Second, you have to travel to the facility. Los Alamos, by design and intent, is not an easy facility to get to. The same holds true for Oak Ridge. You finally arrive at the facility, ready to do experiments 24 hours a day for 3-4 days and then the system fails. Why? Since the facilities are so complex, no on is really certain but "We think it will operational in a half an hour." I sympathize with the operators of the facilities, since they are trying their level best to get the facility back on line and want to be optimistic. However, after you hear this numerous times throughout the night, it becomes a little thin when the sun is rising and you are sleep deprived. But still, you do not leave, since maybe the facility will be back on line shortly and you may finally begin to do experiments that are key to your research. At the time, Los Alamos was operating in a parasitic mode. I can relate similar horror stories about my experiences at the Stanford Synchrotron Radiation Laboratory when it was operating in a paratistic mode.

So, you can conclude that scientists who use the neutron and x-ray facilities are masochistic. This, however, is far from the truth. Rather, tolerating these abysmal conditions demonstrates the importance and unique capabilities of these facilities in addressing scientific and technologically important questions. This situation, however, does not exist at present and the efforts of Patricia Dehmer, lie at the solution to these problems. Through a series of workshops and panel reports, initiated by Dehmer and the late Iran Thomas, BES identified the sources of the problems and placed stringent conditions on the continued support of the facilities which led to a suite of x-ray and neutron facilities, including the spallation neutron source, that are available to the user in a reliable manner. I must also add that during ht course of the renovations and new construction projects, Dehmer used the expertise of Daniel Lehman to scrutinize the planning and construction projects which resulted in tremendous cost savings, reductions in project cost overruns, and timely completion of the projects. Again, this reflects the attention that Dehmer has placed on detail and her commitment to the scientific community. These improvements are now paying off with a growth in the community and a return in competeviness of the United Stated in neutron science. As an academic scientist, I have no qualms in having studies use these facilities and base a large fraction of their theses on results that emanate fro these facilities.

From my experiences on the Basic Energy Science Advisory Committee, and Steering and Advisory Committees of several facilities, an ever-appearing problem that arises is budget reductions to the requested BES budget. Facilities represent only one component of the portfolio of responsibilities of BES. When the BES budget is passed down from Congress, BES is expected to fulfill all its commitments and, as such, budget reductions invariably impact all aspects of BES' portfolio. If budgets were inflated, a reduction would have minimal impact. However, this is clearly not the case. For example, the Advanced Light Source at Berkeley is shutting down for two months as a consequence of a budget reduction. This translates into a stall on all research that relies on the use of soft x-rays for research. Scientific research is intensely competitive and delays of this nature can make or break primary ownership of a discovery. If this were only a matter of the prestige or glory of a scientist, it really would not be of tremendous consequence. However, discoveries lead to intellectual property which, when viewed in terms of American Competitiveness, can have far reaching consequences.