EMERGING TECHNOLOGIES: WHERE IS THE FEDERAL GOVERNMENT ON THE HIGH TECH CURVE?

HEARING

BEFORE THE

SUBCOMMITTEE ON GOVERNMENT MANAGEMENT, INFORMATION, AND TECHNOLOGY

OF THE

COMMITTEE ON GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

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CONTENTS

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MONDAY, APRIL 24, 2000

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON GOVERNMENT MANAGEMENT,
INFORMATION, AND TECHNOLOGY,
COMMITTEE ON GOVERNMENT REFORM,
San Jose, CA.

The subcommittee met, pursuant to notice, at 10 a.m., at the NASA Ames Research Center, Building 3, Moffett Field, San Jose, CA, Hon. Stephen Horn (chairman of the subcommittee) presiding.

Present: Representatives Horn and Ose.

Staff present: J. Russell George, staff director; Bonnie Heald, professional staff member; and Bryan Sisk, clerk.

Mr. HORN. The hearing of the Subcommittee on Government Management, Information, and Technology is called to order.

Mr. Ose is on his way, should be here in 10, 15 minutes, and will join us, and perhaps some of the local members will join us.

But we are here today to take a glimpse into the future. Many of our witnesses are leading expeditions into the new frontiers of science, from newer, faster computer power to the most fundamental elements of life. This diverse array of expertise is woven together through their scientific research that will profoundly affect the society in the 21st century and beyond.

Despite technological advancements in other nations, the United States remains very solid in terms of its scientific research. It is vital to the Nation's economy and social fabric that it retains that lead.

We will examine the Federal Government's role in this hearing and a whole series of hearings probably in Washington and some in the field in terms of the Nation's wealth of emerging technology. We want to know what type of governmental policies are needed, if any, to encourage scientific research and what policies may have a chilling effect on innovative scientific pursuits.

Over the past several years, the subcommittee has learned that antiquated computer systems have inhibited the departments and agencies of the executive branch from being the efficient, effective, and financially accountable agencies that taxpayers want and deserve.

NASA, I might say, is a rare exception from some of the agencies that are not working well. We give them an A in terms of their financial management. We give them an A in any numbers of areas. So it is great to be at this center.

Today we will examine some of the emerging technologies that may enhance government operations and operations generally all over the Nation, and thus benefit the American people.

We welcome our witnesses today. Let me tell you a little bit about how this subcommittee works. This is the Subcommittee on Government Management, Information, and Technology. I am Stephen Horn, the chairman.

[The prepared statement of Hon. Stephen Horn follows:]

ONE HUNDRED SIXTH CONGRESS

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House of Representatives

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Subcommittee on Government Management, Information, and Technology

Emerging Technologies:
Where is the Federal Government on the High Tech Curve?
April 24, 2000

Opening Statement
Chairman Stephen Horn

This hearing of the Subcommittee on Government Management, Information, and Technology is called to order.

We are here today to take a glimpse into the future. Many of our witnesses are leading expeditions into the new frontiers of science – from alternative power sources to the most fundamental elements of life.

This diverse array of expertise is woven together through their scientific research that will profoundly affect society in the 21st century and beyond.

Despite technological advancements in other nations, the United States remains at the cutting edge of scientific research. It is vital to the nation's economy and social fabric that it retains that lead.

We will examine the federal government's role in the nation's wealth of emerging technology. We want to know what type of governmental policies are needed to encourage scientific research, and what policies may have a chilling effect on innovative scientific pursuits.

Over the past several years, this subcommittee has learned that antiquated computer systems have inhibited the departments and agencies of the executive branch from being the efficient, effective and financially accountable agencies that taxpayers want and deserve. Today, we will examine some of the emerging technologies that may enhance government operations and thus, benefit the American people.

We welcome our witnesses today, and look forward to their testimony.

Mr. HORN. Mr. Ose is one of our key members who will arrive here soon, and we are delighted to have this wonderful group of witnesses, and I thank Samuel Venneri, Associate Administrator for Aero-space Technology of the National Aeronautics and Space Administration, whose help has been very invaluable, and I might add that the way we do business is we call on you in the agenda, and once we call on you, your full statement is automatically in the record. So you do not have to request it. It goes into the record.

We would like you to look us in the eye and summarize it in 5 to 10 minutes if you could because we cannot just read the statements or we will be here until midnight. So we would appreciate that if you could just summarize them, and your full statement will be here for the record and printed and will be part of a report that we will give to the full House of Representatives.

And I might add that we will also keep the record open for another week at the end of this so that any of you going home after the meeting who want to write something else, you can file it with us, and anybody in the audience or other people in Silicon Valley, we would welcome the comments on this area.

We do as a tradition in the Government Reform Committee have all witnesses swear and affirm to an oath, and that is to tell the truth. So if you would stand and raise your right hands, and if there is anybody also behind you, some of your people that might talk, get them to stand, too, so that I do not have to have three baptisms going here.

[Witnesses sworn.]

Mr. HORN. The clerk will note that the nine witnesses have affirmed the oath.

And we are delighted to start with Samuel Venneri, Associate Administrator for Aero-space Technology, National Aeronautics and Space Administration.

STATEMENT OF SAM VENNERI, ASSOCIATE ADMINISTRATOR FOR AERO-SPACE TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. VENNERI. OK. Thank you, Congressman.

It is a pleasure to be here. If it's OK, I would like to use some audiovisual to summarize the written statement we turned in.

Mr. HORN. Please proceed.

Mr. VENNERI. Well, yeah. Thank you, again, for the opportunity to do this.

And like I said, our written statement is turned in for the record, as you mentioned.

What I'd like to do today is talk about the technology for the 21st Century. We have a $2 billion technology budget in NASA, but what I want to focus on is really what we see as the revolutionary technology for the next century, including where the next industrial base is coming from, and we look at it as three primary areas: biotechnology, nano technology, and information technology.

But the way we're structuring it is really look at the synergistic coupling between those areas and the type of products that you can achieve if one develops each leg of this triangle and then looking at the implications of integrating these technologies at a system level. But you see at the middle is really where we're moving toward, putting intelligence, evolvability, and adaptive both at the system level and subsystem level of what I mean by this new technology base, and I'll illustrate that as I go forward.

This is an example of the breakthrough in nano technology. What you see here are carbon nano tubes that were accidentally invented in 1992 at NEC by the Japanese. Subsequently there's investments going around the world, both the United States, Europe, and Asia, dealing with understanding this phenomenon, and what does this mean in terms of the implication to both electronics and structures?

And the key difference is you're looking at things that are on the order of atom's size, and for the first time we're talking about building things from atoms up, not etching material down, and as for structural applications, we run the numbers, and if we could make a graphite composite out of carbon nano tubes, you would have something that would be 100 times the strength of steel at only one-sixth the weight.

And for us, a single staged orbit space vehicle would have its weight cut in half if that material was available today.

This is really what I meant to illustrate in terms of this idea of building from the atom up. We're really not starting at the end item here of a system of a final vehicle, but, in effect, building the system, the electronics, really at the quantum level, and building this idea of thinking into the system.

So think of this as our future spacecraft and other products other than aerospace would really have a central nervous system, a hierarchy of intelligence and evolvability, repairability as you start to move some of the biologically based systems together.

And, again, what this means is the era of using silicon as our only source of developing the next computer opens up the whole possibility of quantum computing, hybrid computing that actually brings DNA into a computing algorithm, and really moves us into approaching what the brain can do today and the massive amount of information we can process.

One of the things we're also looking at in this information world, and this kind of gives you an example, future developers will be basically manipulating and visualizing processes at the atomic scale, and that's basically how all structures are put together.

Failure mechanisms start really at the atomic level. We tend to have engineering theories today that approximate that behavior, but fundamentally we would be working at that sources and, in effect, using nano tweezers to move this material around.

One of the aspects that I want to illustrate this as part of this revolution in information, if I compared where we are today with the e-commerce, the Internet, this is like television in the 1930's as far as the impact on society and what does it mean. So you haven't seen anything as to what the true Information Age is going to mean in terms of the impact not only in our products, but in society as a total.

And what I depict here is something that shows researchers and working with an intelligent agent. This young woman manifesting itself is really our idea of what the ultimate in intelligent agent would be, where you're talking in a natural language. You're visualizing your product. You're walking through the product at any scale. This is the sort of thing you would have to have if you were going to build a nano device up, but more importantly, how people work and interact in the computing environment.

We don't deal in our everyday life sitting at keyboards and artificially constraining our senses in our everyday life. So we're looking at how our full human senses can be brought into the information technology of the future.

This is an example of some of the things from our perspective of what nano and biotechnology means and where you start looking in terms of our systems, from nano structured engineering to this idea of biomimetics, where you're starting to mimic engineering functionality with biological processes and perhaps even looking at something like artificial DNA being used for us to have our spacecraft, in effect, repair and replicate themselves.

And this is really kind of a more detailed listing of the type of things we would do, from smart materials, electronics, the human centered computing systems that I showed that illustration of people working with the computing environment differently with multi-faceted interfaces. This has huge implications of how we do space missions and how we actually do the thing that we have the most concern about, of humans and long duration space missions.

How do we see that they get the health care that they need when there's no lifeline tied to Earth? So we clearly have to revolutionize the technology, which again brings it back down to what we would do on Earth.

Now, last week we just signed an agreement with the National Cancer Institute in terms of a cooperative program in technology dealing with aspects of what I'm referring to here. They're interested obviously in cancer detection and treatment, and we talk about these nano phased materials coupled to biology. You start to thinking about treatment now at the cellular level, not dosing whole bodies with chemotherapy.

So you're looking at manipulation and dealing things at single individual cells and being able to implant vaccines and dosages into the cell. Now, again, we're doing it from human space flight. It has huge implications to health care delivery systems that's totally different than what we've done up to now.

And so in summary here, we're really looking at this revolutionary technology vision, this zone of convergence, as we call it, which is really taking three distinct industrial bases today, looking at where that industrial base is going, and then creating of an industrial base of the future that is within each of these legs that I have depicted.

But, more importantly, it's going to really create a baseline of the 21st century industry based on the research that's being developed today.

And I want to leave this on a summary though. The first bullet said that's what we're really looking at. These three areas will impact all of society and the world.

It's going to really require a new industrial base. As I said, these materials are not made for structural applications the way we make today, and we're no longer talking about a silicon based computing industry. So you really are looking at a new industrial baseline that hasn't been generated yet, and the educational system.

The training of the work force of the future is an absolute requirement to work with the universities today, and our secondary schools in bringing the work force and the society that understands this technology push will be the society that reaps the economic benefits of the future.

We're working, innovative government, academia, industry partnerships today. We clearly would like to work with an industry that really doesn't exist today to produce and make in bulk property these carbon nano tubes so that we could start looking at structural applications, as well as electronic applications in these systems.

And the last bullet on here, it's something we've been thinking about, and I just want to mention what we are going to implement. Obviously when I had that first chart, I used the word "intelligence evolvability" of some of our systems. That's getting close to human ethics, and it's getting close to concerns if you look what happened with these genetic plant materials. I think if things would have been addressed differently then, you wouldn't have this uproar today over this misunderstanding about genetically engineered crops.

We have that same concern when we start talking about attributes of intelligence in our systems. So we're forming a technology ethics subcommittee under the NASA advisory committee structure. This is the way the NASA Administrator gets outside input from a very formal, structured way of bringing people from industry, universities into NASA.

We're going to form a subset under some or with some religious leadership involved in that to really look at this whole idea of technology ethics in the future and to make sure that we look at the implications of some of these technologies that we're describing today as our vision for 5 to 10 years from now, that we're on solid ground that the ethics of technology and how it's applied, how it could be misused is also addressed from the grassroots, from the day that we start.

So thank you very much for this opportunity, and you know I would entertain any comments today now.

[The prepared statement of Mr. Venneri follows:]

Hold for Release
until Presented by
Witness

National Aeronautics and
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April 24, 2000

Subcommittee on Government Management, Information and Technology

Committee on Government Reform

House of Representatives

106th Congress

Statement by:
Samuel L. Venneri
Associate Administrator
Office of Aero-Space Technology

Hold for Release
Until Presented by Witness
April 24, 2000

Statement of
Samuel L. Venneri
Associate Administrator for Aero-Space Technology
National Aeronautics and Space Administration

before the

Subcommittee on Government Management, Information and Technology
Committee on Government Reform
House of Representatives

At the

NASA Ames Research Center
Moffett Field, California

Mr. Chairman and Members of the Subcommittee, I am pleased to have this opportunity to be here with you today to discuss the future of technology. Technology has enabled NASA to make great accomplishments over the past four decades and will enable us to make great accomplishments in the future.

As we look to the future we can first look to the past to see what the future likely has to offer.

Every century since the beginning of the Renaissance has been punctuated with great advances in science and technology that have brought about dramatic changes in our lives. In the 1600's, Galileo used emerging optics technology to change our view of the cosmos. Newton's laws of motion and gravity in the 1700's revolutionized our view of the world and how it works. In the 1800's, Maxwell formulated the laws governing electricity and magnetism. And, in the 1900's, relativity and atomic theory disclosed the unknown at the smallest and grandest scales.

This century will be no different. Three key emerging, interrelated technologies will provide NASA—and the country—with a new pathway to revolutionize our missions and the scientific and engineering systems that enable them: biotechnology, nanotechnology and information technology. Over the past decade there have been tremendous scientific break throughs in the understanding of these technologies. And, it is only fitting that we discuss these technologies here since so much of it originated and prospers in California.

We are going to initiate a long-term integrated strategy to exploit these technology areas to enable new products and missions for the future.

The first element of NASA's technology strategy is biotechnology—the truely revolutionary technology of the 21^{st} century. Since the formation of the first cells on Earth, all living systems have developed an extraordinary capacity to adapt to rapidly changing conditions, building a high degree of resilience enabling them to overcome damage and evolve in response to new environments. Furthermore, they do all this at the molecular scale, processing vast amounts of information with incredible energy efficiency. In terms of size, memory, processing speed and energy consumption, biological systems are up to a billion times better than the systems we build today. These are the characteristics NASA will build into its future missions and systems.

The next element is nanotechnology, which begins at the atomic level and provides the capability to create structural materials, electronics and sensors with unique properties and capabilities. In the future we will measure the way we design and build our systems by the atom, not by the pound. Today we have research activities under way to enable new material systems based on single-walled carbon nanotubes—single molecules a nanometer in diameter and about a micron in length. They are up to 100 times stronger than steel and just 1/6 the weight. Variations of these tubes can form nanometer-scale wires with 100,000 times better current carrying capacity than copper.

In another form, carbon nanotubes can be semiconducting and could be configured as digital electronics. If we can grow these tubes with the right properties and assemble them into the right kinds of networks, we can reduce the size of microelectronics by a factor of at least 10,000.

The emerging information technology revolution forms the third element of our technology strategy. This encompasses how we develop knowledge—not manipulate data—and how our future systems will look and operate more like living systems than machines. We will build future aerospace systems with distributed sensory systems—like a central nervous system—to allow us to monitor and control every function. Our computer systems will more resemble the human brain with the capacity to learn. They will respond to natural language and interact with us as cooperative partners. They will not replace humans, but enhance our capability, allow us to conduct safer missions and increase overall productivity

However, we at NASA do not view these three technologies as independent from each other. They are highly integrated and synergistic. Biological processes are inherently designed, built and operated at the nanoscale—atom by atom, the ultimate in miniaturization. Single cells perform the work of entire chemical factories. The information contained in a DNA molecule is a billion times more dense and energy efficient than anything we can build out of silicon. The model of the ultimate thinking computer is the brain.

Despite this, we have serious barriers to overcome before we can achieve the full potential of this technology triad for the 21^{st} Century.

Today we are less than a decade away from hitting the "brick wall" of conventional micro-miniaturization. Using the best technology available today, we can mass produce microsystems with feature sizes of about one tenth of a micron. Advanced lithography may achieve a resolution below a tenth of a micron, but this is still 100 to 1000 times greater than the atomic scale.

A computer capable of completing a trillion operations per second using today's microelectronics would consume on the order of a megawatt of electricity. However, the human brain consumes less than 10 watts of power while operating orders of magnitude faster.

Our challenge is to learn how to make these revolutionary new devices cost effective and reliable. The answer does not lie in chipping away material atom by atom, but by building it up, atom by atom. In searching for ways to do this, we have found that the answer is all around us. Biological processes have operated at the atomic scale since the beginning of life on Earth. Modern lithography exploits the technology of photography to mass produce circuitry at the micron scale. And biology functions on an even grander scale through self-reproduction, self-assembly, and the ability to adapt and specialize to respond to a dynamic environment.

In fact, biology can provide the ultimate capability and inspiration to achieve the full potential of the digital revolution. Atoms work together to form complex molecules. Groups of molecules perform more complex operations. The complex molecules assemble into higher level building blocks—cell membranes, internal structures and DNA—the subcomponents of a cell. Chemical and electronic communications between cells enable the components to come together and work as an integrated system.

This same hierarchy applies to how we design and build our current information systems—software and computers. The microchips that are so ubiquitous in our daily lives are built from millions of simple electronic gates assembled into computational cells that are laid out in complex circuits. The software we use to control them is built byte by byte from individual keys strokes—each like a single atom—to form lines of code—a software molecule—that form computational modules that, in turn, form complex code. In the end, we have millions of lines of code—tens of millions of key strokes—that only have useful meaning when the hardware/software system is taken as a whole.

The critical distinction between biological systems and current computers is that they may seem to come to life when we use them, but they can only adapt, evolve and think to the extent we anticipate the environment and operating conditions they will encounter and build in appropriate response mechanisms.

As we develop the technologies of the future, we will extend this paradigm to all of our space and aeronautics systems. We will build them—conceptually, analytically and physically—from the atomic scale to the macro-scale. We will build into them the sensory capability to be aware of a dynamic environment, the intelligence to determine how to respond to it and the adaptability to change in form and function.

At NASA we plan to focus significant effort on the zone of convergence formed by the overlapping domains of nanotechnology, biotechnology and information technology. And, in particular, we intend to focus on the center of the zone where the synergy between the three becomes much more powerful than the individual technologies—the zone below a technology event horizon where sophisticated properties of complex systems dissolve into simply discrete atoms.

This is the region where we must learn to design and build these complex, intelligent systems and to predict their properties and behavior.

By combining expertise in biochemistry, molecular and cellular biology with NASA's expertise in physical micro-systems and biotechnology we can develop the fundamentals for an entirely new technology discipline. Biologically-based processes will form the basis for the design, fabrication and operation of nano-scale devices and integrated micro-scale systems.

In particular, we need to exploit six specific features of biological systems: selectivity and sensitivity at the atomic scale; the ability of single units to massively reproduce with near zero error rates; the organizational capability to self-assemble into highly complex systems; the ability to adapt form and function to changing conditions; the ability to detect damage and self-repair; and an ability to communicate among themselves.

Our scope will be to develop the fundamental technology to design and build useful biology-inspired systems that have these attributes. However, NASA has a specific mission to accomplish, and our activities should be clearly directed towards accomplishing that mission.

Some of what we make will be completely biological, such as thin, protective films to protect sensitive material from harmful UV—this could include our own skin. Some of what we make will be inspired by biology, such as neural networks that mimic the function of the brain. For the most part we will use the best of both biological and biologically-inspired worlds to make hybrid systems. For example, consider multi-functional materials that have different layers for different purposes. The outer layer would be tough and durable, capable of withstanding the harsh environment of space, but it would also have an embedded network of sensors to measure temperature, pressure and cumulative radiation exposure. When surface temperatures become too hot, sensors would trigger a response in the outer surface of the material to change reflectivity and cool the surface. If it becomes too cold the reverse would occur. The sensors would also transmit this information to other parts of the system.

The next layer down could be an electrostrictive or piezoelectric membrane that worked like muscle tissue. A network of nerves would stimulate the appropriate strands and provide power to operate them. If a rise in the radiation dose rate were sensed, an alarm would be issued.

The base layer could be a highly plastic layer that would sense any penetrations or tears and flow into any gaps. Ideally, it would trigger a reaction in the damaged layers that would initiate a self-healing process. Also, damaged sensors, electrical carriers or actuators would be bypassed and the network would automatically reconfigure to compensate for any loss of capability. What we would have is a smart, functional, durable material that could be used to cover the outside of spacecraft or used to make adaptable space suits for astronauts.

As an example of what can happen when the right people get together for the right reasons at the right time, consider recent advancements in the development of carbon nanotubes. About a year and half ago NASA started to work with researchers at Rice University to produce carbon nanotubes for structural and electronic applications. When we started working with them the best available production process was measured in milligrams per day and the cost in thousands of dollars per gram. Since that time they have developed an entirely new production process. This year we expect them to demonstrate continuous production at the rate of up to 100 grams per day of carbon nanotubes in a small laboratory-scale reactor. After successful understanding of all processing effects and material property characterization we will be ready to move toward industrial commercialization.

The key point of this example is that the best progress results from the best people working together from government, academia, and industry. This is especially true of emerging, revolutionary technologies whose full cost, capability and range of application is still unknown. During this critical pre-competitive stage the government can play a crucial role through multiagency research and development efforts, such as the Information Technology Research and Development Program and the National Nanotechnology Initiative, and by fostering cooperative and joint activities with industry and academia. Our universities are the country's most fertile source of new and innovative ideas, but it is the commercial sector that makes the benefits of new technology available to all of us.

At NASA we are committed to developing a stronger relationship with the academic community and involving them more in our long-range technology efforts. We are also committed to developing innovative ways to work with industry to benefit from technology advances in the commercial sector and assuring that the technology NASA develops transfers to the commercial sector more effectively. Our overall approach is to develop longer term relationships based on a shared vision for new technology and the impact on new products and applications.

Over the next decade we need to move aggressively to develop this technology vision for the 21st Century and stimulate a new industrial base. This mirrors the emergence of the microelectronics industry of the 1970's and the internet and e-commerce industry of the 1990's—both of which began as government R&D investments.

A critical element for this vision is the need to invest in the educational system to develop the future workforce needed in the development and application of this new revolutionary technology capability. The economic engine and improvements to the quality of life for the 21st Century will be fully exploited by the society that aggressively pursues new technology products and insures the workforce infrastructure is in place to implement this future industrial base. The implications of these discoveries for society will be continually examined as they develop. Humans will be the ultimate decision makers.

Mr. Chairman, I have given you a brief summary of NASA's view of three critical emerging technologies and the impact they can have. However, as a final indicator of what these technologies have to offer consider the phrase written across the frieze of the National Archives, "Past is Prologue." History has proven the insightfulness of that statement. Based on the last 300 years of revolutionary technology and the potential of this technology revolution, this century is off to a very good start.

Mr. HORN. Well, thank you very much.

Can you hear me in the back? I do not know how these microphones work, but here we are. Now it might work.

You have mentioned the information technology. You have mentioned the biotechnology. I would like you to spend just a few paragraphs because I think the one that people do not understand at this point is the nano technology. So if you could just pull together a few nonscientific paragraphs of what this all means, I would appreciate it.

Mr. VENNERI. OK. Ever since, you know, the beginning of time, we've had people look at material development. I guess it goes back to King Arthur days of making better steel. Up through the 1950's and 1960's, we have a whole engineering technology baseline of making metals, making things out of plastics.

And what we tend to do is we develop understanding of processing at that scale that's really at a level above molecular level. What we found is that we can artificially produce fundamental building blocks of material for both electronic and structurally that the world has never seen before.

This was projected in ideas that you could make atom type little building blocks. You have the fundamental, strongest material because everything here in this room is made fundamentally of atoms joining.

For the first time we're able to build, replicate, and have a manufacturing process that makes these tubes the same way every time you turn the process on. You know, in anything that you're going to make commercially, you have a process that has to be repeatable. It can't be a one time fluke in a laboratory.

So what we can do is manufacture carbon bits that are on the order of a few atoms in size, and then be able to manipulate and make these things form up, and hopefully by next year, we would like to be able to have carbon nano tube fibers, equivalent to what you see graphite fibers today, the things that you see in airplanes and golf clubs.

And we will have a material system that is absolutely built upward from atoms, not being formed at another scale and size. So we're talking about designing, working, and manipulating fundamental bits of things that are like manipulating atoms, and that's the major difference.

When you hear the word "nano technology," what people are referring to is manipulating things at the atomic scale, not on another scale going higher up in feature size.

Mr. HORN. I thank you for that. That is very helpful.

Our next witness is Gilman Louie, the president, chief executive officer of In-Q-Tel.

It is a pleasure to have you here.

STATEMENT OF GILMAN LOUIE, PRESIDENT AND CHIEF EXECUTIVE OFFICER, IN-Q-TEL

Mr. LOUIE. Thank you, Mr. Chairman. I appreciate the time and the effort the committee has put to allow us to speak today.

I have some overheads and some graphics that will help us through my presentation.

I just want to start off by saying that In-Q-Tel is a nonprofit corporation, formed for the express purpose of helping the CIA, was chartered by the CIA, to find and acquire new technologies using methods that the technology sector uses today to develop and acquire new technologies for the 21st century.

Next slide, please.

Now, the CIA has a five-step process in which it uses to collect, process, and disseminate information, and do its analytical work, and what the CIA has realized is that unlike over the last 30 years in which information technology was an important tool, going forward it's going to be a requirement for its basic core mission of operations, and without adequate information technologies, the CIA will not be able to perform its central and core mission in providing useful information and analytical information to the President and to the staff in order to make good decisions for the government.

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Now, the CIA has a lot of challenges. Fundamentally, if you were to look at the CIA as you would look at many of the other Federal institutions, you would find that its information technology infrastructure is lagging behind best commercial practices today. It was very much built in the 1950's and the 1960's around the concept of providing information in a secure fashion and protecting its information, and its fundamental security is based on what we call air gaps, the physical removal of the systems, the information systems, from the outside world.

The challenge today is that more and more of the information, particularly open source information, comes from the outside world, and whereas this air gap used to provide a level of protection for the CIA, it's now inhibiting its ability to complete its mission and for it to get the information on a timely basis.

Next slide, please.

Now, the CIA, as expressed to In-Q-Tel, and you have to remember that In-Q-Tel is one of many solutions that the agency is looking toward to provide a vehicle to get the best quality of information technology into the agency.

Our focus, we focus on four primary areas: the safe and secure use of the Internet; information security; how to use attributed architecture; and how to bridge those distributed architectures from within the agency; and how to provide knowledge from all of the terabytes of data that it collects.

Next slide, please.

One of the things that we realized is that when we began to look at the CIA's fundamental problems, it's that the agency's value is not so much that it has an ability to give contracts and spend money, but the problems themselves have huge commercial values, and what I mean by that is if a commercial company or group of commercial companies are able to solve some of the problems that are core to the agency's information technology needs, those organizations would have what we call first mover advantages in the marketplaces.

So if you were to look at the CIA, you would say, "Gee, its current technology infrastructure is behind the curve, but its needs are ahead of the curve."

And what In-Q-Tel's mission is to do is to focus in on the intersection where there is commercial world needs to agency problems. The agency has other information technology problems that do not have commercial viability. Those are being served by other organizations within the agency.

We're focusing in on the intersection of those two spheres.

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Now, what is our role? There's been a lot of press about In-Q-Tel being a venture capital fund. Let me first start off by saying we're more of a solutions house. The reason why the nomenclature of venture capital was pinned to our title is fundamentally that's the language of the Valley. That's the language of information technology. That's the language of the 12 different high tech centers throughout this country that they understand.

We are really a combination, a hybrid between a strategic venture capitalist like a corporate venture capital fund, and an incubator, and we use incubating techniques, which is nurturing companies to solve the problems of the agencies and help them through their development path that also brings their products to a commercial world.

Now, that has a huge advantage for the CIA. In the old days the CIA would give out contracts directly to individual contractors and professional services organizations, of which a solution would solve a particular problem.

The problem with that model is it requires 100 percent of the dollars from government to supply to those organizations to solve the problems.

On top of that, the total cost of ownership is much higher than if government was able to get commercial companies to build off-the-shelf solutions, in which COTS could be an effective tool of solving the agency's problems and using industry standards to provide a natural form of migration, of upgrades, and migration of technologies.

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So why venture capital? Why not other models? Why not use an FFRDC? Why not create a research center? Why not create and just simply streamline our ability to acquire technology and streamline the FAR?

I think fundamentally today as you look around at the landscape of this country and also the global economy was it moves to a knowledge based economy, we're beginning to realize that what's driving corporations is no longer simply the ability to turn a profit, but to build a new paradigm in which knowledge had value.

And if you look at that, you have to begin to realize that you need to align the strategic needs of corporations with that of your problem set, and if you're successful and if you're able to do so, you'll be able to leverage not only your own government dollars, but commercial dollars, commercial research, commercial talent, who today is not particularly interested in doing government contracting, who's out pursuing the Dot.com universe and the knowledge based universe that we're beginning to create around it, and if we don't align that language with the way government operates, it will never be able to get in front of the power curve.

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Now, strategic investment takes a lot of forms, but one of the things that In-Q-Tel realizes is that it must not get in the way of a corporate—corporation's strategic mission. We have to be able to say, "If you solve this problem, when you make it strategic to why you exist, you can have first mover advantage in the marketplace."

For example, we have terabytes of data right now within the agency, multilingual, geospatial, voice, video, images. Whoever creates that next search engine technology that allows the agency to pick out that needle out of the haystack of data it also would have huge commercial value. And so instead of having the CIA foot the entire of bill of creating that technologies, which could cost hundreds of millions of dollars, let the venture world use their dollars, let the commercial world use its dollars and leverage their efforts to solve the agency's problems.

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Now, this requires what we call in the venture world a vetting process. This is not a notion that's very understood by government, and that's the notion of failure. This model is built around the concept that companies and ideas are allowed to fail, and at the end of the day from what you start off with is huge value.

Now, the way we start our process is we may do 15 different incubators in the particular period of time. Of those 15 incubators, in which we'll invest anywhere from $50,000 to $500,000, we'll migrate them down to 8 prototypes, and we'll use a spiral technique of having companies build rapid prototypes of their ideas so that we can actually touch and feel them.

And of those, we migrated down to four or five successful commercialization solutions. This allows us to very quickly from idea to marketplace deliver real products of real value in a time span that most organizations use to actually create an RFP process.

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Now, in order to make this model work, we actually have a joint partnership between the CIA and the nonprofit organization In-Q-Tel. In-Q-Tel is responsible for doing what we call competitive intelligence or landscaping. We go out and tell the world that we are a venture capital fund, and they submit to us all sorts of wonderful, interesting, new ideas that may have value.

In fact, to date we've had over 300 inquiries, 200 submissions from 31 different states of technologies that may fall within our technical need. The agency tells us what their problems are. We try to do a match between their problems with those potential solutions.

We manage the portfolios. We make strategic bets. We ask companies in our Q3 and Q4 process to develop rapid prototypes. Those prototypes are then driven by the agency back into the building, and In-Q-Tel helps those companies commercialize and provide COTS solutions.

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This is a kind of hard to read slide, but this shows the range of programs that we're working on and the kinds of companies that we're working with. As you can see, there are very large, traditional government contractors that we're working with who are actually working in a very unique way with us in that they're providing technologies with the concept and hope that they can spin those technologies off to new commercial ventures, as well as working with very small startup companies trying to break through and create new technologies for the government.

We have technologies from MEMs, micro electronic systems that do micro sensors all the way through broad band search engines. So we have the full gambit of technologies and the full gambit of players, as well as reaching out to universities.

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Now, our fundamental advantage in the marketplace from other institutions is that we use the language of the Valley to engage technology companies. We negotiate and work on their terms, and we use a series of strategies from venture capital to convert mechanisms to equity, to licenses, things that are very different from government, but really allows us to really excite the market space.

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So with that, I think that In-Q-Tel—let me just finish up with a couple of comments. In-Q-Tel is an organization designed to take risks, and the reason why we have to take risks is because that we are right now in a risky game of knowledge management and information technology, and using kind of the government approach of no risk, zero tolerance of failure, we'll never be able to reach out there and plot those destructive technologies that can make fundamental change in how we live our lives and could affect our national security.

So our motto is to engage organizations, to embrace risk, to take the changes that are necessary to yield success, and our goal is to use venture capital as a way to acquire technology not purely for returns on investments.

Thank you.

[The prepared statement of Mr. Louie follows:]

Statement of Gilman Louie
President of In-Q-Tel, Inc.
Committee on Government Reform
House of Representatives
April 24, 2000

Mr. Chairman, I am honored to appear before the Subcommittee this morning to discuss In-Q-Tel. I am especially pleased that the Committee is looking into emerging technologies and how they may be applied to Government operations. In-Q-Tel is a unique – and very special – effort to ensure that the CIA is able to take advantage of emerging technologies to achieve its vital mission.

At the outset let me say what an honor it is to serve as President of In-Q-Tel and to play a role in this exciting endeavor. It is imperative that our Government be able to take maximum advantage of the creativity and expertise in the high tech community to achieve national objectives. And, as the Founding Fathers recognized, the first responsibility of government is to provide for the national security. Critical to our national security is the role played by the Central Intelligence Agency and the other members of the Intelligence Community. They are the eyes and ears of the Nation; they are the first to warn us of threats. At the end of the day, it is their job to ensure there are no more Pearl Harbors. Today, it is absolutely vital that they have the best technology available so there will be no more Pearl Harbors.

Let me now turn to some specifics about why In-Q-Tel was created and how we are going about our responsibilities.

The CIA has substantial information technology needs that cannot be met using in-house resources or the conventional acquisition methods. In-Q-Tel was created to solve that problem.

CIA's information technology needs include the following:

- To bring the CIA's IT infrastructure up to commercial standards; CIA is not currently able to keep up with the extraordinarily rapid development in IT infrastructure.
- To reduce IT acquisition time and costs; it takes too long and costs too much to bring IT technology into the Agency, and by the time it finally arrives, it is often woefully out of date.
- To identify and respond to disruptive technologies; CIA has got to be on top of the developments in new and disruptive technologies.

- To attract the commercial leaders in information technology; under the conventional acquisition methods, commercial and technological leaders of the IT community often have few incentives to work with government.

- To leverage the power of the commercial and venture markets; the IT revolution is fueled by private industry, not by government. CIA must use the commercial marketplace – and the venture capital engine – to assure that it has access to the best technology available.

- To reduce reliance on "point solutions;" CIA must have solutions that reach across all of its systems, not just small solutions to single problems.

- To move to open standards; CIA must be able to operate with the standards used by industry.

- To improve the national IT infrastructure; if In-Q-Tel successfully develops new technology that will help the CIA, it will also help the rest of the nation.

- To stimulate the marketplace and foster competition; the In-Q-Tel model has generated enormous interest and is already helping stimulate the marketplace and encourage competition, not only for government markets but also for commercial markets.

- To move toward commercial off-the-shelf solutions; CIA must move away from unique systems designed solely for its own use. They must take advantage of the commercial genius and use off-the-shelf solutions with lower life-cycle costs.

CIA found that traditional acquisition methods are simply not capable of meeting their needs. There are several reasons for this.

First, information technologies change at a breathtaking rate. Keeping up with the developments in new technology simply does not permit the use of traditional government contracting methods that take months or years to complete.

Second, many government contract procedures and regulations are burdensome to the commercial developers of information technologies. For example, the government may impose substantial accounting and control requirements. The government also seeks intellectual property rights and imposes lots of red tape that simply has no attraction to the high tech community. Quite frankly, the high tech community doesn't need the government as a market. Government is no longer the principal buyer of technologies.

Third, the conventional acquisition system often does not permit the government to influence the strategic direction of technology. It is not like the Cold War when much of our aerospace and high tech industry was driven by the government market and the commercial market followed. It is now the other way around.

Finally, traditional acquisition methods give the Government little insight into the rapid developments in the IT community, especially concerning potentially disruptive technologies.

Recognizing these shortcomings, CIA Director George Tenet approached Norm Augustine, the former Chairman and CEO of Lockheed Martin Corporation, in late 1998, and asked if he would serve as the chairman of a new non-profit corporation that would assist the CIA in meeting its high technology needs. Mr. Augustine readily agreed and, working with Mr. Tenet, put together an absolutely first rate Board of Trustees, including former Secretary of Defense William Perry; John Seely Brown, the Director of Xerox Palo Alto Research Center; Alex Mandl, the former President of AT&T; Jeong Kim of Lucent; Stephen Friedman, former Co-Chair of Goldman Sachs; John McMahon, former Deputy Director of CIA and former Executive Vice-President of Lockheed Martin; Paul Kaminski, former Undersecretary of Defense; and Michael Crow, Executive Vice Provost of Columbia University.

In-Q-Tel was incorporated in February of 1999 and is an independent non-profit corporation established to assist the CIA. We are currently applying for tax-exempt status under Section 501(c)(3) of the Internal Revenue Code. The articles of incorporation provide that the corporation will operate exclusively for charitable, scientific and educational purposes, including but not limited to the following:

- Performing and promoting research and related scientific endeavors in the field of information technology;

- Fostering collaborative arrangements that make private sector and academic information technology expertise more readily accessible to agencies of the United States; and

- Fostering the development of information technology that will benefit the public, private and academic sectors in the United States.

Our initial funding has come entirely from the CIA. We will focus on solutions that address priority Agency challenges that also have valuable commercial applications. The Agency and In-Q-Tel have negotiated a "Charter Agreement" with a duration of five years. The Charter sets out the basic relationship between In-Q-Tel and CIA. In addition, In-Q-Tel receives annual contracts from the CIA that spell out specific requirements and provide funding. At the moment, CIA has given us four primary areas of interest:

1. Safe and secure use of the Internet.
2. Information security.
3. Distributed architectures.
4. Knowledge management.

We refer to these four areas as the "Problem Set" for which we are seeking solutions. We work closely with the Agency to understand these problems so that the technology we locate will be effectively applied within the CIA. As this point let me emphasize that our work is unclassified, and we seek to be as open as we possibly can be. Obviously, many of the applications of the technology we locate and help develop will be classified, but the technology itself and our relationship with the CIA is unclassified.

The CIA has created an in-house team to help us understand its problems and to ensure that the solutions we identify and develop can be applied within CIA. This role is crucial because if we produce technology that does not meet CIA's needs, we will have failed.

The business model adopted by In-Q-Tel has several major elements. First, we are engaged in a constant process of "terrain mapping" to identify and evaluate existing and emerging technologies. In this regard we have reviewed hundreds of unsolicited proposals that have come to us from companies with good ideas that may well be of great advantage to the CIA and the rest of the Intelligence Community.

Second, we have begun to develop some of these technologies in contracts with individual companies, both large and small. We have already identified several very promising technologies. When one considers that the company has been in existence barely over a year – and I have been on board only since last fall – I think our achievements are truly remarkable. Some of this is a result of our efforts, but much is also attributable to the great interest in our company and the enormous response we have received from high technology companies who are interested in trying to work with the Government in this new and creative way, and the CIA's dedication to this endeavor.

Third, we are using the engine of venture capital in order to identify technology with great promise for the Agency. As you know, Mr. Chairman, venture capital is the vital engine that identifies and supports the best ideas that emerge in the high tech community. The only way for CIA to identify technologies early and to influence their development in a way that will be valuable to the Agency is for In-Q-Tel to participate in the venture capital process. Accordingly, some of the funds we have been given will be invested in companies not only to develop prototypes or to do demonstrations, but also as an equity investment. In the equity deals we are negotiating, we will be able to align the strategic objectives of the company with the Agency needs as the company is developing commercial applications for its products. Our venture capital activities will promote outreach to new players who would not previously have thought of working with the Government. It will also permit us to leverage the money we have many times over by participating with venture and corporate dollars in the same companies. The venture capital model uses the best practices of the industry and puts a trusted party in the deal and technology flows. Finally, by participating in equity we hope to be able to reinvest the proceeds of our equity investments in order to become self-sustaining so that no government funds will be necessary for In-Q-Tel to operate as a service for the Government in the future. And we also hope that some of these funds will permit us to recruit and retain high quality people in a very competitive market.

Finally, Mr. Chairman, let me address the issue of risk. The CIA is to be commended for recognizing that a bold new approach was necessary to meet its IT needs. When CIA has taken risks in the past, it has produced great results. We only need think of the U-2 and the spy satellites – many built very close to where we now sit – to know how the CIA has taken risks and produced phenomenal technology that has been of great benefit to the nation. The CIA is doing the same with In-Q-Tel. But when one takes risks, there is always the possibility of failure. There is the possibility that some of the technologies in which we invest will not pan out. There is also the possibility that the business model we have developed is not the best model to achieve our objectives. There is the certainty that we will be criticized.

But if we do not take risks, Mr. Chairman, and if we are not prepared to be bold, we will never meet the critical information technology needs of our nation's Intelligence Services. I hope your Subcommittee will work with us to meet this challenge. I commend your Committee for looking at these issues, and I look forward to answering your questions. Thank you very much.

Mr. HORN. I thank the gentleman.

And we now move to Dr. Charles Shank, the director of the very prestigious Lawrence Berkeley National Laboratory at the campus of the University of California, Berkeley.

Welcome.

STATEMENT OF DR. CHARLES V. SHANK, DIRECTOR, LAWRENCE BERKELEY NATIONAL LABORATORY

Mr. SHANK. Thank you very much, Mr. Chairman and members of the subcommittee.

It's my pleasure to be here this morning to share my thoughts on a number of specific emerging technological areas and their tremendous benefit for government operations. I want to focus on scientific developments at the Lawrence Berkeley National Laboratory where we made major contributions in the areas of energy, information technology, health, and the environment.

Many of our technologies for improving energy efficiency are delivering major cost savings at both public and private sectors of the economy. For example, in the area of building technologies, we have developed a computer based energy analysis tool, advanced fluorescent lighting, novel windows, new appliance standards, and these are all saving in aggregate more than $2 billion a year annually in energy costs, and we estimate the government share of these savings at about $80 million.

Recently we concluded the first U.S. demonstration of highly efficient, automated, electrochromic smart windows at the Ronald Delums Federal Building in Oakland. These windows offer the prospect of saving up to 40 percent of the lighting and cooling needs of typical offices, while reducing glare and improving the comfort of the work space.

At the Phillip Burton Federal Building in San Francisco, we are now completing the world's largest demonstration of an integrated office lighting system. This effort indicates that if we made use of 50 percent of our buildings and actually took advantage of this technology, we could reduce energy use in the country by 55 terawatt hours annually, and this is almost 10 percent of all the national lighting energy consumption.

Our vision is that every Federal building will employ our technologies and further reduce costs by hundreds of millions of dollars per year, thus contributing to the Federal goal of reducing energy use by 35 percent between 1985 and the year 2010.

The Berkeley Lab is the home of National Research Scientific Computing Center, one of the world's most powerful civilian scientific computing facilities used by thousands of scientists across the country to tackle very complex research problems. It is a tool for scientific discovery.

We also operate the Department of Energy's Energy Sciences Network, which serves the DOE laboratories and thousands of government, industry, and university scientists.

Berkeley Labs research also would include pioneering contributions to networking technology whose advancements have made the Internet a powerful—a more powerful and useful tool. For example, we at the Berkeley Lab helped develop the multi-CAS backbone protocols that enable such things as the video CAS that is taking place right now over the Internet of this hearing.

This advance allowed one to be able to broadcast over the Internet without bringing the Internet down by saturating all of its lines. It's quickly becoming the standard for electronic connectivity, allowing government staff at widespread locations to engage in effective deliberations, and without the time and expense of travel to widely distributed resources.

We're also involved in a number of technologies of current interest here in the Silicon Valley. In partnership with the Sandia Laboratory, the Lawrence Livermore Laboratory, we've been working with a limited liability corporation funded by Intel, Motorolla, Advanced Micro Devices, and Micron, and are developing a new photolithographic tool using extreme ultraviolet lithography.

Now, this program is well on its way, and we have high hopes to be able to develop systems to produce computer chips that will have feature sizes less than 70 nanometers, which is quite an advance from where we are today.

The technology that we're working on can shrink the critical dimensions of a chip features by a factor of four and greatly improve the power of these chips. We expect that this technology, if all goes well, will be employed in the year 2005.

And as I'm talking here today, we are in the midst of a great revolution in biology, and one of those very important events that is about to take place is that we have nearly deciphered the human genome, often termed the "book of life." The genome contains 3 billion pieces of information that describe our entire genetic make-up.

In 1986, Charles Delisi of the Department of Energy took the bold step of proposing that we begin a project to decipher the human genome and determine the complete DNA sequence of 23 human genomes.

Now, this was considered a major challenge. The way in which technologies were being used to actually begin this project did not give one great hope that this would be accomplished in any time soon. In fact, I remember when I became Lab Director and people began to talk about this, they thought this was a task best done in a penal colony rather than in laboratories.

And, in fact, whole new ways of deciphering the genome have been produces. New informatics tools have been created, and we are well on our way to finishing this task. It was a prodigious task to produce the sequencing of 3.2 million base pairs.

Our original effort was to complete by 2005. We're going to complete that schedule well ahead of that. We at the Berkeley Laboratory and our partners have just reported three of the chromosomes that have been completed in their first initial rough draft, and they'll be finished before the end of the year.

Now, what are the implications of this revolutionary advancement? Well, the availability of a complete genome is a major breakthrough in fundamental biology as scientists compare entire genomes, gain insights into biochemical and physiological and disease pathways.

And last month at our, DOE's, Genome Institute, we described this new draft of the three chromosomes, and we've determined that these chromosomes estimate—have about 10,000 to 15,000 of the nearly 100,000 genes that are important for actually producing the protons—the proteins that make our bodies work.

Defects in these genes lead to genetically linked diseases such as kidney disease, prostate, colorectal cancer, leukemia, hypertension, diabetes, and arteriosclerosis, but maybe more important is what we're going to see in the future.

Remarkable capabilities will soon exist for physicians to understand their patient's individual genetic make-up. This is going to enable a new epoch in health care and we think about individualized diagnosis and treatment at lower cost and drug reactions that often affect only a small fraction of the people. Such drugs might even be able to be used in the future where your generic make-up will indicate that they are useful for you and maybe not for others.

In summary, our research and development, strongly rooted in the physical and natural sciences, now offers the prospect of transforming government operations in many ways. The continued benefits will be a more informed government delivering more effectively managed public resources for the nation.

Thank you.

[The prepared statement of Dr. Shank follows:]

Testimony of
Dr. Charles V. Shank
Director, Lawrence Berkeley National Laboratory
before the
House Committee on Government Reform
Subcommittee on Government Management, Information, and Technology
April 24, 2000

Mr. Chairman and Members of the Subcommittee:

It is my pleasure to be here this morning to share my ideas on emerging technologies and their tremendous benefit for government operations. I want to focus on the scientific developments at the Lawrence Berkeley National Laboratory, where we have made major contributions to the efficiency and effectiveness of our government, especially in the areas of energy, information technology, health, and the environment. Our research and facilities serve many government agencies, industry, and universities. This work, often developed in partnership with universities and industry, has an impact that makes government cost less and deliver more. The ultimate outcome of our efforts may revolutionize how government operations are conducted, and result in far better management of public resources.

Highly Efficient Government Facilities

Many of our technologies for improving energy efficiency are delivering major cost savings to both the public and the private sectors of the economy. For example, in the area of building technologies we have developed computer-based energy analysis tools, advanced fluorescent lamps, novel windows, and new appliance standards that are saving the nation more than 2 billion dollars annually in energy costs. We estimate that government's share of these savings is about 80 million dollars.

Recently, we concluded the first U.S. demonstration of highly efficient, automated electrochromic "smart windows" at the Ronald Dellums Federal Building in Oakland. These windows offer the prospect of saving up to 40 percent of the lighting and cooling needs of typical offices, while reducing glare and improving the comfort of our workforce. Similarly, Berkeley Lab recently worked with the U.S. Postal Service to develop an entirely new lighting system for post office work areas, employing new fixtures and integrated control systems. The system is saving 50 to 60 percent of the lighting costs. Because lighting is a major cost in post office buildings, the overall utility bills have been reduced by 30 percent. Equally important is the fact that the postal workers are happy with the improved lighting quality.

At the Phillip Burton Federal Building in San Francisco we are now completing the world's largest demonstration of an integrated office lighting control system. This study indicates that a 50 percent use of the new lighting controls in offices, schools, and retail buildings could reduce national lighting energy use by about 55 terawatt-hours annually (about 0.6 quads), or almost 10 percent of all national lighting energy consumption. Our vision is that every federal building will employ our technologies and further reduce costs by hundreds of millions of dollars per year, thus contributing to the federal goal of reducing energy use by 35 percent between 1985 and 2010.

New Technology for Government Information

Berkeley Lab is home to the National Energy Research Scientific Computing Center, one of the world's most powerful civilian scientific computing facilities, used by more than 2500 scientists to tackle complex research problems. We also operate the DOE Energy Sciences Network, which serves DOE labs and the thousands of government, industry, and university scientists who access the scientific resources of DOE facilities. Berkeley Lab's research in networking technology provides the advancements that have made the Internet a power and useful tool. In the early 1970s, to advance our physics research we were the first government research facility to place a supercomputer on the Internet. Later, we developed the computing protocols that reduced congestion on the Internet and made it more reliable. In 1989, the high-energy physics community developed the World Wide Web.

More recently, Berkeley Lab helped develop the Multicast Backbone protocols that enable videoconferencing among many locations without degrading network performance. The system enables government organizations to share information at low cost and high effectiveness. The Multicast Backbone is becoming the current standard for electronic connectivity, allowing government staff in widespread locations to engage in effective deliberations without the time and expense of travel. The successor to the current Internet and Multicast Backbone technology is represented by our work on "Computing Grids" that will have a revolutionary effect on science, business, and government. These grids will have unprecedented connectivity, far stronger computational tools, and guaranteed access to widely distributed resources. In the future, the entire wall of your office could become a computer screen enabling shared work and access to your collaborators.

The Laboratory is also working to extend the frontiers of imaging and visual information. We are developing an imaging system with one billion pixels, about 100 times more than existing individual charge-coupled devices (CCD). This system uses Berkeley Lab-developed sensors that have the broadest high-efficiency bandwidth in the world, extending from visual wavelengths almost into the infrared. This digital camera system and the component sensors are being developed for use by the physics community, much like the original World Wide Web, but already there is growing interest for many other imaging applications.

Throughout the government and private industry there is concern about maintaining the integrity of the Internet and protecting against hackers. The future of electronic commerce is dependent on finding a solution to security and privacy issues and the integrity of the service itself. Although we are a civilian research laboratory that does not conduct classified research, we have developed some of the most powerful software available to monitor our entire site and cut off intruders. This software allows for high-speed access and open communications, yet it provides a high measure of protection. This kind of system can protect our government networks while enabling the public's access to government information and services.

Our vision for improved computational power is to move rapidly toward the next generation of processor technology. In partnership with Sandia/ Livermore and the Lawrence Livermore National Laboratories, and funded by Intel, Motorola, Advanced Micro Devices, and Micron, we are conducting the Extreme Ultra Violet Lithography research program. This program will develop lithography systems to produce computer chips that feature sizes less than 70 nanometers (and possibly down to 20 nanometers). The technology we are working on can shrink the critical dimensions of chip features by a factor of four, and can greatly improve processor power. We expect that these Extreme Ultraviolet Lithographic systems will be deployed in the year 2005. As the powerful processors are commercialized and enter government information systems, we may even see a smaller and faster government.

The Genome Revolution

This year one of the most revolutionary achievements in the history of biology is taking place. We have nearly deciphered the human genome, often termed the "book of life". The genome contains 3 billion pieces of information that describes our entire genetic make up. In 1986 the Department of Energy took the bold step of beginning the Human Genome Project to determine the complete DNA sequence of the 23 human chromosomes. The Energy Department's role arose from the historic congressional mandate to study the genetic and health effects of radiation and chemical by-products of energy production. From this work grew the insight that the best way to learn about these effects was to study DNA directly. The major challenge was the prodigious task of sequencing the 3.2 billion base pairs, an effort originally expected to take until 2005. We will complete the task well ahead of that schedule.

What are the implications of this revolutionary advancement? The availability of complete genome sequences is driving a major breakthrough in fundamental biology as scientists compare entire genomes to gain new insights into, biochemical, physiological and disease pathways. Thousands of diseases have been linked to genetic causes, and people vary in their genetic susceptibility to disease and drug tolerance. Last month at DOE's Joint Genome Institute, we completed the draft sequence of three chromosomes that contain an estimated 10-15,000 genes, including those whose defects may lead to genetically linked diseases such as kidney disease, prostate and colorectal cancer, leukemia, hypertension, diabetes, and atherosclerosis. Remarkable capabilities will soon exist for physicians to understand their patients' individual genetic make up. This will enable a new epoch in health care through individualized diagnosis and treatment at lower cost and less risk of harmful drug reactions.

Cost Effective Environmental Protection

Environmental protection is also a major government responsibility requiring the best scientific information available. On a global scale, the increases in carbon dioxide in the atmosphere are well documented. But what are the fate and effects of the "green house gases?" The supercomputers at our National Energy Research Scientific Computing Center are addressing this problem. We are developing more realistic simulations of the Earth, adding missing parts, such as the biological components in the ocean, to improve these complex models.

We estimate that each year only half of the world's carbon emissions are added to the atmosphere. The other half is being sequestered in the oceans and on land. We are now trying to better understand how the oceans sequester carbon, and whether this can be enhanced in cost-effective ways. We are developing a low cost autonomous robotic carbon sensing system to understand the biological, chemical, and physical processes in the ocean's carbon cycle and to evaluate sequestration opportunities. We also are studying methods for geological sequestration of carbon dioxide, including the evaluation of the use of oil and gas reservoirs and subsurface brine deposits. With this improved information on geologic and ocean sequestration the government can do a better job of developing the appropriate steps to address global climate change.

Transforming Government Operations and Programs

In summary, our research and development, strongly rooted in the physical and natural sciences, now offers the prospect of transforming government operations in many ways. These changes will be made through unprecedented electronic connectivity and processor power, by improved efficiency of all government facilities, and by delivering on the government's mission to protect the health and welfare of U.S. citizens and the environment. There is no doubt that quality scientific investments have been paying off for the nation. The continued benefits will be a more informed government, delivering more effectively managed public resources for the nation.

Mr. HORN. Thank you very much.

That's a marvelous bit of leadership in terms of helping the business community, the building community, and the Federal offices where we'd like to spend less and get more of a result.

So we can discuss that some more.

We now have our fourth presenter, Dr. Stephen Popper is the associate director of Science and Technology Policy Institute at the Rand Institute in Santa Monica, and are you part of the group that now has a sort of graduate school there, or there is an overlap?

STATEMENT OF DR. STEVEN W. POPPER, ASSOCIATE DIRECTOR, SCIENCE AND TECHNOLOGY POLICY INSTITUTE, RAND

Dr. POPPER. Yes. I, in fact, teach a course in the RAND Graduate School.

Mr. HORN. Yeah, I thought that was a great opportunity. I once spent a lot of my scientific time at the Brookings Institution, and they did that in the 1930's, and you sort of carried on that for people that are policymakers, and we read your studies when they come. You have a very good person in Washington to make sure we get all of your booklets.

So we're glad to have you here.

Dr. POPPER. Thank you very much, Mr. Chairman. Thank you for the opportunity to appear before you and contribute to the question of how emerging technology may enhance government operations.

But I think it's important to point out that technology is going to be a double edged sword for government, that the rate of technological change not only raises new possibilities for enhancing government operations, but an era of constant and continuous change will pose many challenges to these same operations. There will be troubling new issues, reduced response times, and changes in the nature and effectiveness of governance.

So in many ways the question is not whether, in fact, to apply emerging technologies to government operations. It's more a question of how and the best way to meet the inevitable challenges.

I applaud the subcommittee for beginning to explore these questions.

Outside of the sphere of national security, there are really three broad functions for governance where both prospects for new capability and for challenges to effective operations arise. These are in the allocation of funds and effective management of their expenditure, monitoring and regulation, and agenda setting and policymaking.

In my written testimony I attempted to offer some examples of applications of new technologies to government operations, emphasizing near term actionable opportunities. Some of these are clear: more effective use and management of Federal data bases and information systems; creating institutions and infrastructures for effective use of e-mail communications between the government and the electorate.

But even for these obvious wins, there will be some subtleties. There's going to be great temptation to overlay new technology on existing processes, whereas in many cases we would be better advised to rethink those very processes in the light of emerging technologies.

In the balance of my oral comments, I'd like to dwell on two applications that I think do possess a little more subtlety, that do require rethinking of fundamental processes of government operations in order to weave in new technological means.

The first is the use of Web-based media to create and manage what has been called by a number of people a "hyper-forum," which is nothing less than an on-line, asynchronous, structured virtual expert panel. There may be more need for this type of mechanism than first appears.

One of the hallmarks of the increasing tempo of technological change is an increasing need for interaction between government, the general public, stakeholders, possessors of expertise and so on in order to generate discussions, create connections, permit feedback.

In the work that we did which led to our study "New Forces at Work," which was subsequently issued as the fourth National Critical Technologies Report, when we asked members of industry, CEOs, CTOs, and so on, where they thought there was an important role for the government in the area of emerging technologies, they pointed out a need to have government perhaps act as a convener, a provider of auspices, an occasion for early discussion over issues such as standards, technology foresight, and so on .

But these types of discussions are frustrated by the practicalities of time, the direct costs, the opportunity cost, and perhaps more, given these constraints, there's very often a need to drive to a perhaps too early consensus. Much information is pared away. It's difficult to reclaim a lot of the nuance, from the transcripts and the records.

Further, these conversations tend to be rather episodic and exceptional by their very nature. So they are very difficult. They are divorced from daily processes both in government and in business. Using the type of means that I have described, a Web-based hyperforum, would lead to structured discussions, allowing for exchange of visions, exchange of information, would provide new opportunities for evolving reflection on a group basis, for the opportunity to examine side issues, sustain an ongoing engagement, help define and craft collective views, and support a process that would segue more naturally into implementation.

The other example I wanted to speak about lies in the realm of policymaking and computation. Consider how the process of policy analysis and formulation occurs today. Very often, when considering policy we are forced to pretend we know the unknowable: what will be the budget surplus or deficit in 15 years or even 10? What will be the state of Medicare or Social Security in 25 years? How much will global warming increase over the course of the next half century, and how much of an effect may that have on our economy.

The result frequently is an engagement in largely fruitless debates over factors that no one can know about. We argue over competing predictions generated by this think tank versus that think tank, none of which are either provable or refutable.

We're trapped into these corners because the means that we have for our analysis and even the rhetoric we use for discussing policy was formed under conditions of relative computational poverty when computers were rare and CPU was dear.

What we then do is we use best guess estimates. We use a lot of ingenuity and creativity to create the best possible model, the best possible representation of the future, statistical approximations; in short, to come up with some sort of a solution that is optimal, in quotes.

Of course, in doing so, we've really only illuminated a single point in space in the vast space of uncertainty we face, and our best guess is almost certain to be wrong.

At this point, the analytical process and the political process become uncoupled from one another, and then politicians are left to moderate, to compromise, to do those sorts of things that they receive precious little thanks for, and yet this is precisely how humans confronted with uncertainty reason. They try to be adaptive. They try to be flexible. They try to seek middle ground.

So the question for us becomes how can we use analytical means, use computers to support precisely what—use computers to support what humans naturally do. In an era of relative computational richness, there are ways. Quite simply, the insight is that when considerable uncertainty prevails, one can be neither sure of trusting a single model as the best plausible representation of some underlying system or having sufficient information available to use transitional quantitative, analytical looks.

What is required are means to examine the full multi-dimensional landscape that are defined by the very uncertainties that create the problem. We need means for conveniently and uniformly generating and examining many thousands of plausible specifications.

We at Rand and elsewhere have used these means, constructed new approaches for this type of policy analysis that have been applied to some policy problems that have traditionally resisted traditional means of analysis and have come to some fairly strong conclusion.

So this has particular relevance in the realm of public policy because it permits public policy decisions to be examined within the context of the problem. That is, it is possible to look at the effect of different policy choices, different strategies of implementation across a wide range of plausible future scenarios.

We have the ability to then explore and craft strategies that explicitly from the outset are designed to be flexible and adaptive. It gets away from the need to make predictions and, instead, supports precisely the type of reasoning engaged in by humans when confronted with uncertainty, namely, trying to find solutions that are robust, that will lead to the least regret.

And finally, this sort of approach would lend itself to the realities of the political process, supporting discussion among stakeholders, but identifying and validating points of legitimate interest.

Let me just sum up in 30 seconds by pointing out that we ought to be aware of technology magic bullets, that any technology needs to fit within the context of its use, which frequently will involve rethinking of fundamental processes and government operations.

Second, to point out that in many areas our technical means frequently outstrip our understanding based on cognitive psychology of how humans will use technologies to interact with one another.

And then finally, I think we should be aware of paradox, that introducing new technologies and supporting the costly infrastructures that they will require may put pressure on mission agency budgets, and that may come at the expense of the basic research that was not only the source of these technologies to begin with, but also the wellsprings of our future prosperity.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Popper follows:]

IMPLICATIONS OF EMERGING TECHNOLOGIES FOR GOVERNANCE IN THE 21ST CENTURY

Testimony of Dr. Steven W. Popper[1]
Senior Economist
Associate Director, Science and Technology Policy Institute
RAND

Before the House of Representatives Subcommittee on Government Management, Information, and Technology (House Committee on Government Reform,)
24 April 2000, Moffett Field, CA

Mr. Chairman and Honorable Members of the subcommittee, thank you for the opportunity to appear before you and contribue to the deliberations of this panel. The point of my remarks may be stated quite briefly. The accelerating pace of technological change will have a considerable transforming effect on the institutions of governance and their operations, whether we will it or no. We possess the option, however, of affecting the direction of this transformation through awareness and by adapting the new capabilities wrought by those same technological changes to the service of both traditional and emerging government operations.

Continuous Change Becomes the New Constant

The conventional wisdom on the accelerating rate of technological change is a truism – that might actually be true. In many respects, the changes to the fabric of daily life witnessed during the years spanning 1801 and 1900 were more fundamental than those occurring during the subsequent century from 1901 to 2000. The 19th Century's transformation, in turn, was largely predicated upon political, social, and technological changes that had occurred during the last part of the previous century. While one must always be wary of historical analogy, evidence suggests that the next one hundred years will witness a similarly breathless degree of change, this time based on the political,

[1] This testimony represents the personal views of the author and does not necessarily represent those of RAND nor of its sponsors. In preparing this testimony, the author has drawn upon parts of the following recent RAND studies: *New Forces at Work: Industry Views Critical Technologies*, Steven W. Popper, Caroline S. Wagner, Eric V. Larson, RAND MR-1008-OSTP; *Global Science & Technology Information: A New Spin on Access*, Caroline S. Wagner and Allison Yezril, RAND MR-1079-NSF; *Information and Biological Revolutions: Global Governance Challenges*, Francis Fukuyama, Caroline S. Wagner, Richard Schum, Danilo Pelletiere, RAND MR-1139-DARPA; *Data Policy Issues and Barriers to Using Commercial Resources for Mission to Planet Earth*, Scott Pace, Brant Sponberg, Molly Mcauley, RAND DB-247-NASA/OSTP; *New Methods for Robust Science and Technology Planning*, Robert J. Lempert, James L. Bonomo, RAND DB-238-DARPA; *Weapon Mix and Exploratory Analysis: A Case Study*, Arthur Brooks, Steve Bankes, Bart Bennett, RAND DB-216/2-AF; and *Sending Your Government a Message: E-mail Communications Between Citizens and Government*, C. Richard Neu, Robert H. Anderson, Tora K. Bikson, RAND MR-1095-MF.

social, and above all technological changes that have taken place during the past twenty-five years.

We are entering a world where not only discrete changes in emerging areas of technology but the very dynamic of a continuous and accelerated process of change on all fronts will affect the way people think and behave in the world. This will be true for the private life of the individual and the public life of the nation, thus exerting a powerful force on traditional structures and modes of governance. Key emerging technologies will, in themselves, present unprecedented challenges for governments to address as will, in the aggregate, the very fact of a constantly changing technological basis for all of our society's interactions.

In the broadest terms, the emerging technologies possessing the most prospect for transformation are: 1) electronic communications and computational ubiquity emerging from the information revolution, 2) human genetic manipulation , biometrics and bioinformatics emerging from the biotechnology revolution, and somewhat more prospectively 3) developments in nanotechnology applied across many technology fields. Their common hallmark is the challenge each presents by supporting or even impelling a shift from collective control and hierarchical decisionmaking to individual control and decisionmaking. If these prospects materialize into fact, they will place considerable strain on the ability of governments and governance structures to act upon, or even perceive where lies, the public's interest in directing the development of these technology areas.

Emerging Technologies and Government Operations

It is clear that these emerging technologies and the implications ensuing from their development and application should be very much the concerns of those federal agencies with clear science and technology mission mandates: NASA, NSF, NIH, etc. But just as the digital revolution, brought about by the triad of microelectronics, telecommunications, and sensor technologies, has now begun to transform even traditional "smokestack" industries, so too we are beginning to see the first evidence of the more traditional governmental functions such as those performed by the Departments of State, Justice – and certainly Congress – facing a need to confront the implications of emerging technology and ceaseless change. Therefore, there is really not so much a question of whether government will choose to avail itself of new capabilities made possible by emerging technologies, but rather how – and how well. The necessity will arise from emerging technologies in turn generating profound changes in the structure of governance itself. Government and its operations must also be a part of this sweeping change or risk its ability to function credibly.

The interactions between technology and governance will be complex. Government will need to define and act upon a concept for operations in arenas increasingly defined by the new capabilities conferred by emerging technologies and the accelerated pace at which they appear. These technologies, in turn, will affect the nature of governance. In this respect, the transformations brought by genetic manipulation and the biological revolution will probably provide the greatest challenge to the ability of government to understand and control the pace of change and will most directly affect traditional concepts of governance owing to their substantial ethical implications. To what extent can we find ways for emerging technologies themselves to enable government to fulfill its traditional role in this new environment – as well as those newly thrust upon it?

To answer the question, let us shift the focus from technologies and instead consider the basic functions of governance. In broad measure, the legitimate purview for government operations lies in three areas: allocating funds and then responsibly managing their expenditure; monitoring and regulating private activity in the interest of a commonly conceded public benefit; and either setting national agendas or providing the occasion for agenda-setting activities to occur. In the balance of this testimony I will offer a few brief suggestions of ways that emerging technologies may be applied to government operations either to allow those operations to continue being sustainable in a new environment or to confer new capabilities upon government operations to meet new challenges. We should also bear in mind that in each instance we face a true choice. We could, either by volition or default, fail to avail ourselves of new technology-based means; we may choose to employ such means but only as an overlay on existing patterns and procedures of operations; or we can re-engineer fundamental approaches in the light of new technology-based possibilities. The general experience with new technology adoption is that only the latter course delivers full value.

What follows are brief examples of technologically-enabled means for affecting one or more of the three main spheres for governance. In the interest of concreteness, I will concentrate principally on recent RAND research findings or on methodologies being developed or explored at RAND. These should be read as exemplars of broader ideas and possible applications of emerging technologies. Further, the emphasis will be on those suggestions that might be actionable in the near-term. I will only address the civilian, non-national security aspects of government operations.

Information Technologies to Better Utilize Data

It is a truism that our times are coming more and more to be characterized by the quantity of information being generated and shared. Timely access to quality information has become a prominent determinant of success in many fields for both individuals and organizations. There is a significant opportunity for enhancing the value of government services by taking advantage of developments in the technology of information storage, access, search, and transfer. This could significantly enhance the fiscal management operations of government as well as leverage and better coordinate government investment.

Many areas of traditional government operations could be transformed by application of information technology. As an example, consider the area of information on science and technology. The example is apropos both for the subject of these hearings and because of the unique character of the federal R&D effort. One is hard pressed to name other vital federal government functions in the discretionary part of the budget that cross so many Executive agency and Congressional committee lines. It is hard to think of any parallel federal activity that has such importance and such a broad involvement of so many agencies. And if this were not enough, the R&D planning problem needs not only to be funded, managed, and administered across the government, it needs to be applied across quite disparate fields of science.

The demand has long existed for information that is more readily available, more integrated, and more usable on federal R&D efforts. In this and other areas, there is a need for means to support "smart" searches of bibliographic information by individual users; software systems that will permit querying various databases and provide coordinated responses without needing to build a new, central database; and a means to parse information in a tiered system to meet the needs of users with varying needs and levels of technological sophistication.

The RaDiUS ("Research and Development in the U.S.") system, developed by RAND and to be maintained jointly by RAND and NSF, was intended both as a tool for meeting a quarter-century old need for viewing cross-cuts of federal efforts in specific areas of research across agencies, but is offered here as a model for similar systems that could be developed for other areas of governance. It combines an intelligent search engine and user interface with an ability to browse across databases maintained by different mission agencies, each with its own standards and format, without imposing a uniformity that would have interfered with the functionality of those databases for the individual agencies.

The value of such tools in enhancing the operations of government agencies could be measured in several ways:

- enhanced efficiency of information gathering and production,
- synergy achieved by combining different databases and the subsequent leveraging of government information assets,
- increased timeliness of delivery,
- wider accessibility,
- multiplying contacts between individuals and authoritative expertise thus increasing the density of information sharing networks, and
- increasing the ultimate effectiveness of information utilization.

Note that RaDiUS did not rely on special R&D data; it used the operational databases of each agency. Similar systems could be created with the same technology to address other areas of government operations.

Such systems, enabled by emerging technology, should be recognized as advances in instrumentation. As with other such advances they will confer an ability to draw new views of the world and its possibilities. The benefits that would accrue would certainly affect information flow between government and citizen, but would also profoundly affect intra-governmental information sharing and decision making.

Communications Between Public and Private

Closely allied to the theme of information flows is that of e-communication between citizen and government. All agencies and members of Congress have now embraced, to one degree or another, the use of e-media on a wholesale basis. What of "retail" communications: those initiated by either party containing specific information targeted to the individual?

Clearly, this is a large topic.[2] Many issues must be addressed relating to standards, costs and their allocation, security, the legal status of electronic communications, access across the "digital divide", technological barriers, and problems with social acceptance. Yet for government operations involving significant amounts of personal communication, e-mail (broadly defined) has the prospect of lowering costs, improving service, accelerating the "wiring" of the U.S., and meeting increased public demands for such options.

The prospect is certainly worthy of further exploration. To better understand the possibilities as well as the challenges, governments at all levels could begin to take

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[2] Neu et al. provides a far more detailed discussion.

preliminary steps. Possible avenues for such personalized communications could be identified and catalogued. Some communications may be a simple sending of messages while others might address more complex actions. Some may be best facilitated by filling out fixed-field forms while others might require more free-form formats. At the same time, facilities and standards for ensuring varying levels of security could be explored with the specific view of supporting the types of potential communications identified by agencies. A regulatory and legal framework similar to that which applies to postal mail should be crafted for this medium as well. And most especially, begin now to consider the problem of access and inclusion for the "unwired". A system of national e-mail addresses might be considered that would integrate with the existing system of domain names but also provide at least the potential for access to all. Few steps currently available would more directly enhance both the perception and the fact of government responsiveness in a faster-paced world.

Internet-Based Public-Private Policy Forums

When it comes to agenda setting and regulatory activities, there are many aspects of government operations that require interaction with the general public, stakeholders, and possessors of information and expertise. This will come increasingly to be the case as rapid technological development transforms all aspects of our society. Here again, a consistent message from the RAND interview projects has been that a process that generated discussion, that created connections, and that permitted feedback would be of immense value in several realms.[3] Yet, the view was often expressed that the practicalities of engaging in such government-public panel discussions, even at the most general level, were a serious obstacle to progress. Opportunities are being missed because of the missing links in this chain of communications. Their very exceptionality has proven an obstacle to making such interactions more meaningful and organic to the structures now in place in both business and government. Expense and logistics are principal barriers as well, hence deliberations remain relatively narrow, episodic rather than ongoing, and somewhat divorced from day-to-day process in either business or government.

This presents another opportunity to link the trends of the computer and telecommunications revolutions for profound change at low cost—to make a more

[3] Popper et al., and Lempert et al. discuss this in more detail.

drastic revision of the process than could have been contemplated previously. Web-based media are now sufficient to support a wide variety of public-private panels in various areas of policy. Asynchronous virtual expert-panel discussions can be conducted to focus and refocus on a wide range of technical or policy issues. Several such panels could address different levels of concern. The Web-based tools would not only permit discussion but would also provide common access to widely available data sources and even to software tools embedded in the sites. These resources could be used to facilitate discussion and permit these panels to be transformed from discussion groups to working groups. Such means, called a "hyperforum", has now been used several times in the course of RAND project work and elsewhere.[4]

This vision encompasses not only wider participation but perhaps more meaningful participation as well. These means would provide a flexibility that would obviate the need to drive too early to a possibly artificial and format-constrained consensus as do, for example, standard Delphi approaches. The process as a whole could, instead, consider more widely the alternative views that exist of the further course and direction of a wide range of topic areas characterized by uncertainty and complex ranges of opinion. In addition, the reformulated process would reinforce the practical value of the ultimate product. During the course of such a hyperforum, lines of communication could be built or strengthened both vertically and horizontally, making implementation of any practical findings less burdensome.

This is a vision whose technological reality could be quickly achieved but whose theoretical underpinnings would need more research. In certain respects the technical means at our disposal have outpaced our understanding of how to apply them. The cognitive aspects of how groups function would need to be reexamined in order to translate this interaction to an entirely new medium. The initial use might not be as a fully functional framework but as a tool to provide augmentation of other, more traditional approaches for drawing in wider participation. This emerging technology supplement to, or enhancement of traditional government operations would fulfill several objectives by creating:

Σ A broader base of discussants, enhancing enfranchisement and "buy-in";

Σ More iterations and more time than a physical setting provides;

Σ Support for both large-scale and one-on-one interactions;

Σ Horizontal and vertical connectivity; and

Σ Ultimately, more interactions leading to more cross-fertilization of ideas.

[4] Examples of this approach may be found on the Web at http://www.hf.caltech.edu/hf/.

The prospect brings into being a heretofore absent mechanism for sharing experience, encouraging and providing an avenue for evolving reflection by individuals and the larger group or groups, examining side issues of importance without running the risk of derailing the main effort, and placing the means to define and craft a collective vision at the disposal of participants in an ongoing engagement among people from government, industry, and universities. In this manner, the technical means so transforming the traditional conduct of government activity and the application of technology to the workplace would also prove the means for elevating the quality of public policy discussion in many fields.

Computation and Policy Formulation In the Face of Uncertainty

We have all become aware of the technical advances in computing technology encapsulated by Moore's "Law" (less a law, really, than a vision more than amply fulfilled by the ingenuity of scientists and technicians in this field.) What is not as commonly understood are the possible implications of the resulting "ubiquitous computing" – being surrounded by an embarrassment of computing riches. In particular this situation, already present in its earliest form, has implications for application to the drafting and implementation of policy.

A fundamental function of government is the drafting and consideration of policy. A considerable amount of policy and operational decisionmaking by government bodies is made under conditions of deep uncertainty where predictions are not possible and different stakeholders will impute different future values to variables of central importance. (What will the budget surplus/deficit be in FY2017? The solvency of Social Security and Medicare? What will be the extent of global warming in 2025? What effect will this have on the global economy?) Currently, the attempts to reason through such futures, determine options, and craft policies are supported by analytical tools developed in the days when computers were scarce, CPU dear, and memory virtually non-existent. These techniques almost universally demand single-point prediction and then develop some optimal, "best-guess" strategy or policy. As a corollary, in most cases there is an implicit assumption that there is a unitary decisionmaker taking a once-and-for-all policy stance that will stay the course from today until the period being considered. These are not characteristics of our present political system. The effect is to constrain policy choices, disenfranchise certain categories of knowledge and other information inputs, and lead to confrontational debates centered on arguments over which presently unknowable fact is most likely to prove true. In reality, the adaptation that naturally occurs as more and better information becomes available then takes place outside the framework of objective, fact-based analysis.[5]

In an environment of ubiquitous computing, however, new methods become available. Rather than using computers as glorified calculators, they may be integrated into the reasoning process by creating a system for designing, conducting, and drawing inferences from the outcomes of what may be called compound, multi-scenario simulations. Briefly, the insight is that when considerable uncertainty prevails, one can be sure neither of trusting a single model as the best plausible representation of the underlying system nor of having sufficient information available to use traditional quantitative analytical tools at the time when decisions must be made. What is required is the ability to examine the full multi-dimensional landscape that is defined by the very uncertainties that span the problem space. Rather than examining one or a few alternatives, the system would provide the means for conveniently and uniformly generating and examining many thousands of plausible specifications, providing visualizations of the outcomes that are accessible even to those not skilled in quantitative analysis, and allowing the user to draw powerful insights in an interactive manner. This possibility arises only as a result of the current speed and ubiquity of computing resources. The essence of the notion is to have computers do what they do best – generate millions of calculations on an on-going basis – while humans then do what they do best – identify patterns, draw inferences, form insights, and interact with one another by drawing from a fuller range of visible information.

Such a system has been applied to several policy problems at RAND and has led to an ability to draw strong conclusions in situations and for problems that had previously resisted standard analytical techniques.[6] It has particular relevance to the realm of public policy. As a practical matter, several benefits would ensue to enhance government operations. First, this approach permits the policy decision to be examined within the context of the problem to be solved so that the effect of differnt policy choices and alternative strategies for implementation might be examined across a wide range of plausible future scenarios. Further, this approach would allow one to explore and craft strategies that are explicitly designed to be flexible and adaptive, subject to future signposts and decision points. Next, it obviates the need to make predictions, in circumstances when the best guess is likely to be quite wrong, in the chimeric quest for

[5] Viewed this way, federal budget processes are based on a string of single-point predictions of the future truly believed in by no one because neither the generators of such forecasts nor their consumers are foolish people.

[6] Brooks et al. is an example.

some optimal solution. Instead, it supports precisely the type of reasoning engaged in by humans when confronted with uncertainty: which actions appear to be most robust across the widest range of uncertainties? What current policies will lead to least regret while preserving options for the future when more will be known? Finally, such an approach lends itself to the realities of the political process. It supports discussion among stakeholders by identifying – and validating—points of legitimate difference. It allows the sharing of visions and inferences among groups. And it has been used in a web-deliverable format as the center of the hyperforum type of web-based discussion.[7] This is an instance where an emerging technology may itself be used to enhance government ability to operate in an environment of accelerated technological change.

Rethinking Government Activity in Emerging Technology Fields

An environment of rapidly emerging technology may not only confer new capabilities on government operations but also modify the roles for appropriate government action. Results from several survey-based projects canvassing industry leaders have shown several areas where those in the private sector see an increasing void that could best be addressed by government operations.

Setting technical standards has emerged as an increasingly important issue affecting not only rates and directions of technological development in many industries but of basic research as well. Set standards too early and one runs the risk of stifling promising lines of inquiry; set them too late and rates of technical progress may be stymied by needless uncertainty. Among industrialized countries, the U.S. standards infrastructure is characterized uniquely by a loosely coordinated system of Federal, State and local governments, voluntary standards organizations, trade and professional organizations, for-profit entities, and industry semi-permanent and ad-hoc groups. Thus far, the U.S. system has been effective in promoting both technological innovation and economic growth – but as the importance of technology grows in all industry sectors shortcomings have appeared and questions have begun to arise. Failure to agree on standards for cellular telephony, for example, has been pointed to as a principal reason why European firms were able to capture both technological and market leads over their potential U.S. competitors.

In this environment, there is a role for government, not as the setter of standards, but as the convenor and provider of auspices for such discussions to take place among producers, suppliers, customers, interested parties, and the government. Currently, it is difficult for such discussions to occur in a timely fashion – if at all. Industry people

[7] Lempert et al. provides an illustration.

readily acknowledge there is a public interest to be served distinct from the private interests of the potential suppliers in a field. This would be a legitimate role for government and one that may be made possible by the type of capabilities conferred by emerging technologies that have been discussed above.

Similarly, the pace of technological transformation is not only disruptive of operations in government. As even traditional "smokestack" industries become transformed through application of the technologies of the digital and telecommunication revolutions, the technology factor as an element of the process that produces marketable goods and services assumes larger proportions. While a boon in many respects, such change also exacerbates for business planning the issues of complexity and uncertainty -- inherent concomitants of technology development. The problem is intensified by a growing need to become more fully aware of developments in other industries and other countries. The very rapidity of technological change makes issues of technology foresight non-trivial as traditional rule-of-thumb approaches based on past experience fail to apply.

Government operations already support limited efforts at technology assessment and foresight through the National Critical Technologies Review process and the support of the World Technology Evaluation Center. The feedback from the private sector is that these are useful, are difficult to reproduce as private efforts, and should be supported fully or even expanded.[8] To understand why, we should examine the value to individual firms. They rarely have the resources to do more than a cursory examination of their own in these areas. Further, they have limited access to truly unbiased sources of such information. What they are searching for is not definitive answers but rather a baseline against which they can test their own perceptions and assessments. In addition, there is a perception that in the midst of so much technological change there is a need to establish a coherent vision, a high ground appreciation of technology developments in the context of higher order goals for our society. Only government can really fit this bill, and here again, the types of new capabilities enabled by emerging technologies can allow such a process to become integrated, seamless, and of considerable use both to the private sector and public agencies who would engage in discussions within a venue that would support such mutual explorations.

At the same time, as such private-public partnership becomes more desirable and tractable, government agencies may be in a position to relinquish some old roles or

[8] See, in particular, Wagner et al. and Popper et al.

perform them in light of new options. As an example[9], DOD and NASA have long been in the business of putting hardware into space and gathering data. As the leading edge of technology development passes from the public sector to the private, new options emerge. An early harbinger is the Mission to Planet Earth (MTPE) program at NASA. A portion of the data will be gathered from commercial sources rather than public ones. Integrated project teams of government and industry technical experts will define mission goals with private science packages flying on government platforms and vice versa. As the possibility for such interchange arises in other areas, government policy on issues related to data standards, data analysis funding, the purchase of data vs. the more traditional building of systems, and, of course, property rights will need to be confronted explicitly. This is an example of government operations conforming to a changing environment and the emergence of new opportunities and challenges. It is an instance less of directly applying emerging technology than of formulating policy for government operations in the context of emerging technology to make those operations more effective and thrifty.

Finally, a note of caution. There is the possibility of falling into a subtle trap as emerging technologies translate into new capabilities that might be used in government operations. Many of these new developments are based on basic research that had been funded by various mission agencies. As this research has borne fruit in the form of new means for monitoring or active response, there is quite understandable interest, indeed even pressure, for those agencies to begin to wield these new capacities and take on the provision of new or expanded service. (Think of NOAA and its enhanced capacity for monitoring, understanding, predicting, and extrapolating consequences.) Through a now-familiar process, the existence of a technologically sophisticated ability we had not previously wielded quickly transforms into a perception that a mission agency and instrument of public policy should employ this ability to the general benefit. What was previously untenable now routinely becomes the expected.

These enhanced expectations for mission performance also generally require considerable outlays for a sophisticated infrastructure to support the new or expanded operational mission. As a general rule, budgetary allocations are not likely to keep pace with the costs of the now more expensive operations. This places pressure on the traditional research funding activities that were the wellsprings of such new-found operational latitude. Such an agency now confronts the challenges of maintaining a standing force to support operations, doing so in a cost effective manner, being in a

[9] Discussed in Pace et al.

position to respond to crisis, financing increasingly more expensive systems acquisition and at the same time continuing the agency mission-supporting R&D.

One of the strongest findings from the RAND interview projects was a near-uniform opinion that among the legitimate roles of government in an era of rapidly emerging technologies one of the most important is to continue to support and maintain the system of basic research that has made it all possible. There should be some sensitivity to the possibility for paradox in utilizing these technologies to enhance government operations; doing so should not come at the expense of the sources of a our future well-being.

Mr. HORN. Well, thank you.

We're going to skip a couple of witnesses now because the mayor of Sunnyvale is with us, and she leaves for court, and we want her well prepared when she goes to court. You have an all American city, as I remember, at least a decade ago, and it's quite dramatic in terms of Sunnyvale, and we're delighted to have you here.

STATEMENT OF PATRICIA VORREITER, MAYOR, CITY OF SUNNYVALE, CA

Ms. VORREITER. Thank you, Mr. Chairman, and it's a pleasure to be here, and we really thank you for coming to Silicon Valley this afternoon and also for the opportunity to share with you some of our thoughts on technology and government.

And while I will share some examples of how the city of Sunnyvale has used technology to enhance our services to the community, the bulk of my testimony is on the critical role that government can play in fostering technology and the importance of partnerships.

Over the past 50 years, the combined research achievements of universities, laboratories, and private industry have made the United States the undisputed world leader in science and technology. Propelled to a great degree by Federal investments in defense and space related activities, American R&D efforts and their spinoffs have greatly benefited the security, health, and economic welfare of both the Nation and the world.

While R&D policy must respond to new realities in terms of public funding, the highly positive impact of the bay area's R&D infrastructure on the region's and the Nation's economy and technological leadership remains clear.

The bay area's economy is knowledge based, innovation driven, predominantly high technology, and it is important to note that this knowledge based strength not only includes silicon valley, with the largest concentration of technology oriented firms in the world, but it also includes a broad distribution of computer and electronics, bioscience, telecommunications, and multimedia firms throughout the region.

The Bay Area Economic Forum, a nonprofit, public/private regional partnership of business, government, academia, and community and labor leaders, has created a collaborative effort called Bay Area Science Infrastructure Consortium to document the region's research infrastructure as a critical element in this economy.

Research and development makes the bay area a model for the emerging regional economies that form the building blocks for our national economy, and its profile includes a very highly trained and educated work force, a pronounced culture of entrepreneurism, flexible and plentiful sources of investment capital, for example, with only 2 percent of the country's population in the bay area attracts 35 percent of the venture capital moneys.

And finally, an abundance of new ideas that are generated by the region's immense concentration of universities, Federal research, and technology oriented companies.

The bay area's regional research and development infrastructure yields a powerful technological continuum that connects the research universities, the Federal research institutions, and private industry, and while these three have different goals and different cultures, each adds to and significantly benefits from the strengths of the others.

For example, while the region's research universities are the heart of its scientific excellence, the cross fertilization of ideas generated by the highly educated, experienced, and creative people that transfer among these three sectors adds an immensely important element to the region's extraordinary human resources, and their interaction continues to lead the bay area's significant contribution to the Nation's technological leadership and we believe our economic success.

The presence of so many private industry research facilities in the bay area further demonstrates how Federal and State support can be leveraged to create an ever larger resource of R&D facilities.

Enhanced bay area science and technology research capabilities contribute directly to commercial select growth and the creation not only of new companies, but we're seeing of entire new industries.

The important role of private industry in the Nation's overall R&D enterprise is clear. The relationship among universities, laboratories, and commercial sector R&D activities is an important issue from the standpoint of national economic competitiveness. For a knowledge based economy, such as that of our San Francisco Bay area with its huge R&D presence, this issue takes on particular special significance.

However, the intense competition results from the emergence of the global economy, and industrial deregulation has created dramatic changes in the private sector's R&D function. Competition has forced our local companies to focus on rapid innovation and product development. The time space from laboratory to manufacturing has been shortened dramatically, which means that the emphasis has shifted from exploratory basic research to more directed research, and from basic research to applied research and product development, a significant shift.

Given the importance of the Federal private industry R&D interface, there are several key issues that should be addressed for us to achieve an even greater value from our R&D investment: Strong Federal support for exploratory research; Federal support for R&D tax credits; intellectual property in the context of public-private collaboration; and, finally, exploration of new models for collaboration.

Several important factors affirm the need for continuing public investment in R&D. One, basic knowledge is a public good. Much of economic analysis concerns how market mechanisms can lead to the efficient production and the distribution of private goods, commodities that are met for the exclusive consumption of individual.

But some goods are more public in nature. For example, street lights in a city benefit any and all who pass by at night. Once the street has been lit for one person, it does not cost any more to light the street for additional people.

The cost of knowledge, big science, big risks. Market pressures may minimize or eliminate the opportunity for profit relating to a great many areas of R&D. The public sector, through its pooled resources can better support big science projects and accept large risk projects since it is not as threatened by a single project's failure.

Once a fixed is incurred for a project, such as space exploration, society benefits broadly from the knowledge spinoffs that can follow.

The need for public support of private investment. Some applied research leads to the discovery of product and process improvements which spill over to other firms that can free ride on the discoveries.

In summary, the bay area's economic strength and our competitive advantages in the global marketplace are inextricably linked to the region's research and development infrastructure. The Nation, the State, and the world have derived enormous health, technological, and economic benefits from the bay area's unique clustering of public and private research facilities.

A special strength of this concentration is the technological innovation and the entrepreneurial spirit that's generated by the interactions and the interrelations between the three sectors.

The strength of scientific and technological infrastructures in the bay area, and in other similar regions across the United States, provides a critical research base for the entire country.

The bay area is, and we hope will remain, a key participant in the national science and technology investment strategy for the 21st century. Through the leadership of the Bay Area Economic Forum, local governments, national laboratories, private universities, and private businesses have created this regional collaborative.

The bay area has, in my opinion, one of the strongest partnerships between the public and private sectors. There is a strong appreciation, respect by the public sector for the improvements in the quality of life that these companies have brought to our region and to our world, and the private sector, in return, looks to their government representatives to make their communities the type of place that is attractive for doing business and desirable for their employees.

We at the local level work very closely with our businesses to make that happen. The Federal Government has a key role to play as well by insuring that the basic R&D is funded and that the research infrastructure is maintained.

Sunnyvale, a city of 130,000 people in the heart of Silicon Valley, has benefited tremendously from the public and private investments in technology. We are now providing services to our citizens in ways not even imaginable just a few years ago. For example, our council agendas, reports, and minutes are available on the Web, as is a tremendous amount of other information about our city.

We will soon be going to a paperless system where council members get their agenda packet by way of a soft book.

In addition, Sunnyvale recently inaugurated an e-permit system, which allows residents and businesses to apply for, receive, and pay for building permits electronically. This was part of a regional smart permit effort, a collaborative of public, private, and nonprofit organizations, and it has moved things to market significantly, which in the private sector particularly, time to market is critical. So we are very proud of that.

A final example is our defibrillator program. Thanks to advances in technology, we have initiated a program so that these life saving devices are available in all of our city buildings, available on all of our police and fire vehicles, and since the program was initiated, 15 lives have been saved through the use of our city defibrillators.

We thank you for coming this afternoon and for recognizing the importance of Silicon Valley in our national and world economy.

[The prepared statement of Ms. Vorreiter follows:]

TESTIMONY OF MAYOR PATRICIA VORREITER
CITY OF SUNNYVALE
BEFORE THE SUBCOMMITTEE ON GOVERNMENT MANAGEMENT, INFORMATION, AND TECHNOLOGY

April 24, 2000
Ames Research Center

Good morning. Thank you for the opportunity to speak to you today on the topic of technology and government. While I will share some examples of how the City of Sunnyvale has used technology to enhance our services to the community, the bulk of my testimony is on the critical role government can play in fostering technology and the importance of partnerships.

Over the past fifty years, the combined research achievements of universities, laboratories and private industry have made the United States the undisputed world leader in science and technology. Propelled to a great degree by federal investments in defense and space-related activities, American R&D efforts and their spin-offs have greatly benefited the security, health and economic welfare of both the nation and the world.

The end of the Cold War, federal budget constraints, and the increasingly competitive global economy have caused a continuing reevaluation of United States R&D policy. However animated this debate, the importance of R&D to the nation remains unchallenged. As the National Academy of Sciences stated:

Leadership in the 21st Century will belong to those nations that can capitalize best on change, and science and engineering research has become the most powerful force for change in our society*our capacity for problem solving and creative discovery will continue to be essential for keeping the United States in its world leadership position economically, militarily and intellectually.

While R&D policy must respond to new realities in terms of public funding, the highly positive impact of the Bay Area's R&D infrastructure on the region's and the nation's economy and technological leadership remains clear.

The Bay Area's economy is knowledge-based, innovation-driven, predominately high technology. It is important to note that this knowledge-based strength not only includes Silicon Valley - with the largest concentration of technology-oriented firms in the world - but also includes a broad distribution of computer and electronics, bioscience, telecommunications and multimedia firms throughout the region.

A key factor in this success can be described in terms of the "cluster" concept - the concentration of related facilities and industries. The Bay Area's large number of R& D facilities enables a constant stream of communication among scientists and researchers in a wide number of disciplines. This technological environment draws new talent who recognize the Bay Area as a place to do their best work.

The Bay Area Economic Form, a non-profit, public-private regional partnership of business, government, academic, labor and community leaders, has created a collaborative effort - the Bay Area Science Infrastructure Consortium (BASIC) - to document the region's research infrastructure as a critical element in this economy. Research and development makes the Bay Area a model for the emerging regional economies that form the building blocks of our national economy. Its profile includes:

· A highly educated and trained workforce;

· A pronounced culture of entrepreneurism;

· Flexible and plentiful sources of investment capital (with only 2% of the country's population, the Bay Area attracts 35% of the nation's venture capital.)

· An abundance of new ideas generated by the region's immense concentration of research universities, federal research and technology-oriented companies.

The Bay Area's regional research and development infrastructure yields a powerful technological continuum connecting research universities, federal research laboratories and private industry. While different goals and cultures drive these three sectors, each adds to, and benefits from, the strengths of the others.

· Research universities educate and train the next generation of scientists and engineers while advancing the frontiers of knowledge.

· Federal Laboratories conduct research and development in support of specific missions and enjoy the capability to carry out large-scale, high-risk experiments over the long term.

· Private industry R&D efforts focus on cutting-edge technology consistent with the demand for profitability. Capital may be limited for basic research in order to concentrate on bringing products to market faster.

While the region's research universities are the heart of its scientific excellence, the cross-fertilization of ideas generated by the highly-educated, experienced and creative people transferring among the three sectors adds an immensely important element to the region's extraordinary human resources. Their interaction continues to lead the Bay Area's significant contribution to the nation's technology leadership and economic success. This spatially concentrated aggregation of research institutions - interacting dynamically with the rich and forward-looking science, technology and business infrastructure - produces extraordinary value for the nation.

The presence of so many private industry research facilities in the Bay Area further demonstrates how federal and state support can be leveraged to create an even larger resource of R&D facilities and talent. Enhanced Bay Area science and technology research capabilities contribute directly to commercial sector growth and the creation not only of new companies but of entire new industries.

Amid the intense national debate on federal R&D policy, the central role played by private industry in the nation's research and development activities is sometimes under-emphasized. Three important factors stand out:

· Currently, over 60% of all R&D activities in the U.S. are financed by private industry.

· From 1991 to 1996, the proportion of gross domestic expenditures on R&D by private industry steadily increased while the proportion financed by government decreased.

· As of 1996, the U.S. ranked among the leaders of industrialized countries in terms of the percentage of R&D being financed by the commercial sector.

The important role of private industry in this nation's overall R&D enterprise is clear. Moreover, the relationship among universities, laboratories, and commercial sector R&D activities is an important issue from the standpoint of national economic competitiveness. For a knowledge-based economy, such as that of the San Francisco Bay Area with its huge R&D presence, the issue of this relationship takes on special importance.

Intense competition, however, resulting from the emergence of a global economy and industrial deregulation, has created dramatic changes in the private sector's R&D function. Competition has forced companies to focus on rapid innovation and product development. The timespace from laboratory to manufacturing has been shortened dramatically. The emphasis has shifted from exploratory basic research to more directed research and from basic research to applied research and product development.

In addition, the shift has been from large to small. While the role of large industrial research facilities such as Bell Labs has declined, that of small and medium-sized companies, as well as of smaller research labs associated with larger companies, has proportionally increased.

· The federal investment in Bay Area R&D facilities - approximately $2 billion annually - is matched by between $8 and $10 billion dollars in private sector R&D funding by companies headquartered in the region.

· The Bay Area has a mix of larger company research facilities, such as those of IBM, Hewlett-Packard, Intel and Xerox, and research activities conducted in laboratories of smaller companies, such as in the bioscience industry.

· The Bay Area reflects the national trend of a strong focus on directed research, applied research and product development. Hewlett-Packard, for example, is currently spending only about 1% of its R&D budget on basic research.

Key Issues

Given the importance of the federal/private industry R&D interface, several key issues should be addressed to achieve even greater value from R&D investment at the regional level.

· Strong federal support for exploratory research. Although private industry funding for R&D is high, its support for exploratory basic research has declined. Federal support for exploratory basic research must remain strong, because competitive pressures undermine private industry's ability to undertake high-risk, long-term projects. As one high-technology business leader stated, "Unless the federal government continues investing in this kind of basic research, there will be a gradual drying-up of that resource." In the same sense, private industry is best geared to do applied and product development research and needs to sustain its commitment to world-class R&D in this arena.

Federal support for R&D tax credits is an incentive to continued R&D investment by the private sector. The R&D tax credit is a recognition of the contribution that private sector R&D investment makes to the strength of the nation's economy. It also recognizes the value of the knowledge created for the public welfare in addition to the more direct and immediate benefits to an individual firm.

Intellectual property in the context of public-private collaboration. This multi-faceted issue must be resolved, with solutions including new models for sharing risk and opportunities for equity gain.

Exploration of new models for collaboration. Many opportunities exist for strategic alliances and joint ventures between the research institutions and industry. These can efficiently match the organizational strengths and research expertise of research universities, labs and elements of the commercial sector. For the research institutions to view such collaborations as productive, the industry approach must be more aware of the core missions of the universities and laboratories. For industry to view collaborations as efficient, the research institutions process must recognize the importance of "time-to-market" and the need to reduce the bureaucratic maze. Greater flexibility should be built into these arrangements.

A regional, knowledge-based economy, such as that of the Bay Area, is highly dependent on the strength of the commercial sector R&D community. That sector, in turn, benefits immensely from the research presence and investment of the federal government and of a concentration of world-class research universities and federal research facilities.

The Bay Area boasts a concentration of research and development facilities unmatched in the entire world. Bay Area institutions offer their sponsors - whether the federal or state government or a private firm - a highly advantageous location for research and development. The sponsor gains the benefits of a cumulative financial and intellectual investment stretching back over half a century - an environment in which the whole actually is greater than the sum of its parts.

The Bay Area's cluster advantages, which may not be able to be duplicated anywhere else, include:

· Higher productivity;
· Assured quality;
· Continuous innovation;
· Unique facilities
· The ability to bring together diverse resources and capabilities to address the most important and

challenging national missions.

Support for R&D also comes from other levels of government. State funding of higher education helps to support public research universities in the Bay Area and throughout California. State laws on investment tax credits can influence private industry investment in research. Local and regional governments also can influence research activity through a wide range of policies and ordinances such as those relating to permitting, transportation and environmental issues.

Research for Public Support of Research

Several important factors affirm the need for continuing public investment in R&D and demonstrate the benefits derived by the public from that investment.

Basic knowledge is a public good. Much of economic analysis concerns how market mechanisms can lead to the efficient production and distribution of private goods - commodities meant for exclusive consumption by individuals. However, some goods are more public in nature. For example, street lights in a city benefit any an all who pass by at night. Once a street has been lit for one person, it does not cost any more to light the street for additional people.

The costs of knowledge: big science/big risks. Market pressures may minimize or eliminate the opportunity for profit relating to a great many areas of R&D. The public sector, through its pooled resources, can better support big science projects and accept large-risk projects since it is not threatened by a single project's failure. Once a fixed cost is incurred for a project - such as for space exploration - society benefits broadly from the knowledge spin-offs that follow.

Knowledge as a capital asset. Easy to store over long periods of time, knowledge, unlike other commodities, does not physically depreciate. Investments in producing knowledge generally yield long-lasting results. Accordingly, the advancement of knowledge has been one of the primary sources of economic growth.

The need for public support of private investment. Some applied research leads to the discovery of product and process improvements which "spill over" to other firms that can "free ride" on the discoveries.

Industrial innovations arising from academic research. Spillovers to industrial applications arise both from privately conducted industrial research at other firms and from academic research, usually conducted at universities and publicly funded research labs. About 10 percent of the new products and processes developed by industry could not have been developed without recent advances in academic research.

In Summary:

- The Bay Area's economic strength and competitive advantages in the global marketplace are inextricably linked to the region's research and development infrastructure.

- The national, state and region have derived enormous health, technological and economic benefits from the Bay Area's unique clustering of public and private research facilities. A special strength of this concentration of research facilities is the technological innovation and entrepreneurial spirit generated by the interactions and interrelations among the sectors in the region.

The strength of the scientific and technological infrastructures in the Bay Area, and in similar regions across the U.S., provides a critical research base for the entire country. As governmental leaders evaluate national and state priorities and strive to receive adequate return on research investment, they should recognize that the nation's existing, world-class research infrastructures will provide the best return on public investment.

The Bay Area is, and should remain, a key participant in the national science and technology investment strategy for the 21st Century.

Through the leadership of the Bay Area Economic Forum, local governments, national laboratories, universities and the private sector have created a regional collaborative. The Bay Area Science Infrastructure Consortium (BASIC) ensures that the region and the nation continue to benefit from investment in R & D activities. The Bay Areas has, in my opinion, one of the strongest partnerships between the public and private sectors.

There is strong appreciation by the public sector for the improvements to the quality of life that these companies give to our region and the entire world. They provide new and innovative products to improve our lives and the commitment their people make in both time and dollars positively impacts education, the environment and other quality of life issues.

The private sector, in return, looks to their government representatives to make their communities the type of place that is attractive for doing business and desirable for their employees. We at the local level work closely with our businesses to make that happen. But the federal government has a key role to play as well, by ensuring the basic R&D is funded, and the research infrastructure in maintained.

Sunnyvale, a city of 130,000 in the Heart of Silicon Valley, has benefited tremendously from the public and private investments in technology. We are now providing services to our community in ways unimaginable only years ago, thanks to new technologies. For example, our Council agendas, reports and minutes are available on the web - as is a tremendous amount of other information. We will soon be going to a paperless system where councilmembers get the agenda packet on a "softbook." In addition, Sunnyvale recently inaugurated an e-permit system so residents and businesses can apply for, receive and pay for building permits electronically. This was part of a regional Smart Permit effort, a collaboration of public, private, and non-profit organizations. One final example is our defibrillator program. Thanks to advances in technology, we have initiated a program so these life saving devises ~~are available on~~ all police and fire vehicles, as well as in public buildings. Since the program was initiated, fifteen lives have been saved through the use of City defibrillators.

Mr. HORN. Well, thank you, Mayor Vorreiter. We appreciate your coming here.

Just one question since you will not be around for the questioning.

Ms. VORREITER. Certainly.

Mr. HORN. Other consortia in the area like the one you talk about in the bay area, have they contacted you to form similar consortiums because you have got——

Ms. VORREITER. Do you mean in other regions?

Mr. HORN. Right, other regions.

Ms. VORREITER. Not to my knowledge. Ours is rather unique, and probably even a more directly unique relationship is the collaboration that the cities of Sunnyvale and Mountainview have with Aims Research Center and the entire Moffett complex. Recognizing the presence of the military and our local universities, NASA-Ames, and our two cities, we have put together what we believe is quite a unique and a very special relationship.

And the Federal Government, NASA in particular, plays a key role in that relationship.

Mr. HORN. What's the role of the community colleges in the bay region and major engineering schools, such as San Jose State University, that often their people are hired first, before a lot of other well known universities?

Ms. VORREITER. Certainly we are now in the process of working with NASA-Ames in their redevelopment of the Moffett complex to attract some university presence that will stem from a nexus of the basic research that some of the universities have that they can bring to the working information technology and the Astrobiology Institute that are going on here at Ames.

And with the Navy's departure from the Moffett complex, there is space available for us to build that relationship. So the universities play a very key role in this relationship.

Mr. HORN. I now yield to the gentleman from California, Mr. Ose.

Mr. OSE. Thank you, mr. Chairman.

Is this on?

Mr. HORN. Yeah, just pull it toward you. There. I think that will do it.

Mr. OSE. How is that?

Mr. HORN. Can you hear in the back of the room?

Mr. OSE. I want to extend my appreciation to the chairman for making this meeting possible. I know he has an abiding interest, and that is putting it mildly, in seeing that these things get examined.

I am particularly fascinated with the mayor's comments, and I am struck by in a very real degree how it is whether a chicken or an egg on some of these things. Which do you do first?

And I want to applaud you for acting here in Sunnyvale and Santa Clara and in this area, rather than waiting for, you know, an endless amount of time.

Coming from a city where we struggle with that, I am complimentary of that.

One question I do have is as it relates to your e-permit process. Having come from the development business, you highlight the significant improvements from that process in time to market.

Ms. VORREITER. Yes, sir.

Mr. OSE. Just where I come from it is at least 90 days to get a permit to do anything. What's the e-permit process? Give me some quantifiable order.

Ms. VORREITER. Yes. We have developed a system with a—before the e-permit process that was an interim development in this one stop, one stop shop, if you will, where as many as 90 percent of the permits that were issued to residences and businesses were issued in a 1-day time period.

We have just developed the e——

Mr. OSE. One day?

Ms. VORREITER. One day. Now, those, of course, are the permits——

Mr. OSE. Garages and pools?

Ms. VORREITER. Yes, that would not necessarily require some significant plans, that would not require Planning Commission and/or city council approval. So more complex developments most certainly require and demand our extensive scrutiny.

But we pride ourselves in this process, and it has been of great benefit to our business community particularly, and also our residents.

Mr. OSE. Thank you.

Thank you, Mr. Chairman.

Mr. HORN. We thank you, and, Mayor, you are excused. Thank you very much.

Ms. VORREITER. Thank you very much.

Mr. HORN. Good luck in court.

Ms. VORREITER. My client will be very pleased to not be there by herself.

Mr. HORN. Well, thank you.

Ms. VORREITER. I appreciate that. Thank you.

Mr. HORN. We will now go back to the regular order, and that's Dr. Richard Williams, the former dean at the College of Engineering, now distinguished professor in mechanical engineering and astronautics, and that is California State University, Long Beach.

Dean Williams, 5 minutes.

STATEMENT OF J. RICHARD WILLIAMS, Ph.D., P.E., PROFESSOR OF MECHANICAL AND AEROSPACE ENGINEERING, CALIFORNIA STATE UNIVERSITY

Mr. WILLIAMS. Mr. Chairman, Congressman Ose, I thank you for the opportunity to address issues relating to new and emerging technologies for enhancing security of government operations.

The U.S. Government operations are increasingly threatened by terrorists and criminal elements that endanger people and property. Rapidly increasing world trade and passenger transportation, accompanied by international and domestic terrorism, require application of appropriate new technologies to counter these threats. These include safe and effective, automated, nonintrusive inspection and identification technologies, including biometric devices for identification; new types of scanning systems; and new techniques for assuring the security of communications and government information systems.

The three elements of identifying individuals can be summed up as what you have, what you know, and what you are. An example of what you have could be a credit card or an ID card. An example of what you know could be a password or a PIN number, and what you are is addressed by the new emerging biometric devices.

Biometric devices positively identify individuals by their personal characteristics, whereas identification cards can be stolen and passwords can be transferred. It is very difficult to transfer the personal characteristics that biometric devices can measure.

These human attributes and behavioral characteristics include fingerprints, the thermal or visual image of the human face, voice characteristics, hand geometry of vein patterns, the iris or retina, DNA, and keystroke or signature dynamics. Fingerprint biometric systems have been in use by the government for over a decade, and the price has fallen from over $3,000 each to less than $100 each. Other types of biometric devices are coming into use, and standards are being developed to insure interoperability.

Advanced sensing technologies are becoming available that will enable the government to insure a higher degree of security for government and other facilities. For example, new x-ray devices have been developed that can provide detailed information on the content of a vehicle or container with a total x-ray dosage far, far less than that of a conventional medical or dental x-ray.

A variety of other advanced sensing systems that are safe and effective are also becoming available. Appropriate new technology sensors, as part of an integrated, automated system for nonintrusive inspection, can be deployed to facilitate effective interdiction of illegal or inappropriate materials and weapons.

For example, INS and Customs are currently pursuing a number of technology initiatives to improve their inspection and processing capabilities. A variety of nonintrusive technologies that lessen the physical invasiveness of searches for drugs and other contraband, as well as saving time, money and reducing the tensions of a search, are also being developed and deployed.

Large x-ray scanners examine entire railroad cars permitting much more rapid inspection than manual searches. Fixed site cargo search x-ray machines that are currently being deployed scan the contents of a tractor-trailer in minutes using a pencil sized beam of x-rays that produce both a transmission image and a backscatter image which provide an excellent view and analysis of the contents.

A person would have to pass through the system 100 times to receive the same dosage exposure as a typical medical x-ray. This nonintrusive search technology is safe to operate and quickly pinpoints concealed contraband or weapons.

Likewise, body search machines deployed at some major airports use x-ray backscatter technology to detect both metallic and organic materials concealed underneath clothing with a radiation dose comparable to the amount of radiation received from a normal airplane flight of 2 hours.

Through the application of new technology, suspects can remain fully clothed as they walk through a large scanning device that can detect contraband or weapons under their clothing. Radiation detectors the size of a pager can alert government inspectors to the proximity of radioactive materials.

An array of advanced technologies are being deployed to guard against threats of weapons of mass destruction. In addition, a variety of hand operated devices are being deployed to examine people and commercial conveyances, including density detection devices, fiber optic scopes, vapor/particle detectors, and laser range finders.

Sensors and scanners can send information directly to computer systems for automated processing. New technology systems can be deployed so that instead of overloading operators with the huge amounts of data from various sensors, computers can analyze and filter data, noting potential security risks that need special attention.

If the security systems are tied into this type of communication system, inspectors can actuate barriers remotely. Having sensors, transponders, and security systems communicate with a computer network allows automated actuation of security measures when problems are encountered.

Classification technologies, including automated vehicle identification second scanning systems can help vehicle inspection stations pursue the dual goals of efficient and effective operation.

An example of this is the Transportation Automated Measuring System developed and demonstrated at Fort Bragg by the California State University, Long Beach Center for the Commercial Deployment of Transportation Technologies. This technology, particularly deployed with additional censors, can have broad applications when deployed nationally as required.

New electronic tags, seals, and transponders can be used to allow properly secured vehicles, containers, and packages inspected at the ports of origin to bypass further inspections.

Automated security systems can be designed to help assure the safety of government operations.

The California State University, in collaboration with the Ports of Los Angeles and Long Beach, and the Alameda Transportation Corridor Authority, which is responsible for the major transportation corridor serving the two ports, in collaboration also with INS and Customs, have proposed a 3-year program specifically designed to demonstrate advanced technology prototype systems that once demonstrated, could be deployed to expedite the flow and throughput of people and goods at border crossings, at air and seaports and other inspection stations throughout the United States.

This project would employ advanced technologies to identify persons attempting to illegally enter the United States or transit points where security is required. The project could also provide an increased ability to identify containers entering ports by utilizing advanced sensing technologies for automated container inspection that would enable inspectors to assess container content, including human cargo and improved targeting of selected containers for manual inspection.

The same technologies that are available to the government to assure safe, secure government operations is increasingly available to well financed criminal and terrorist organizations. The U.S. Government agencies must keep on the cutting edge of technology applications and ensure the widespread deployment of effective systems that ensure the security of government operations.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Williams follows:]

New and Emerging Technologies for Security Enhancement

J. Richard Williams, Ph.D., P.E.
Professor of Mechanical and Aerospace Engineering
California State University, Long Beach

United States government operations are increasingly threatened by terrorists and criminal elements that endanger people and property. Rapidly increasing world trade and passenger transportation, accompanied by international and domestic terrorism, require application of appropriate new technologies to counter these threats. These include safe and effective automated non-intrusive inspection and identification technologies, including biometric devices for identification, new types of scanning systems, and new techniques for assuring the security of communications and government information systems.

Biometric devices positively identify individuals by their personal characteristics. Whereas identification cards can be stolen and passwords can be transferred, it is very difficult to transfer the personal characteristics biometric devices can measure. These human attributes and behavioral characteristics include fingerprints, the thermal or visual image of a human face, voice characteristics, hand geometry or vein patterns, the iris or retina, DNA, and keystroke or signature dynamics. Fingerprint biometric systems have been in use by the government for over a decade and their price has been reduced from over $3000 each to less than $100. Other types of biometric systems are coming into use and standards are being developed to ensure interoperability.

Advanced sensing technologies are becoming available that will enable the government to ensure a higher degree of security for government and other facilities. For example, new x-ray devices have been developed that can provide detailed information on the content of a vehicle or container with a total x-ray dosage much less than that of a conventional medical or dental x-ray. A variety of other advanced sensing systems that are safe and effective are also becoming available. Appropriate new-technology sensors as part of an integrated, automated system for non-intrusive inspection can be deployed to facilitate effective interdiction of illegal or inappropriate materials and weapons.

For example, INS and Customs are currently pursuing a number of technology initiatives to improve their inspection and processing capabilities. INS and Customs are installing automated license plate readers at international border crossings to automatically read front and rear license plates of vehicles entering and exiting the country. A system of cameras and sensors scan the fronts and rears of arriving vehicles and enter the license plate data directly into the computer in about a second. This allows inspectors to direct their full attention to vehicles and their occupants rather than spending time manually entering license plate data into a computer at the inspection station. SENTRI (Secure Electronic Network for Traveler's Rapid Inspection) systems use technology to identify enrolled vehicles and people and display information and pictures to the inspector. VACIS (Vehicle And Cargo Inspection Systems), which are being deployed at land border crossings, airports and seaports, use gamma ray imaging to detect contraband within vehicles and cargo containers. This system is not only nonintrusive, it can be disassembled, moved and reassembled at another location the same day.

A variety of non-intrusive technologies that lessen the physical invasiveness of searches for drugs and other contraband, as well as saving time, money, and reducing the tensions of a search, are also being developed and deployed. Large x-ray scanners examine entire railroad cars permitting much more rapid inspection than manual searches. Fixed-site cargo search x-ray systems that are currently being deployed scan the contents of a tractor-trailer in minutes using a pencil-sized beam of x-rays that produce both a transmission image and a backscatter image. This provides an excellent view of the contents, and a person would have to pass through the system a hundred times to receive the same exposure as a typical medical x-ray. This non-intrusive search technology is safe to operate and quickly pinpoints concealed contraband. Likewise, BodySearch machines deployed at some major airports use x-ray backscatter technology to detect both metallic and organic materials concealed underneath clothing with a radiation dose comparable to the amount of radiation received from the natural environment on a 2-hour plane flight.

Through the application of new technology, suspects can remain fully clothed while they walk through a large scanning device that can detect contraband under their clothing. Radiation detectors the size of a pager can alert inspectors to the proximity of radioactive materials. An array of advanced technologies are being deployed to guard against threats of weapons of mass destruction. In addition, a variety of hand-operated devices are being deployed to examine commercial conveyances, which include density detection devices, fiber optic scopes, vapor/particle detectors, and laser range finders.

Broadband encrypted communication systems will allow operators to disseminate data over wide areas while maintaining information security. Wired and wireless communication systems allow a stand-alone computer to be part of a regional or even global information network, given satellite communication technology. Sensors and scanners can send information directly to a computer system for automatic processing. New technology systems can be deployed so that instead of overloading operators with huge amounts of data from various sensors, computers can analyze and filter data, noting potential security risks that need special attention. If the security systems are tied into this type of a communication system, inspectors can actuate barriers remotely. Having sensors, transponders, and security systems communicate with a computer network allows automatic actuation of security measures when problems are sensed.

Classification technologies, such as weigh-in-motion and automated vehicle identification, used in concert with bypass lanes, can help vehicle inspection stations pursue the dual goals of efficient and effective operation. The Transportation Automated Measurement System (TrAMS), developed and demonstrated at Fort Bragg by the California State University, Long Beach Center for the Commercial Deployment of Transportation Technologies, is an example of a new classification technology that can have broad implications, particularly when deployed with additional sensors. Future classification technologies integrated with historical databases may greatly improve the selection mechanism to recognize carriers that are habitual or potential problems. New electronic tags, seals, and transponders can be used to allow properly-secured vehicles and containers inspected at their points of origin to bypass further inspections. Future versions of these technologies will actively denote the status of the vehicle, driver, and cargo to alert authorities to potentially illegal or dangerous situations. Automated security systems can be designed to contain these vehicles or pedestrians with minimal interruption of regular traffic flow.

The California State University, Long Beach, in collaboration with the Port of Long Beach, the Port of Los Angeles, and the Alameda Corridor Transportation Authority (which serves the two ports), has proposed a national demonstration project known as the CSULB, INS and Customs Inspection Technology Infrastructure Project. This demonstration project would include the installation and evaluation of existing new technologies and the development, installation and evaluation of advanced technology prototypes at the Los Angeles International Airport, the Port of Los Angeles, the Port of Long Beach, and the Alameda Corridor. This project could help to disseminate enhanced inspection technologies throughout the United States as new technology prototypes are proven. This would have significant benefits as new systems are deployed nationwide. .

The CSULB, INS and Customs Inspection Technology Infrastructure Project is proposed as a three-year program specifically designed to demonstrate advanced technology prototype systems that could be subsequently deployed to expedite the flow and throughput of people and goods at border crossings and air and sea ports throughout the United States. This project would employ advanced technologies to identify persons attempting to illegally enter the United States and expedite the processing of personnel at INS border stations. The project could also provide an increased ability to identify containers entering ports by utilizing advanced sensing technologies for automated container inspection that would enable inspectors to assess container content, including human cargo, and improve targeting of selected containers for manual inspection. The project is intended to have a force multiplying effect to maximize the use of current government personnel. It would also serve to improve coordination between inspection agencies, help to standardize inspection procedures, reduce paperwork, and allow activities to continue beyond normal business hours. The renovation necessary to upgrade the inspection technology infrastructure would not interfere with existing operations.

It is estimated that $15 million will be required over three years to perform the tasks necessary to implement the CSULB, INS and Customs Inspection Technology Infrastructure Project. $5 million would be needed the first year to successfully initiate this national demonstration project in fiscal year 2001. This funding could be allocated in the Construction account of the United States Immigration and Naturalization Service portion of the Department of Justice section of the Commerce, Justice, State, the Judiciary and Related Agencies Appropriations Bill. There were a number of appropriations for these types of renovation projects in the fiscal year 2000 appropriations bill. It is important that this funding be an addition to the INS budget and not a redirection of funds from some other critical INS need.

The same technology that is available to the government is increasingly available to well-financed criminal and terrorist organizations. U. S. government agencies must keep on the cutting edge of technology applications and undertake the widespread deployment of effective systems to ensure the security of government operations.

Mr. HORN. Thank you very much. Appreciate it.

We are going to have to have a recess now. We have some technological situations with our equipment that needs to be done, and so we will take a 10-minute recess. I think it is now roughly 12:57 by my watch, and we will say at 1:07 or so ought to be about it.

So we are in recess.

[Recess.]

Mr. HORN. The committee will resume. The recess is over, and we will go back to the regular order, which is Mr. Richard H. Davies, the president and chairman of the Western Disaster Center.

Mr. Davis.

STATEMENT OF RICHARD N. DAVIES, PRESIDENT AND CHAIRMAN, WESTERN DISASTER CENTER, INC.

Mr. DAVIES. Thank you, Mr. Chairman and Mr. Ose, and thanks for the opportunity to discuss the Western Disaster Center project and some new thinking at the Federal level concerning disaster management.

Disasters today are recognized as a real national security issue. Disasters on foreign soil can dramatically impact the U.S. national security interests. Two very quick examples come to mind. The event in Turkey last year almost brought down the Turkey Government. The big earthquake in Taiwan could have been used by China as an opportunity to move across the straits, but actually ended up being an opportunity for cooperation between Taiwan and China.

In the United States disasters cost the Federal taxpayer, us and everybody else, about $1 billion per week. This is a 10-year average that's been going on awhile now. So it's well defined; it's well understood, and that's $50 or $60 billion a year of Federal direct costs. Indirect costs are probably another $50, $60 billion.

There has just been a recent report that says severe weather disasters in the United States have increased over 300 percent in cost. We're also faced with a big change in manmade disasters, be they terrorism or be they just somebody playing on the computer like we just saw a couple of weeks ago here locally.

I know the committee did a lot of work on Y2K. That was very useful.

The Western Disaster Center is a not-for-profit research center working to develop two strategic efforts: the Western Disaster Information Network and the Institute for Crises Management.

As the risk and associated costs of disasters continues to grow, it is imperative that technological advances be harnessed to aid the State and local disaster managers in reducing loss of life and property. It is frequently forgotten that the real war fighter, the real front line troops in disaster response and recovery is the local disaster manager. It is those organizations that are supported by the State and Federal agencies when their resources are exceeded.

The revolutionary advances in technologies and information technology communications and computing in changes in Federal defense and intelligence policy now enables the sharing and distribution of disaster related data and information as never before.

Now, today it is actually possible to use classified imagery in the defense or—excuse me—in the response to disaster management.

There are processes in place and on the shelf to take classified imagery and make it what is called derived product.

One of the frustrations I'd like to point out to this subcommittee is there's actually, although that policy is in place and is utilized, there is no process in place to get that information quickly into the hands of the State and local disaster managers. Again, they're the real front line troops. The Federal process is in place. The concerns are still in the intelligence world to release that to the Federal and State people.

The advances in commercial remote sensing are well understood, and the one meter resolution satellite built at the Lockheed Martin facility just across the road here are going to dramatically change how we do disaster management.

The technologies of geographic information systems, GPS, and satellite communications, are also now just taken for granted. I think it's quite remarkable that we drive down the street today, and we actually know where we are. I mean it's just a few years away that that, you know, wasn't true, but it's taken for granted now.

These are real utilities. So if we can actually incorporate all of this information in the disaster management process.

The Western Disaster Center is working on the development of a U.S. National Disaster Information Network. There's also a program to have international links up of this process, and that's called the Global Disaster Information Network.

In fact, this week the third Global Disaster Information Network conference is taking place in Turkey. We, the Western Disaster Center, is an active participant in this process.

In a recent independent study of the National Disaster Information Network concept, the National Research Council endorsed the idea. This is a program that has been reviewed and studied for the past 5 or 6 years with many, many reports. So there is no policy lacking.

I'd like to point out that in the same time period this program has been thought about at the Federal level, a company called Netscape started in MountainView right up the street here. Since that time, Netscape grew, declined, grew, and was recently sold for a couple of billion dollars.

We are still waiting for the National Disaster Information Network to take fruition.

The U.S. National Disaster Information Network is being built on a framework that involves public and private stakeholders. In forming this long term organizational structure, this process has begun, but as I mentioned, it is slow. There is an integrated program office. There is an executive committee that oversees operations, and today this activity is working under the U.S. National Security Council.

There is a Pacific Disaster Center. It was first proposed in Hawaii in 1993. It reached initial operating capability in 1996, and has actually received between $20 and $30 million of funding through the DOD.

The Western Disaster Center concept actually started to evolve in 1997. We established ourselves as an independent nonprofit in March 1999. Just last week, in fact, I was contacted by some people who live in Colorado Springs, and they were interested in the Midwest Regional Disaster Center.

We are a not-for-profit. We are working on two efforts. As I said, the Western Disaster Information Network; we're also working on an applied R&D component of this effort we call the Institute for Crises Management. This evolved from a recommendation of a recently published President's Information Technology Advisory Committee report to establish Enabling Technology Centers.

We have actually proposed a very unique process or procedure to fund this concept. This is where we think we're different. We propose using the American Red Cross as our business model. Under the Stafford Act, which is the governing Federal legislation controlling how the Federal Government reacts to and responds to disasters, the American Red Cross has the responsibility to provide disaster relief. That responsibility is defined in a document called the Federal response plan.

So when you see a disaster and you see the American Red Cross set up and doing their work, it's not just the goodness of their heart. They're there because the law says they have to be there. They are the lead agency required to do that mission.

What's unique about that is they are not a government agency. They're a not-for-profit, public-private enterprise.

We propose reinventing the National Disaster Information Network concept along these same guidelines. We are advocating the change of the Stafford Act to incorporate the National Disaster Information Network concept and to define that it be developed as a public-private, nonprofit enterprise.

We believe there's no better place to do that than here in Silicon Valley. We have been working with some of our industry partners on the development of that concept. We do have some frustrations obviously for the slow development of this process and are looking forward to working with your subcommittee and other subcommittees and other organizations within the Federal Government on the development of the National Disaster Information Network.

Thank you.

[The prepared statement of Mr. Davies follows:]

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SUBJECT: Emerging Technologies: Where is the Federal Government on the High-Tech Curve? The Western Disaster Center Perspective:

- Federal policy concerning the use and application of available high-tech capabilities is as important an issue as the technology itself.

- The ability of the nation to mitigate, plan for, respond to and recover from natural, environmental and man-made disasters is today recognized as a significant national security issue. Disasters in the international arena can dramatically impact US foreign policy and national security interests.
  - During most of the 1990's, direct Federal disaster costs averaged as much as $1 Billion per week.
  - In the latter part of the 1990's, Federal costs related to severe weather disasters increased over 300% and development continues to expand across the US in areas vulnerable to all natural disasters -- floods, tornadoes, hurricanes, and earthquakes.
  - The threat posed by man-made disasters (terrorism) is significant and yet to be fully recognized. The increasing technical complexity of the nations infrastructure puts the country at significant risk.
  - The threat of new and reemerging infectious diseases pose a rising global health threat and will complicate US and global security over the next 20 years.

- As the risk and associated costs from disasters continues to grow, it is imperative that recent technological advances be harnessed to aid the State and local disaster manager in reducing loss of life and property.

- Revolutionary advances in the technologies of communications, remote sensing and computing now enables the sharing and distribution of disaster related data and information as never before.

- In order to address this national security issue, a US National Disaster Information Network, with provisions for international link-ups, is under development. The Western Disaster Center is an active participant in this process.

- In a recent independent study of the US National Disaster Information Network concept, the National Research Council's Board on Natural Disasters concluded -- "if the system is used correctly, there can be no justification for continuing in the current mode of non standard, disparate resources when available modem technological developments would make their linkage into a system in a relatively straight-forward matter with obvious potential payoffs in saving lives and reducing losses."

- The US National Disaster Information Network will be built on a framework that involves public and private stakeholders in forming a long-term organizational structure. The process has already begun to solve Federal-level challenges through an Integrated Program Office under the auspices of an interagency Executive Committee directed by the National Security Council.

- As a not-for-profit research center, the Western Disaster Center is working to establish the Western Disaster Information Network as part of the operational US National Disaster Information Network. The Western Disaster Center is also working to establish the Institute for Crises Management as an applied R&D component of the proposed US Virtual Enabling Technology Center In Crises Management, part of the evolving Information Technology for the Twenty First Century initiative.

- In this endeavor, the Western Disaster Center has also proposed a unique public/private-funding concept to support the development of the US National Disaster Information Network. Using the American Red Cross as the business model, the Western Disaster Center has proposed that the Stafford Act (the governing Federal legislation addressing Federal and State disaster issues) and the Federal Response Plan, be amended to define the US National Disaster Information Network as a not-for-profit public/private enterprise.

- Rather than relying on the Federal government to develop the US National Disaster Information Network, the Western Disaster Center further proposes that the nations private high-tech business sector, led by California and Silicon Valley entrepreneurs and venture capital investors, take the lead to establish this public/private partnership.

Richard H. Davies
President & Chairman
Western Disaster Center, Inc.

Mr. HORN. Thank you very much.

Our second to the last speaker is Dr. Susanne Huttner, the executive director of the Industry-University Cooperative Research Program of the University of California.

STATEMENT OF SUSANNE L. HUTTNER, Ph.D., DIRECTOR, INDUSTRY-UNIVERSITY COOPERATIVE RESEARCH PROGRAM, UNIVERSITY OF CALIFORNIA

Mr. HUTTNER. Thank you, Mr. Chairman and members of the subcommittee, for inviting me to participate today. It's a real honor to be here, and we're pleased——

Mr. HORN. You are going to have to get that microphone close to you.

Mr. HUTTNER. Closer.

Mr. HORN. Close. If you cannot hear in the back, put your hands up so that we can make sure you can hear.

OK. Go ahead.

Mr. HUTTNER. In addition to being the executive director of the Industry-University Cooperative Research Program, which is a $60 million a year, 3-year partnership between the State of California, U.C., and California industries in six different sectors of the California economy, I am also the director of two system-wide biotechnology programs and am going to largely focus my comments today on the life sciences.

I had expected, given the high tech theme, to be the only person who was talking about the life sciences, but I shouldn't have been so surprised to hear people whom I would have expected to talk about physics to be talking about life sciences because there's a dramatic convergence happening today between the life sciences and other fields of science and engineering, and the extent to which we can capture and direct that convergence, we're going to get dramatic new developments both in terms of public benefits and in terms of economic growth in the United States and our competitiveness in worldwide markets.

The United States continues to grow in the development of new sciences and that often leads to new convergences, but those convergences depend upon careful attention because there are cultural differences between different fields of science. They don't naturally readily work together. Funding comes from different agencies, and that tends to keep scientists apart.

So we need to come up with new ways to create opportunities for them to work together more often, but let me return to biotechnology. The United States is a world leader on commercial biotechnology, and California is the principal driver.

California is host to one out of every three U.S. biotechnology firms, and in fact, you'll find that one-third of all U.S. companies are clustered very closely around University of California campuses, Stanford, Scripps Research Institute, the Salk Institute, and CalTech.

There's a very intimate relationship between the emergence of commercial biotechnology and public investment in basic research and graduate education. In fact, you see co-localization geographically between excellence in basic research and graduate education and the emergence of commercial biotechnology companies.

In California, we've gained 50,000 new jobs with average salaries of about $65,000 a year, and these jobs largely didn't exist as recently as 15 years ago. This has been an important contributor to our recovery from the very serious economic recession that hit California over the last decade.

Now, the effect is truly dramatic when you look at the way these linkages play out between publicly funded research activities and commercial activity in a new knowledge based sector of an industry. There's a study that was undertaken by an economist at the University of California, and what she found is that one out of every four California biotechnology firms was founded by a University of California scientist, either one of our faculty members or one of our alumni, and more than 85 percent of California's biotech firms hire people with advanced degrees from the University of California.

As she expands this study to include Stanford and CalTech. and the other major research institutions, I think it's likely we're going to find that every company in the State has a direct and essential linkage to publicly funded research in the State of California.

Now, all of this can be traced back to a strong history that's more than 40 years long of Federal investment in the life sciences. That's an important part of the policy that has created the foundation on which a remarkably broad array of companies have been founded. This is not a series of companies that have a lot in common. In fact, this is a highly diversified industry where there are many opportunities to run with the best and brightest ideas that happen to come forward.

So just to summarize the background, it's worth noting that success in biotechnology here in the State of California and other parts of the United States has been based on four critical factors that are also common to high technology sectors.

One is world class basic research in graduate education institutions that are supported strongly by Federal investment.

The second is strong sources of venture capital and other investment funds that are willing to invest in new ideas.

The third is a community of experienced entrepreneurs, and the fourth is an infrastructure that addresses the needs of the young, promising, but usually cash strapped companies, and that's what you see in regions of the State of California where there's been dramatic growth of bioscience or high tech companies.

Silicon Valley, of course, is the premier example, but you need only look down to San Diego, where the economy had essentially gone belly up, and it has completely recovered, but with companies that had never existed before because they were able to create the appropriate kind of business infrastructure.

The future prospects for biosciences is really remarkable. Analysts say that just as the last century was marked by advances in physics and chemistry, the 21st century will be the life sciences century, and that will be based not just on advances in health care, but also in the kinds of applications that you heard from our earlier speakers that apply information about biological systems to a remarkable array of applications.

I'll just give you very brief descriptions of four areas that I've discussed slightly more in my testimony. Of course, there's medicine and health care. The human genome project is laying an important substrate, but we're just at the threshold. We're going to be able to identify the individual nucleotide sequences in the genome, but that won't tell us what the genes do, and it won't tell us how they interact in complex systems like tissues.

It also doesn't tell you how they behave in health and disease. There's a great deal of complex research that has to go on next to take advantage of the information that's been developed in the human genome project.

A second area is food and agriculture. It's natural to apply advances in genetics to plant breeding, and, in fact, American farmers have already increased farm income dramatically using genetically engineered crops that have reduce input costs in farming.

There will be in the next 5 years a wide array of crops that are specifically tailored to improve nutrition, flavor, and other kinds of characteristics that are valued by consumers. All of this is being fueled in part by the National Science Foundation plant genome initiative.

Energy and environment is another area of tremendous potential in the life sciences. There are biological strategies for environmental clean-up, natural resource conservation, and for using biological sources as renewable sources of energy.

And finally, another area is law enforcement and forensic science. Everyone saw what was used in the O.J. Simpson trial. In fact, DNA fingerprinting is being used throughout the United States, and the advances in biochemistry that are being used in law enforcement today are giving us a wide array of tools for more specifically analyzing the make-up of biological evidence.

Now, the impact of Federal policy on the ways in which life sciences could advance in any of these areas and others is important, and I'd like to just very briefly touch on it.

First, the funding policy of the Federal Government has been important, and I strongly encourage you to stay the course. What has worked and will continue to work is broad based Federal support for investigator initiated research, not targeted research; investigator initiated research that allows for a great deal of serendipity to occur in research and supports the kind of incremental enhancements in knowledge that has led us to where we are today.

And in fact, if we had leaders of the biotechnology industry here today, they would tell you that if 20 years ago the Federal Government had started to target funding for agencies like NIH to where there seem to be trends today, we may not have had the biotechnology industry develop.

There is an area in the Federal funding arena that does deserve your attention. The work force requirements today are very different than they've been as recently as a decade ago. We need to train scientists in a completely different way that enables them early in their research training to get experience in the physical sciences and information technologies, but we need to have incentives to develop those kinds of programs.

With that kind of funding, we're going to have the leaders who will be flexible and adaptive and can move forward a variety of industries in the future.

A second area of policy that's very important is intellectual property. I'll only say that the Bayh-Dole Act has had a dramatic enabling effect on the biotechnology industry. It has enabled companies to reach into university research laboratories and take advantage of new knowledge that we're creating, provides them market protection for a period of time, and since the early participants have been in the pharmaceutical area, and they typically have product development schedules of 15 years or longer, that's been extremely important.

Another area that's very important to considering how advances in the life sciences will play out is regulatory policy.

To date we've seen tremendous advances in biomedicine and in the biotechnology industry, and in my view that was fueled in part by the Food and Drug Administration's early announcement way back in 1980 that they were going to treat the products of biotechnology the same as other similar products and create no new regulatory barriers.

That sent a strong signal to investors, and as you saw, there was enormous investment in the 1980's in biotechnology startup companies. We benefited from that in California. It provided us opportunities to take knowledge out of the University of California, Stanford, Scripps, Salk, and USC and get it out into the economy rapidly, but they had to make sure that they were going to be treated fairly, and they were.

The situation in agricultural and environmental sciences is very different. Both USDA and EPA created new regulations specifically targeting the use of our newest and best genetic methods. They've increased the cost of early stage R&D, and that has discouraged investment.

You haven't seen robust growth of entrepreneurial companies in agricultural and environmental sciences, and yet the opportunities are arguably as great as they are in biomedicine. We need to revisit these policies and consider their reasonableness.

About a week ago Congressman Nick Smith of Michigan, who is chairman of the Basic Research Subcommittee of the House Science Committee, released what I consider to be a landmark report on biotechnology policy. That subcommittee considered very carefully the issues of risk that have been circulating in the public arena over the last few years, brought scientists in to address them, and came to the conclusion that the risks associated with these new genetically engineered crops and microorganisms are the same as the risks associated with crops or microorganisms that are modified using older and more familiar genetic techniques.

It strongly encourages revisiting the regulatory structure and providing some incentives to get these sectors moving.

Now, the opportunities and challenges that face the Federal Government are tremendous. I'd like to end my comments by just noting that there has been a tremendous culture change in the private sector, and you see it just about anywhere you go in Silicon Valley and in other pockets of the State where there have been dramatic developments of entrepreneurial, high tech, or bioscience companies.

This culture is fueled by small businesses made up of people who are real risk takers, who know how to capture new knowledge and take advantage of it. This culture of risk taking is what we need to understand better, and we need to reinforce it.

If government wanted to take advantage of new technologies, you have to recognize that bureaucracies have a tendency to tamp down any change. We have to hire the kinds of scientists who will support that same kind of culture of creativity and risk taking if we're going to take these new technologies and move them into government.

And if we do that, I can foresee where you would be able to leverage dramatically your investments in various Federal agencies by getting them to work together better. The National Institutes of Health present a remarkable model on how to both support the development of new knowledge and technologies and utilize it effectively through communication and interrelationships with agencies.

But not all agencies have been able to participate in that the same way. The Environmental Protection Agency has a culture that views new technologies, in my view, as risky by definition. If it's new, it's something we're not familiar with, and it undoubtedly includes some kind of risk in their view.

I think that's a problem. If we want to solve environmental problems, we've got to capture this new technology.

Thank you very much.

[The prepared statement of Dr. Huttner follows:]

"Life Sciences Research, Innovation, and Economic Competitiveness: The Role for Federal Government"

Testimony of

Susanne L. Huttner, Ph.D.
Director, Systemwide Biotechnology Programs
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My name is Susanne Huttner. I appreciate the opportunity to participate in this hearing. I am Director of the Systemwide Biotechnology Research and Education Program and the BioSTAR Project of the University of California (UC) that promote basic research, graduate education, and public policy analysis. I am also Director of the UC Industry-University Cooperative Research Program, a $60 million a year three-way partnership between UC, the State of California, and California industry that promotes research partnerships in biotechnology, communications, digital media, life sciences informatics, microelectronics, and semiconductor manufacturing. Each of these three programs serves all nine campuses, three National Laboratories, and Agriculture Experiment Station that make up the UC System.

It is from my experience with these programs that I offer the following comments. As the only speaker coming from a biotechnology background, I principally focus on the life sciences, but can address issues relevant to those high tech fields with which I have experience.

The U.S. Biotechnology Economy: California as Driver

California life sciences enterprises, particularly the state's biotechnology industry, present an interesting case study of the profound economic effects that Federal science policy can stimulate. The U.S. is world leader in commercial biotechnology and California is home to one-third of our nation's biotechnology firms. The state's biotechnology industry has created more than 50,000 new jobs that largely did not exist as recently as fifteen years, ago. The average salary is $65,000 a year. New companies are being launched every year and the industry, collectively, is attracting record amounts of capital investments to the state.

Economists have reported that the state's success can be traced in significant part to the linkages between these firms and California's federally funded basic research and education institutions. Specifically, studies have shown that biotechnology firms, across the nation, tend to co-localize geographically with the strongest basic research institutions.

The effect in California is dramatic: one out of every four California biotechnology companies has been founded by a University of California scientist, including the world's three largest firms. As the analysis expands to other institutions, namely, Stanford University, the California Institute of Technology, the Scripps Research Institute, the Salk Institute, and the University of Southern California, it is likely we will find that the majority of California firms have been founded by scientists from the state's basic research institutions that rely heavily on federal research grants.

More than forty years of federal investment in broad, investigator-initiated basic research laid the essential substrate for California's success. California basic scientists developed the seminal methods of gene splicing and genetic engineering. The world's first commercial biotechnology companies were launched in the state. Today, California researchers in its universities and biotechnology industry continue to define the frontiers of science and to exploit most rapidly the opportunities for commercial applications.

C By way of background, it is worth noting that this success in biotechnology, just as in high tech industry sectors of the state, is founded on four critical factors:

1. world-class basic research and graduate education institutions supported by federal funds;
2. sources of venture and other investment capital;
3. a cadre of experienced entrepreneurs;
4. infrastructure that addresses the needs of young, cash-strapped entrepreneurial businesses.

Future Prospects in Bioscience Industries and Government Opportunities

Looking forward, the future is even more promising. Analysts predict that just as the economy of the past century has been marked by advances in physics and chemistry, the 21st century will be fueled by the life sciences. The past two decades, alone, have dramatically demonstrated the increasing relevance of the life sciences to the private sector. I will briefly describe just four areas of immediate or near-term impact.

Y **Medicine and Healthcare:** Millions of Americans have already benefited from advances in medicine derived from molecular biology and genetics. The Human Genome Project's impact is just beginning and holds opportunities that we cannot, yet, begin to imagine. It is producing drugs that are precisely designed to target specific tissues and molecules. It is also producing highly sensitive and broad arrays of diagnostics that enable early detection and intervention in disease to reduce healthcare costs and time lost due to illness. As research proceeds beyond the Human Genome Project into the more complex analyses of the function of proteins encoded in genes, and as the application of information technology to bioinformatics accelerates, there will be medical breakthroughs that we cannot, today, imagine. Medicine will move towards individualized healthcare.

Food and Agriculture: Agriculture and food production industries are already experiencing crop yield are enhancements and increases in farm income from genetically engineered crops. There will be rapid trends in American agriculture towards crop yield improvements with concomitant reductions in acreage and input requirements. New consumer-oriented food and health products will be introduced by firms using genetic engineering of plants to produce value-added improvements in the nutrition, safety, and health benefits of foods. Developing countries are gaining crops that withstand insects and disease without costly pesticides and other treatments. The foundation for all of this is being laid by the National Science Foundation's Plant Genome Project. Agriculture and food will benefit from the same advances in genetics and bioinformatics that will drive medicine and healthcare.

Environment and Energy: Biological strategies are proving effective in both environmental clean-up and natural resource conservation. Microorganisms and plants are being developed to serve as bioremediation agents that can eliminate toxic substances from soil and water. An array of diagnostics provide sensitive and accurate detection and characterization of contaminants in complex samples. Plant metabolism is being genetically engineered to produce starch-based polymers that can be used to produce plastics-like materials. Biomass conversion is used to produce ethanol fuel. Overall, the goal is to explore how the metabolism of living organisms can be used to eliminate toxic substances from the waste stream and contaminated sites, and to serve as a renewable sources of energy and materials that currently depend upon fossil resources.

Law Enforcement and Forensic Science: DNA "fingerprinting" is applied in evidentiary operations by federal and local law enforcement agencies across the nation. The research tools and reagents of biochemistry and molecular biology are becoming mainstays in forensic laboratories. Advances in the life sciences will continue to improve the precision and reliability of evidence collection and analysis.

The Impact of Federal Policies

In each of these areas and others, the government's role in the underlying commercial and economic process is multifaceted.

Federal Funding Policy – Stay the Course: First and foremost is federal funding policy for life science research which has been the wellspring for biotechnology. Strong funding for the intramural and extramural research programs of the National Institutes of Health (NIH) and, at a lower dollar level, of the National Science Foundation (NSF) has been essential. Central to success is the continuing focus on a broad-base of investigator-initiated research and decision making by peer review.

There is considerable concern in both the private and public research communities about what appears to be an increasing tendency to earmark federal funding for targeted research goals, thereby redirecting funds that otherwise would support broad-based fundamental research. As leaders in the biotechnology industry often note, if forty years ago the federal government had embarked on a policy of targeting research goals today's biotechnology industry would likely not exist. Only a wide spectrum of basic research supports the needed incremental establishment of knowledge about complex biological systems needed in medicine, agriculture, and other applications.

A concomitant benefit of federal funding policy in the life sciences has been the steady production of well-trained scientists emerging from graduate and postdoctoral education programs tightly linked to basic research programs. These scientists are participating in all aspects of commercial biotechnology as the entrepreneurs, R&D performers, manufacturing staff, business development leaders, and other key, scientifically expert employees of competitive firms.

There is a critical immediate need for increased federal support for broadly multidisciplinary training programs that produce scientists skilled not only in the fundamental fields of biology, genetics, biochemistry, and physiology, but also in computer science, mathematics, statistics, and other fields involved in information sciences. The products of these kinds of training programs will lead the next wave of advances in the life sciences. The rapidly evolving bioscience industries depend upon scientists educated in a manner that fosters flexible and adaptive problem solving and the ability to work creatively in widely interdisciplinary teams.

The importance of merging the life sciences and information technologies cannot be overstated. The extent to which we are able to do so will determine the pace and scope of future advances in biomedicine and applications in healthcare.

Federal Policy on Intellectual Property: The Bayh-Dole Act has played a singularly important role in the history of commercial biotechnology. The law provides a mechanism by which companies gain proprietary rights to new knowledge developed in government-funded laboratories (including university faculty laboratories). The market protection conferred by patents is essential to companies targeting products with very long development times, such as the fifteen years typical for bringing a new pharmaceutical to the market. Research advances are now more broadly and more rapidly transferred from the basic research laboratory to the commercial R&D pipeline. The prospects for tangible public benefit from federally-funded research have been significantly enhanced.

Federal Regulatory Policy

Biomedical applications in commercial biotechnology have flourished, in large part because the Food and Drug Administration announced as early as 1980 that the new biotech drugs and diagnostics would be treated the same as other, similar products. Investors were strongly encouraged and the U.S. biotechnology industry rapidly grew.

Federal regulatory policy has taken a very different course for agricultural and environmental applications, and economic impacts have been affected. The U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) have developed new regulations for biotechnology research and products. The new regulations, focused specifically on the use of the newest and most precise genetic methods, has increased the cost of early stage R&D and discouraged commercialization.

These policies deserve reconsideration. A week, ago, Congressman Nick Smith, Chairman of the Basic Research Subcommittee of the House Science Committee, released an excellent analysis of the policies. The report presents a thoughtful and accurate assessment of the scientific evidence on risks associated with the new genetic methods used in agricultural and environmental applications of biotechnology. It supports the scientific consensus that the new genetic methods and their products are not inherently unsafe and can be managed using the same regulatory and private sector safety systems used for other, similar products.

The report is aligned with the findings of the National Academy of Sciences, the National Research Council, the World Health Organization, and the United Nations. It calls for a reassessment of the continued need for USDA's and EPA's stringent biotechnology regulations.

Bringing federal regulatory policy at USDA and EPA in line with the scientific consensus on safety and risk will send a strong message to the private sector and fuel investment. This will set the stage for advances in food production, toxics cleanup, and natural resource conservation,

Opportunities and Challenges for the Federal Government

As I have already alluded to, there are many ways that technological advances in the life sciences can (and in many cases, already do) benefit the federal government. Opportunities for direct applications can be found in health-related, law enforcement, environmental, and food and agriculture-related agencies.

In order to take best advantage of these opportunities, however, government needs effective surveillance and analyses to identify emerging innovations and to assess their potential usefulness. It also needs effective technology transfer and integration mechanisms to put the innovations to practical use. Most if not all high tech and biotech firms have new ventures and business development units that perform these kinds of functions. They have created a distinctive culture that promotes innovation and creativity, and rewards risk-taking. This is not a culture commonly found in government, although there are exceptions. As a result, there is often a gap between government and useful new technologies.

The gap can, however, be bridged through strategic initiatives that build a strong scientific workforce in government and reward creativity and innovation. There is no substitute for staff who are well educated and current in their training. An excellent example of a government agency staying at the cutting edge and rapidly utilizing relevant technological advances can be found in the NIH. NIH supports a world-class research staff and promotes the development and transfer of new knowledge and the utilization of new technologies and products produced in the private sector. The agency plays an unparalleled leadership role in advancing the boundaries of biomedical research and innovation.

There is an emerging gap in agriculture. USDA supports an array of Agriculture Experiment Stations and Cooperative Extension Programs that, historically, have played a leadership role in promoting the development and adoption of innovative new technologies in commercial agriculture as well as in the agency's own programs. In the past decade, their importance has waned and a considerable gap between the private sector and government has grown. Particularly in plant breeding and germplasm development, technological advances in industry outpace efforts in government-supported programs. Access to technologies and genetic resources are increasingly limited by cost and intellectual property barriers.

The challenges at the EPA are, perhaps, the most serious. The agency's own regulatory policies create barriers to development or adoption of new environmental technologies by agency scientists, even when those technologies could advance EPA priority goals for environmental clean up and waste reduction. One gets the impression that the agency operates around the principal that, when it comes to technology, "new" is synonymous with "risky." Commercial innovation is largely limited to those technologies used in identification and characterization of contaminants. EPA's regulatory policies present potent disincentives to technologies that would be used in the field to clean-up waste or reduce waste streams.

Summary

This is a remarkable time in the life sciences. The acceleration of scientific and technological advances of the past two decades are the result of concerted activity at the interface between industry, universities, and government. Public benefits are accruing across a broad swath of medical and public health applications. They reflect the productive convergence of commercial entrepreneurism, publicly-funded basic research and education programs, and federal government policies on science funding, regulation of bioscience technologies, and intellectual property. Benefits are also emerging from enhancements in farming and foods, although the synergies among the sectors are substantially less robust. Most strikingly, however, the prospects for substantial benefits accruing from environmental and energy technologies are affected by government policies in a very negative way, which discourages commercial investment in R&D.

Thank you for inviting me to participate in this hearing. I would be pleased to provide additional information, as needed.

Mr. HORN. Well, we thank you. That's a very good presentation. And our last presentation is by Dr. Lea Rudee, the director of fellows program at the California Council on Science and Technology, which is based at the University of California, Riverside.

STATEMENT OF LEA RUDEE, Ph.D., DIRECTOR OF THE FELLOWS PROGRAM, CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

Dr. RUDEE. Thank you, Chairman Horn, members of the committee.

I'm Lea Rudee, as you heard, director of the Fellows Program of the California Council on Science and Technology. That's a part-time job. I'm also a professor of material science at the University of California, San Diego, where I do research in nano technology as an individual faculty member. I was the founding Dean of the Jacobs School of Engineering as UCSD.

The California Council of Science and Technology is an independent, nonprofit organization that is modeled in part after the National Research Council. The CCST was established by State legislation in 1988 to actively represent the State's science and technology interests.

It is currently comprised of 120 science and technology leaders from industry and academia. Since its creation, the California Council for Science and Technology members have worked with State and Federal agencies, government officials, and others to help implement policies that aim to maintain California's technological leadership in a vigorous economy.

One of the things the council did starting a couple of years ago was create a major study of the science and technology infrastructure of the State of California. It was the first comprehensive study of its kind done. It ended up having 12 investigators and teams from a variety of public and private institutions, which led to a major report. I have both the executive summary and the short form of the report with me today for people who would like it. A lot of the data is reproduced in my statement here, which I will not read to you.

However, in this report, which is now called the Crest Report, California Report on the Environment for Science and Technology, there were two items uncovered which we feel are ones that affect Federal policy, and are affected by Federal policy, and that should be brought to the attention of the subcommittee.

One of them is, as just about everybody notes, that California is a real leader in the science and technology research and development world. What the study showed was that, California does about 20 percent of the Nation's R&D, and that's been constant over the last 30 years. Of course, it has all grown, as everything has grown.

But when you look in detail at this, there has been a major shift in the last 15 to 20 years. That is not in the total amount of industrial based R&D. Currently virtually all of the industrial R&D is supported by the industry itself, where in prior years, a decade or so ago, before the fall of the aerospace industry, much of industrial R&D was supported by Federal dollars, mostly from Defense and NASA.

One of the changes that's occurred is that the industrially supported R&D has a much shorter time horizon. Companies want to support work that will affect their bottom line, certainly in the term of office of their CEO, and more often in the present quarter.

So the character of the research has changed. It's led to a higher number of patents. But leaders in this area in academia and industry are worried that the shorter term view will mean that we're, in some sense, eating our seed corn. We're not going to come up with long term ideas out of industry that had occurred before.

And so we strongly urge that the Federal Government, in various ways, support more long term R&D at industries.

Another problem area, where the Federal Government certainly can play a role, is that of producing a skilled labor force.

One of the key things we've uncovered was that the total undergraduate science and engineering degrees in California, and this is across all segments of higher education, private, public, Cal. State, and the University, has dropped 18 percent in the last decade. The biggest drop has occurred in the Cal. State system where the number of engineering degrees has dropped by 25 percent. That's very important because 40 percent of the State's engineers have come from the Cal. State system over the long haul. This is a significant problem, we believe, for the future of California's science and technology industry.

In order to remedy this, we need to work better at the K through 12 level. We have to insure that students have a proper grounding in math, science, and technical skills.

One of the ways to attack this, we believe, is to incentivize people to get their teaching credentials with a background in science, and not encourage people who are teaching outside their study area with temporary kinds of certifications. The Federal help, we feel, can come through more scholarships in this area, both for engineering and science students, so that we can even out the need based support. We can encourage more students to get into education, and to take teaching jobs at the—that have the proper background in science and math at the K through 12 level.

We think that—and it was not part of this report—that some of the developments that NASA-Ames is proposing in their research park, etc., will help on both of these issues in getting Federal support to do basic research in industry, and to work toward improving the K through 12 system.

Thank you again for the invitation, and I will be happy to answer any questions.

[The prepared statement of Dr. Rudee follows:]

Remarks by Dr. Lea Rudee to the Subcommittee on Government Management, Information, and Technology – April 24, 2000

Thank you Chairman Horn for the invitation to speak to the Subcommittee on Government Management, Information, and Technology today. I am Lea Rudee, Director of the Fellows Program for the California Council on Science and Technology.

At this meeting, I would like to raise two points. The first deals with the increasing need for the federal government to support basic, pre-competitive research. The second deals with the dwindling supply of a skilled workforce and the increasing need to invest in education.

CCST is an independent, nonprofit organization that is modeled in part after the National Research Council. CCST was established by state legislation in 1988 to actively represent the state's science and technology interests. It is currently comprised of 120 S&T leaders from industry and academia. Since its creation, CCST members have worked with state and federal agencies and government officials to help implement policies that aim to maintain California's technological leadership and a vigorous economy.

California is the world's leader in advancing S&T research and in creating new technology enterprises. Despite the defense cutbacks of the 1990s, today the state enjoys the benefits of a diverse economy of high-tech industries. However, even as the state experiences a strong economic recovery, CCST members are concerned whether California can maintain its S&T leadership in the face of increasing competition, and whether all Californians are benefiting from the state's resurgence.

In evaluating California's future, CCST identified three questions that need to be answered: (1) Are the people, capital and governmental policies in place to respond to an evolving high-tech economy? (2) How will the state respond to increasing competition for federal funding in science and engineering research at California's research institutions? (3) What can policy leaders do to ensure that California's educational system, especially its K-12 schools, better prepare students for future high-tech jobs?

It is in the context of addressing these issues that I speak to you today. The answers to the above questions shape the policy needed to guide California, and the Nation towards a sustainable high-tech economy of the future.

To answer these questions, CCST commissioned the California Report on the Environment for Science and Technology. CREST is the first comprehensive report on the status of the state's S&T infrastructure. California's S&T infrastructure consists of its research-intensive industries, the R&D activities that sustain these industries, and the educational system that supplies these industries with prospective employees and advances in fundamental knowledge.

For this report, CCST spent two years studying the state's government, industry, federal labs, foundations, K-12 schools, academic institutions, and venture capital firms, and analyzed the ability of these institutions to create and use new technology.

The CREST report clearly demonstrates the importance of the high-tech industry to California's economy. High-technology industries are responsible for a "California Technology Miracle." In California, 9.3 percent of all jobs are in high-technology industries, far above the national average of 5.6 percent. Average annual wages in high-technology industries are over $60,000, roughly double average pay in all private, non-farm industries. R&D sustains these industries, and here again California leads the nation, with 20 percent of the nation's R&D compared to 12 percent of the U.S. population and 13 percent of the U.S. Gross Domestic Product.

The significance of the CREST report is that the factors that make this technology miracle happen are clearly quantified and analyzed. To fulfil the promise of a great future, important changes must occur. Specific actions by the state government, industry and academia are now evolving from the CREST recommendations. Two areas from the CREST report that I will highlight at these hearings are the continued need for Federal support for basic research and the need to continue developing the science and engineering workforce.

The first area to elaborate on is Federal research support. This support has greatly stimulated California's high-tech environment making the US Government a major factor in fostering the "California Miracle." The Federal government has been instrumental in the development of a robust science and technology environment in the nation and in particular California universities, national laboratories, and technology industries. It is important that congress continue its strong support of funding for basic science research in the National Science Foundation, the Department of Defense, NASA, the Department of Energy, and other Federal science agencies.

The importance of funding basic research can be explained by the following. R&D expenditures in California increased between 1975 and 1995 from $14 billion to $30 billion in constant 1987 dollars which accounted for nearly 20% of total U.S. R&D over those years (in comparison Michigan was 7.25% in 1995 and New York was 6%). However, federal funding of industry R&D decreased (in constant 1987 dollars) from $8.35 billion in 1981 to $4.4 billion in 1997 and decreased as a share of US total from 40% in 1981 to 25% in 1997. During this time industry funding of industry R&D increased in constant 1987 dollars from $5.3 billion in 1981 to $20.6 billion in 1997 and increased as a share of US total from 12% in 1981 to 21% in 1997. Federal Government funding of Universities and Colleges R&D in California increased in constant 1987 dollars from $ 0.82 billion in 1981 to $1.5 billion in 1997 but decreased as a share of US total from 14.5% in 1981 to 14.04% in 1997

The above data shows that thanks to a surge in privately funded R&D, California R&D has held the 20% R&D share despite a near-collapse in defense-related activity. As of 1997, private industry funded 82% of industrial R&D and 68% of all R&D in California, up from 46% and 35%, respectively, in 1989. Industry financed industrial R&D grew 8.7% per year over the1981-1995 period, offsetting cuts in federally financed activity.

This shift in R&D support from the Federal Government to private represents a shift in R&D focus. Industry tends to have a shorter time horizon and their emphasis is on the "D" in R&D. The dramatic increase in patents during this period of R&D funding transition is an indication of R&D privatization. To be most effective, the Federal government's role must focus on the "R" in

R&D and that translates to Federal support for basic, pre-competitive research at our laboratories, universities and colleges.

A second key issue in California is the science and engineering workforce and the need to continue meeting industries' growing requirements for those skilled workers. Federal policies are integral components to California's private and public educational institution's planning for meeting the state's workforce needs. As state, local and industry efforts work to improve and advance science and math education at all levels in California, it is critical that Federal support continues to higher education through student financial aid programs; and K-12 math and science education programs and teacher development programs.

California's ability to produce skilled labor will be a critical factor for the future performance of California private sector, high-tech companies. Undergraduate science and engineering degrees awarded in California declined 18% from 11,800 in 1990 to 9,700 in 1996. Within the California State University, which has historically provided 40 percent of the state's engineers, engineering enrollments declined by 25 percent in the 1990s, paralleling an 8 percent decline in the physical sciences.

The quality of California's science and engineering doctoral programs is high and California's academic research is of excellent quality. However, California is falling behind competing high-tech states in terms of the quantity of inputs into the academic scientific process, e.g., faculty and Ph.D. candidates.

Substantive changes must be made at the K-12 level to better prepare students for high-tech careers when they graduate so that they have the right combination of skills to satisfy employers expectations. We must ensure that K-12 students have a solid grounding in math, science and technical skills. Incentives must be developed that encourage K-12 students to pursue elementary and high school teaching careers. At the same time teacher education programs must be expanded. Reasonable minimum training requirements for public school teachers must be imposed. Incentives that encourage teachers to pursue subject certification; and minimize out of subject teaching assignments must be developed.

There is a link between Federal support for research and the financial aid for the development of the science and engineering workforce. Federal research funding is crucial because it supports basic research but also because it supports the education and training of postdoctoral, graduate, and undergraduate students. Financial aid is also important, but both work together. One without the other leaves a huge vacuum. Financial aid is crucial to make sure that all socioeconomic groups in our society can aspire to a higher education.

In summary, the plans of NASA Ames to develop new programs with the aim of advancing basic research and emphasizing outreach in education are closely aligned to the recommendations of CCST.

Thank you again Congressman Horn for the invitation to address this subcommittee and I would be glad to answer questions at this time.

Mr. HORN. Well, thank you very much.

We will now start with questions, and I am yielding 10 minutes to Mr. Ose, and then I will take 10 minutes, and then he will take 10 minutes. So please proceed. The gentleman from northern California.

Mr. OSE. Thank you, Mr. Chairman.

As is usual in our committee meetings, we take our questions or pose our questions in typically the order that you've all appeared. So I'm going to work through that accordingly, and that is not to just say—the first are first because they are first and not on any other reason.

On the nano technology stuff, which I believe Mr. Venneri spoke about first, it is so cutting edge, I wonder how it is that we insure an adequate discussion, if you will, amongst the scientists of that technology.

And I am reminded of our difficulty in Congress in trying to write rules, regulations, or laws, if you will, that require an institution of higher education who might do research to share that technology in an adequate fashion.

How do we achieve that goal?

Mr. VENNERI. Well, let's see. There are a couple of phases of that. This administration has organized among all the Federal Government a national nano technology program that required all of the Federal agencies to get together and, in effect, produce one document that said, "Where are the investments today and where should they be going?"

We're in the process of looking at worldwide investment. We're trying to develop government policy today to get at the issues that you're bringing up, namely, not one of just doing basic research, but the policies required to go from basic research to demonstrations of technology insertion, all the way to encourage industry investment into radically new industry processes that would have to use this new technology baseline.

So it really spans the gamut. We're at a fundamental exploration stage now of research where scientists and engineers are beginning to understand that basic property, and there clearly needs to be overlaid on that a policy of government investment, industry partnerships, and then bringing the universities in because, quite simply, the work force that would exploit that technology base really isn't available.

Mr. OSE. If I may followup on that, it almost seems like we have a very large challenge there, my concern being that we may inevitably end up trying to do too much or lacking an adequate focus of being a clearing house. That may not be the right word, but a clearing house, if you will, for this information.

Now, does the nano technology institute that you are talking about that we are in the process or have completed setting up have sufficient focus to make sure that that information or that knowledge base is distributed?

Mr. VENNERI. It's really NSF that is the lead agency. Agencies like the Department of Energy, and NASA are on this team of people of senior executives in the government. We're trying to really use the modern Information Act to get the information out there, and then the usual means of workshops and scientific conferences.

And I share your concern because it takes more than just published papers and standard workshops. There needs to be other mechanistic approaches that include innovative investments and perhaps bringing the venture capital community in that would look at ways of putting this technology into an industrial policy, and that's the gap that you're referring to.

Mr. OSE. Mr. Louie, is there a shortage of venture capital in these area?

Mr. LOUIE. Actually, there's billions of dollars of venture capital in these areas, and they're all very competitive, trying to see the best new technologies and companies to invest in.

Mr. OSE. Well, I have to admit I was, as a private sector person, I was somewhat interested in why the Federal Government would commit $60 million to a venture capital instrument, given my understanding that there is a substantial amount of venture capital out there looking for homes.

And I regret missing your testimony. If I could, I am trying to figure out how it is the government, Federal Government in this case, in a venture capitalist role could properly identify what its financial objectives are either in terms of end of the process profit or rate of return or any other conventional standard you'd care to introduce.

Mr. LOUIE. Let me kind of do a review of some of the comments I made at my presentation. That may answer some of your questions.

I think, first of all, that the CIA particular needs in four areas of information technologies are areas that are—currently has large sums of venture capital investing in those particular technologies. One of the challenges the CIA has is since it doesn't, quote, unquote, swim in the valley, as George Tenet would say, it's unaware of many of the developments and technologies that are happening in here.

The venture capital community is very small, very tight. People know each other. It's a very well regarded network from all the different technology centers throughout this country. And there was an opportunity and is an opportunity for the Federal Government by tapping into those existing networks, can find out those destructive technologies early on.

In many cases these early investments that we have made—we are making were brought to our attention by other venture capital funds, what we call the A level funds, who have come across technologies that may be interested to the Federal Government, and what we do is we use a variety of traditional strategies like terrain mapping. We look at a particular company who approaches us and take a look at everybody who is in that competitive space.

We invite companies to come and talk to us, but fundamentally the reason why we're doing it is because in many of these cases we're able to take a million or a few million dollars of Federal Government money, leverage it against $20, $30, $50 million of private sector venture funds, develop technologies which are specifically applicable to what we're doing, and in many cases companies have provided us their technology at cost and told, at least in terms of the research component, that they would rather not take dollars from us, and if we could put $1 million in investments, they could raise the $20 million necessary to do the research from other sources. Yet we get all of the technologies we need for the CIA.

Mr. OSE. I am willing to take more information on this, but we are going to move on. I am not convinced that using $60 million for venture capital achieves perhaps the same bang for our buck as a focused $60 million in basic research.

You need to understand that's probably a philosophical issue more than it is anything else.

Mr. LOUIE. Yes, I don't think there's a substitute for pure research. I think this is $60 million that they might have to spend hundreds of millions of dollars in acquisitions. It's a different goal.

Mr. OSE. But there is no lack of venture capital in the market is what I——

Mr. LOUIE. No. In fact, many of those venture funds at teaming with us on many of our deals.

Mr. OSE. OK. Dr. Shank, if I could, you have touched on a subject that is near and dear to my heart. You talked about in your testimony the O&M savings from building ownership in terms of energy usage, operations, and maintenance. And I'm curious. I see the testimony on the cost savings, but I did not see, for instance, the relative cost per square foot construction.

For instance, if a standard building in today's environment under a conventional energy plan costs $100 a foot and we're going to look at a building that's going to have 30 to 40 percent less expensive energy operations after it's built, what would its relative cost be, 120, 140?

Mr. SHANK. I think that the cost savings that I gave in my testimony, in fact, included the cost of the capital that went to achieve those cost savings.

Mr. OSE. Right, but I do not see a comparison, if you will, on a, pardon the basic terminology, on a per foot basis. I mean, I am a building. All right? I build a building, and it costs me X number of dollars a foot using conventional technology and energy measures. You are going to have to put it in layman's terms for me.

If I were to use the technology that you have highlighted here, that would generate savings on lighting costs and energy and overall utilities. Would I be at something more or something less than what I would call a traditional——

Mr. SHANK. Well, I think one has to look at the service life of the building and the aggregate cost of building the building, plus operating the building, and from the government point of view, you want a building that you've paid for and you operate. The up-front cost is a piece of that.

I think that the cost savings that I gave there include the additional investments that have to be made in order to utilize those technologies, and that is part of the net investment in order to get the return for any of the cost savings, and many of the things that we have done in this area, for example, windows that have insulation properties of walls, those windows and the cost of those windows and the amortization of those costs depend on from product to product.

But if you are going to talk about cost savings, you have to include that initial investment.

Mr. OSE. That is what I am trying—I do not——

Mr. SHANK. Each technology will have a different—I can't give you an answer to dollars per square feet. I could take the aggregate cost of the building that you have there and tell you what the ultimate savings would be, assuming a cost of energy, but I cannot tell you what that increased cost would be for the building.

I'd be delighted to provide that information to you if you'd like in terms of what it would cost to make an investment to get these returns.

Mr. OSE. That is the information I am trying to get to.

Mr. SHANK. And I can provide you with that, but the aggregate cost that is quoted there, the numbers of we hope to see billions of dollars of savings will come about because we use less energy. We made an investment up front in order to use less energy to accomplish the goal of higher energy efficiency, and each of those will have a cost recovery time line, and those are the appropriate numbers.

But I would be delighted to provide that information to you and show you where we are in terms of taking advantage of the investments that we have made in this area and have produced cost savings.

Mr. OSE. As a landlord, I can tell you for a fact building is one thing. Operating it is the second step, and I would welcome to have that information not only available to Congress, but to the—I mean I know contractors look at this all the time as well as building owners, but to make it part of the record, Mr. Chairman.

Mr. SHANK. I would be delighted to do that.

You will also notice that there are tools that we have developed, software tools for designing energy efficient buildings. Those tools are widely available from the Department of Energy, which are standard tools now for energy design, lighting design, and those tools themselves add the ability to produce avoided energy cost with very little investment.

Mr. HORN. Without objection, the letter you send back on the data on this will be put in the record at this point.

And that is very helpful. I agree with Mr. Ose completely, having gone to the legislature many a time to get a building on the Long Beach campus, and we never lost one, but we always heard about, "You guys always spend too much money on this and that," and so forth.

The capital outlay is a drop in the bucket compared to the operation. The operation will chew you up in a couple of years, and the amortization usually on capital outlays is sort of crazy if you aren't looking at the operational costs.

Now, as I remember, doesn't Berkeley have a School of Architecture?

Mr. SHANK. Berkeley does have a School of Architecture. They have collaborated with the lab and, of course, many of the tools that we use are ones that are used by folks who are teaching architecture.

Mr. HORN. That is great because usually it does not work that way. Usually they are off in the clouds somewhere, and I am delighted to hear they are working it into the students' understanding of how you can save 40 percent on electrical cost. That to me is a terrific achievement.

Mr. SHANK. We have an architect actually who heads this program in our lab.

Mr. HORN. Yes, that is great.

Mr. OSE. Mr. Chairman, if I might.

Mr. HORN. Yes.

Mr. OSE. I went to Berkeley, and I think I was the last Republican that graduated from there. [Laughter.]

Mr. HORN. You and the Young Republicans in 1964.

Mr. OSE. That is right. We were tight, let me tell you, but the program that Dr. Shank is referring to was so successful that the information made it into the business school, and I have been trying to utilize it ever since.

Excuse me. I did not mean that. My time is up.

Mr. HORN. Well, you always ask great questions. We will get back to you.

And let's talk a little bit about the nano technology that Mr. Venneri and I had an exchange on. I think you are probably in the best place right now to give me an answer to this question, which is: what are the social benefits of the emerging technology? And what do you see as the potential dangers down the line and how we prevent them from occurring.

Mr. VENNERI. Yeah, that's an astute question. Let me be brief with an answer. That's something we're thinking about. We're not taking that lightly. It's really those three technology areas, and one of the—two of the other witnesses today alluded to that, too. It is really the coupling of nano technology with the information technology and biotechnology, that really each one separately will have an advancement in our base, but combined will put us at another technology decision point that really does effect our products.

In our case, we're looking at it for thinking spacecraft and machines that assist astronauts in harsh environments, but the potential for that technology to be abused is very high, too, and to be used in products that could be one case benefiting society and the other case hurting society or the potential to hurt society is there.

We think that is something we need to look at, and it is something that I alluded to in terms of this technology ethics, and it goes back to, you know, when we invented atomic energy, and actually the scientists in the 1930's had that same question, if you recall, when Dr. Oppenheimer was trying to stop the use of nuclear weapons after World War II.

We're at, I think, another brink or another bifurcation point of needing to go back, and that is not just NASA, but government as well, both the congressional side and the executive side. I think there needs to be some thinking in terms of how we address the potential breakthroughs and pitfalls of technology, and perhaps a dialog.

It was alluded to the benefits of genetically altered plants, but look at the controversy, the lack of information, the lack of clear policy that really rippled through not only this country, but around the world over where that was totally misunderstood, and that was something benign.

This is something that is not necessarily benign. I think maybe the science fiction writers tend to elevate it higher, but it's something I think we need to address.

Mr. HORN. Anybody else want to comment on that question? Any other thoughts on answers on that?

[No response.]

Mr. HORN. Well, let me move to a point that Dr. Huttner noted, the FDA, Food and Drug Administration, which is an agency within the cabinet office, cabinet department of Health and Human Services.

Now, a lot of problems have occurred over the years with the FDA, and often it has been 11 years before they could ever clear a project that is a pharmaceutical, and when we ask pharmaceutical companies, "Why can't you lower your costs? When you go to Mexico, you lower them. When you go to Canada you lower them. How come we are having to pay this, this, and this, and particularly senior citizens?"

So we are now going to add a pharmaceutical cost solution, shall we say, on the Medicare program. We will do that in the next 2 or 3 months because we have to, and that is because the price of pharmaceuticals is immensely high when you're trying to get at the diabetes problem and all the rest of it that senior citizens seem to increasingly have.

So the problem would be to what degree do you think the FDA is in a position to really deal with nano technology, and what do you think would be the problems, if any, and what should Congress do or give them either a different type of authority, or how do we deal with this so that technology is not, shall we say, put under the stamp of the bureaucracy and you do not see it for years when you have an evolving technology?

Mr. VENNERI. Yeah, if it was strictly nano technology, then I wouldn't see the FDA involved, but I think you're using that in the term of this revolution and this convergence of biotechnology and engineering coming together in the forms of miniaturization at that scale.

Right now you don't want to have agencies like ourselves and DOD that are technology based being totally in that decision mode. I don't think the FDA has the expertise or the background either to address it. It's really perhaps beyond any one agency, and that's what I was suggesting in terms of the political process, which really sets government policy driving it.

I don't think any one government agency and the regulatory agencies that exist today are really structured or have the expertise in them to deal with it in the form that we're talking about.

Mr. HORN. Well, if you had your druthers, how would you structure the review agencies to deal with the very difficult questions? Some will be ethical, and just like cloning and what that's done in the Congress. How would you put it together?

Granted it is interdisciplinary with different focuses and people that should be neutral to be able to look and see is there an impact that we should worry about or is that just sort of hyperbole that we shouldn't worry about?

Mr. VENNERI. Well, actually to get our hands around it, we're actually going to set up a structured subcommittee under our advisory process that brings in a cross-section of people in most likely to be led by a non-technocrat, but someone with, you know, religious training in the life sciences. If you want a sense of ethics, and to actually do that ourselves, we will use that process to gather information, then use that as a way for us to structure policy that we think makes sense.

And I'm suggesting perhaps on a national scale, that model ought to be followed.

Mr. HORN. In a sense that's what universities do with their ethics committees, is to have people that have different perspectives and review the type of research that's going on. So would it be such as those research——

Mr. VENNERI. That's correct, and in our case, we would identify what we would think would be potential problems to be concerned about in investments, in protecting information. You know, we know how to do things to protect nuclear weapons information, but this is much more complex because this information isn't falling under the national security. So it's out in the public, and it's out in all of the universities.

What we're talking about is being done on a worldwide basis now. So this is not within the confines of the U.S. Government.

Mr. HORN. To what degree would the National Institutes of Health be involved with NASA in this?

I am asking that question because the National Institutes of Health, we've poured several billion more than anybody thought into them in the last 2 or 3 years, and obviously there is a major sort of rush, shall we say, and I agree with some of it, to have the genetic side of NIH pursue these various and sundry things. And they are sort of squeezing one of the laboratories they have had within the NIH, which would deal with pharmaceutical companies in terms of, say, plant life, marine life, and so forth as it relates to some of their diseases, cancer, AIDS, in particular.

And they have the authority from Congress to move money around, and the question would be how do we deal with that when you have got NASA and you have got Agriculture, and if you want to get into the genetics of some of the plants, one of the able Secretaries of Agriculture was pretty good at it, a guy named Henry Wallace, who brought us hybrid corn.

And our European friends do not have a strong Academy of Sciences, which would allay a lot of the fears that they put up simply to keep our products out of there, but how do you feel you would move on that, on some of those? Maybe energy is included in this, but in terms of I guess what the behavioral sciences would talk about with all of this matrix that we need to bring the best of every agency to look at this and to have an opinion on it, but not be able to block it.

Mr. VENNERI. I really believe that to get at the issues you are saying falls into one particular camp: OSTP; I think, whatever the next administration is. I think that is relevant policy for them to undertake coming this fall, and actually for the next Congress.

Your subcommittee, I think, is a good starting point to actually focus in on that particular issue. It's no longer technology, but the ethics of technology, and structuring a government coordinated effort. It really emanates from the administration and Congress to make sure that agencies are working together and they are putting in place the safeguards and what I would call the peer reviewed ethics, and to not have it be each agency do their own thing, but really falling under a government framework that can be an articulate policy for this country, and hopefully the other parts of the world would follow that.

Mr. HORN. Now, how has the Office of Science and Technology been as you have seen it just on NASA matters and the Science Advisor to the President, which is a key position few people know about, talk about or anything else?

But I remember under President Eisenhower, he had a very distinguished professor of chemistry from Harvard that did a lot of good work in those days. But is that enough for the White House or should there be something within the Office of Management and Budget that parallels?

Because they have regulatory authority of either holding up regs, or not implementing them, and of course, they presumably survey the administration, but they also sit on things, too, like other bureaucracies.

And so you think the OST, Office of Science and Technology, is the one that ought to be because of the knowledge base that would come to that with them?

Mr. VENNERI. Yeah, I would agree with that, and OMB works with them now on actually two initiatives in this administration. One, Dr. Neal Lane, who is the head of that activity, pushed a national nano technology program, and in reacting to the information technology lack of investment by the Federal Government, roughly a year and a half ago they structured a Federal-wide activity in information technology R&D that was lacking in the country.

Now, this is moving at very high speed, what we're talking about, and the issues of technology ethics really came in our mind about 6 months ago when we saw the implications of some of the things we're postulating for products, and it was also in our interactions with National Institute of Health, particularly with Rick Klausner, who runs the National Cancer Institute.

We told him our plans about this technology ethics, and his reaction is: good idea. We want to work with you on it.

Mr. HORN. Of course, he has left now, hasn't he?

Mr. VENNERI. Well, he was still there last week.

Mr. HORN. Oh, was he?

Mr. VENNERI. He was thinking of leaving.

Mr. HORN. I thought he had left.

Mr. Louie, do you have a comment on any of this?

Mr. LOUIE. You know, I think ethics and how all of this—advances of technology are moving so fast and so quickly that historically in which you can contain technologies in our universities and in our Federal research centers, I think the rules have changed. I think the commercial market space has really put trillions of dollars into investing in these new technologies. So the genie is out of the bottle.

The question is: how do we manage that? How do we be responsible? How do we as a government lead by example and get corporations, especially in the global marketplace, to understand the impacts of their technologies?

This is not an easy challenge that can be legislated. It's something that we're going to put a lot of energy behind. It's not an easy problem.

Mr. HUTTNER. Mr. Chairman.

Mr. HORN. Yes.

Mr. HUTTNER. Can I just make a comment?

Mr. HORN. Sure.

Mr. HUTTNER. I can't help but reflect on our experience in biotechnology here, and I'd hope that we had learned something. Back in the mid-1970's there was a certain amount of debate that was promoted by the research community about the safety of using the new gene splicing techniques, and what we failed to understand at that time was that we weren't making it clear to the public, especially to the media that, in fact, these techniques weren't so different.

They were incremental enhancements over other technologies. So we had lost the opportunity to explain that this was a continuum of advances, and we had a lot of experience with earlier technologies, and we could use that experience to judge how best to use the new advances.

So as we're moving forward in the area of nano technology, which is quite a buzz word these days without a lot of definition attached to it. I think we need to be cautious to build the right context around it and bring it into focus for the specific applications and research targets that we're talking about.

Mr. HORN. Do you want to add anything to that, Dr. Rudee?

Dr. RUDEE. No, thank you.

Mr. HORN. Mr. Davies.

Mr. DAVIES. No, sir.

Mr. HORN. Dr. Williams.

Mr. WILLIAMS. Yes, I think on the genetic engineering of food there's a lot of talk and controversy. If a food product, whether it be plant or animal, is genetically engineered to be tastier, to be more nutritious and that's all that's done, or to be more productive in the case of cattle or crops, then that's good.

The concern I would have is when genes are added to perhaps make a plant that people eat contain a pesticide that will kill bugs. This, of course, is being talked about. If this is done, then you are introducing a new substance, not necessarily nutrition, into the food product. That needs to be looked at very, very carefully to insure that this new substance that's being introduced, which is called it a natural pesticide, if you wish, is, in fact, safe; absolutely 100 percent safe for human consumption.

Mr. HORN. Dr. Popper, do you want to add anything to that?

Dr. POPPER. Yes, Mr. Chairman. I think you quite rightly point out the problem of coordination that exists in this field and, indeed, in many other emerging fields of technology and science.

There are a couple of other institutions within government that try and affect this coordination, one, of course, being the National Science and Technology Council, where the national nanotechnology initiative was incubated, as well as PCAST, the President's Council of Advisors on Science and Technology.

I can't recall precisely in which document. I don't know whether it was on the formal recommendation by PCAST or the actual national nano technology initiative as it was announced, but I believe they deliberately called for a set-aside, for a certain proportion of the funding precisely to focus on better understanding of the social, cultural, moral, ethical issues that would result from developments in this area of technology.

Mr. HORN. Dr. Shank, any words of wisdom?

Mr. SHANK. Only to say that the ethical issues are really only a part of the problem. I think that we at the society have developed a set of fears about technology, some based on fact and some based on fiction, and I think that gaining the trust of the people in the country about applying these technologies is an extraordinarily difficult thing to do, and I think that contemplating the ethical issues is certainly important, but also providing people with enough interest—enough information to be able to make informed judgments.

I think we're all facing problems in our research environments where there's a great deal of concern, and these concerns tend to go in waves, in fashion. There was a period of time as just was pointed out that biotechnology was going to be banned. I live in a city that banned biotechnology and moved all of the biotechnology companies out of the city. Now they'd like them to come back.

I think that these are issues of fear. We have to have patience. It takes time, and I think that all of these efforts are appropriate and need to be done.

Mr. HORN. Gentlemen, we thank you, and the gentleman from California, Mr. Ose.

Mr. OSE. Thank you, Mr. Chairman.

I want to go back to one particular thing. I think, Dr. Huttner, you mentioned it. Congressman Smith's report on risk in the food supply as a result of changes in the regulatory structure over seeing biotechnology versus what I would call classical Mendellian genetics indicates that there's no evidence to suggest that biotechnology foods have any greater or less degree of risk than those that are created through classic Mendellian genetics.

Mr. HUTTNER. That's right.

Mr. OSE. That is accurate?

Mr. HUTTNER. That's accurate.

Mr. OSE. Is it accurate to say that in a very real sense, the development of biotechnology in these added attributes to plants, for instance, basically accordions or compresses the time during which genetics could otherwise be used to improve a plant?

Mr. HUTTNER. Yes.

Mr. OSE. In other words, are we achieving through biotechnology what we're going to achieve anyway through classic Mendellian genetics?

Mr. HUTTNER. Yes, with greater precision. The difference between classic breeding techniques is that you take two sexually compatible plants and exchange hundreds of thousands of genes in a random fashion between the two plants in the new progeny, and as a result of that, you'll get some of the traits you're looking for, but you often get other kinds of traits that you didn't want.

So just like drugs, it takes a long time to develop a cultivar that's going to be useful in agriculture. It can take as long as a decade or longer for a new kind of plant to be put into production agriculture.

Mr. OSE. It is like children, you know. Sometimes you get what you want. [Laughter.]

Mr. HUTTNER. That's right.

Mr. OSE. Last night we did not.

Mr. HUTTNER. But with the new techniques, you can identify the genes that are encoding the trait that you're interested in and isolate just that gene and manipulate it without changing the rest of the genome of the plant, and so the findings of the National Academy of Sciences and the National Research Council in 1987 and 1989 are clear. Because we know more about the kinds of genetic changes that we're making, we're in a better position to judge safety and risk than we ever have been with traditional breeding.

And I'd just like to add a point of clarification. There's not a food that's derived from plants that we're eating today that doesn't include genes to protect it against insects and diseases, and if you want to call them pesticides, you can, but I personally would rather not think of them that way, but they're plant defense mechanisms.

Now we're able to identify defense mechanisms wherever they occur in nature and move them into our crop species. That doesn't make them inherently different or less safe.

Mr. OSE. I just want to make sure I understand this. I sit on the Agricultural Committee. So I have more than a passing knowledge of this, but do you know of any evidence of a peer reviewed or otherwise—excuse me—I should say scientifically peer reviewed basis to indicate that we have a higher or lower degree of risk when you compare biotechnology food products with non-biotechnology or traditional Mendellian type of food products?

Is there any difference or any evidence, any difference in risk to the consumer?

Mr. HUTTNER. No, there's no evidence in the scientific literature that has demonstrated that there's significantly greater risk of using genetically engineered plants in farming or in food production when it's used in the typical situation of plant breeding standards, food processor standards, and FDA oversight mechanisms in producing the new food for sale in the marketplace.

Mr. OSE. Thank you.

Let me, if I may, kind of change tracks here, and this is more of an open question to all of you, though I'm going to start with Dr. Popper.

You talk about the standards or creating the standards to bring certainty to industry within the technology, and then we have a lot of testimony today that the technology is moving so fast it's almost impossible to establish a standard. How do you reconcile that?

And I'd appreciate any input from anybody on this one.

Dr. POPPER. Yes, Mr. Chairman, Congressman Ose, you raise precisely the point. This is exactly why this is such a troubling issue.

On the one hand you have technologies developing quite rapidly. On the other, there is a sense, a growing sense at least based upon the sort of interviewing that we did that in many cases there is a difficulty in finding that fine line between when you actually establish standards that might, in fact, allow greater pace of technological development by introducing a certain amount of certainty versus the risk of setting standards too early that might freeze development and thereby cutoff opportunities that might otherwise arise.

And it is precisely because of that complexity that we find that people in industry feel the need to be having conversations at a very early stage of the development process, conversations which are difficult for them to engage in not only between the potential producers of goods, but also conversations with upstream suppliers of components and technologies, and conversations with the downstream end users of these products for legal reasons, for practical reasons.

They find it very difficult to engage in this sort of discourse and suggested that, in fact, this is an area where government could lend a hand, not in terms of setting standards, not in terms of imposing standards, but in terms of providing an occasion, providing venue, acting as a convener, so that the people who have interest in this area can engage in precisely that discussion. Do we need standards? When do we need them? What sort of sign posts should we look for, etc?

Mr. OSE. I think the classical example that I am familiar with had to do with the cellular technology where we've basically yielded the manufacturing process to either Ericcson or Nokia.

Dr. POPPER. Yes, that is precisely the example that comes up frequently, an instance where to this day European manufacturers are able to move more rapidly, to introduce more advanced technologies to the benefit of their customers than our United States firms precisely because of lack of standards.

Mr. OSE. Does anybody else have any input on that?

Mr. LOUIE. Yeah. You know, standards are always a tricky issue because it in some ways is required to enhance competition. I look at standards like rice patties. There are these plateaus in which you want to have standards so that people can kind of harvest the rice, and there are times when you want the kind of legal standards behind and zoom up the other end of the curve.

I think the government needs to understand its kind of role in helping out companies decide to put together standards that are good for industry, as well as good for government.

And if you look at the government dollars that are spending in acquisitions, the U.S. Government may not be once like it was 10 or 30 years ago in terms of influencing technologies by straight investment, by commercial acquisitions, but still has a role to play, and we just made an investment in a consortium called Open GIS, which is data fusion for 3D space. It's a big problem that everybody is running around trying to map the globe.

Mr. OSE. Did you mean we made an investment?

Mr. LOUIE. "We" being taxpayer dollars.

Mr. OSE. OK.

Mr. LOUIE. Going into a consortium of companies because the Federal Government had the interest to make sure that all the different technologies that deal with maps talk to all the other technologies.

And so instead of waiting for somebody that sees the standards, we notice that there was this momentum in the marketplace to form a consortium. So what we did was we just added some more dollars into the pot to encourage that development in the publishing of those open standards for the rest of other companies to use without actually writing the standards ourselves that we think we could use in a variety of technology fronts to encourage open standards, but at the same time not trying to be the governing body that dictates what those standards are.

Mr. OSE. If I might interrupt for a minute, I want to yield 2 minutes to the chairman.

Mr. HORN. I know that Dr. Venneri has to go, and before you leave, I want to thank you for all you've done to help this be a very useful forum.

Now, we've touched some of these areas, but we haven't had much resolution on them, and I just wondered. You know the whole works on the nano technology. What do you think we should cover that we haven't said anything about?

Mr. VENNERI. Right now we're—I tried to coach my presentation to say we're at the embryonic stage of a technology baseline for the next century, and at the beginning stage of this, I can't predict what's going to work out or not. I'm not sure 5 years from now if I'm going to have these ultra lightweight, super strong materials that, you know 10 years ago was the realm of science fiction articles.

The problem, the challenges I think we see, I think we touched upon in some respects, and let me try to summarize. We have a society that I don't think understands technology. So we have a problem. My friends and colleagues that I work with, we're a very small, skewed part of this society. In some cases, I think this is a technologically adverse society we're in. We don't do a very good job of explaining technology to the U.S. taxpayer, the U.S. citizen. So I think we have a long way to go toward explaining the technology vision for this society, how it relates to their quality of life, not in technocrat terms. It needs to be clear government policy and be clear investment.

We have a responsibility, on the other hand, particularly in the Federal Government, to do that risk mitigation of inventing the next baseline of technology. Most companies we find do not invest in the long term, high risk, high payoff. They simply will not invest in it. You know, the return on profits or profitability, and they're in a very competitive, get next year's product out, particularly the electronics industry.

So we're really looking at what the Federal Government role is in high risk research with a high payoff, and that research needs to be gears toward how it translates from the laboratory into the industrial base.

My career in the government, I've seen a lot of "gee whiz" technology ideas, would not have a chance of making it into any sort of technology baseline simply because it wasn't thought through enough. The issues of repeatability wasn't there. The impact on our products were not thought through. So it's the application sense, understanding the system application, and then really looking at the policy because we're in this technology for the next century.

I think you saw the beginnings of it in the biotechnology controversy that started in the 1970's and is still going on to this day. It shut stem cell research down in this country by the Federal Government, and so what we're concerned about is this biology coupling with engineering which we believe is going to be a reality.

We're on another plateau of a new engineering, scientific foundation. It's going to be this biology revolution coupling to traditional engineering, which is why I draw that triangle.

And the implications of that, I think we need to work as this technology ethics, as we develop the research infrastructure. We almost need to start that now. It's too late 10 years from now to talk about how the computer from 2001 and the implications of what that would mean in terms of society.

And so that's why we're looking at this as an embryonic stage of industry.

We need to do something about our education system. I agree with the assertion over what we see coming out of our education system, and it's simply not just get more people going to college. We need to go back to the grassroots. We need to look at our math and science foundations at the K through 12. We need to stimulate our young children to move into the university environment, not bemoan the fact that we don't have people in the university environment.

So I think there almost needs to be a national policy on education that goes back at the K through 12 level toward a society that is becoming more and more technology driven, and an educational system that doesn't address that from the grassroots is going to leave people short here in the next two decades.

So those are the issues that I have.

Mr. HORN. Well, I agree with you, and I was planning to raise the one on education because I feel very strongly that in this State, which once was a leader in public education, we have without question fallen back in the K–12 operation on science and understanding of technology and the community college system, which is about 107 campuses in this State. They are doing some excellent work, and we need to if Silicon Valley or Nano Valley or whatever we can to call it now, but Silicon Valley should be working with those 107 community colleges on what type of programming and on the electronic side, but getting into this on the biological side, we need to stress the same thing.

And it just infuriates me when some bill comes in that says, "Well, we want 200,000 people from abroad because we don't have anybody here." That is nonsense. We have got them, and those are good jobs. Those are $60,000 a year jobs right now in Silicon Valley, and we need to be educating people.

And if you told them that was $60,000, there would be a real focus because they could see a future somewhere, and the State never has enough money to get the latest generation for the classroom or the laboratory. So that ought to be their contribution, and ours ought to be to really educate people so they can bring people together at the third grade at least and get basic science concepts there and think in that terms.

And in kindergarten there ought to be decisionmaking, to start with, in the school system, which they seldom do, but, you know, what are the consequences if I do this, and little students ought to know that. You know, they memorize baseball cards. They could learn another foreign language, which they ought to do, and one of them ought to be the scientific language and the mathematics language. Those are all languages.

And yet we don't see the leadership here that's putting that together, and if we don't do it, we're going to really be in problems of shortage of skilled people, and as you say, we don't want to be a bunch of Luddites. Those are the people in, I think, around 1810 in England that just went in and smashed all of the machinery because they thought their jobs were going, and we have a lot of that in this society. You are taking my job away.

And yet we are creating new jobs, and I thought your testimony was excellent on that in terms of what it has done in San Diego where they had some real problems in the aerospace industry. Although they are loaded down with the Navy there, but they have certainly moved ahead, and Southern Los Angeles has not yet moved ahead, whereas Silicon Valley recovered.

Fairfax Silicon Valley in Virginia is going to be a major place. Every time I go to Dulles I see a new building popping up, and that is about once a week or every other week.

So I thank the gentleman for permitting us to ask that question and partially answer it, but thank you again, Sam. Appreciate it.

And the gentleman from California.

Mr. OSE. I have but one more, Mr. Chairman.

Mr. HORN. OK.

Mr. OSE. Dr. Rudee, you talked about the inputs, if you will, now, the teachers that open up young minds to all of this new thought and new training. I know that we have in particular one bill we passed off the floor of the House, the Teacher Empowerment Act, I believe, that would give grants to localities or to teachers themselves to go get that extra training as the generations move through and there's higher and higher and higher expectations.

Could you expand on how we make sure our teachers, those people you remember from first, second, and third grade that just kind of crafted our lives, if you will; how do we make sure we help them meet our objectives?

Dr. RUDEE. Well, I am not an expert at the K through 12 system. My observation is that there's no magic bullet. You've got to do a lot of different things.

I think teachers are still underpaid. It doesn't attract people. You heard the $60,000 number. You know, that doesn't translate to any of our school districts.

One of the reasons we have to pay better, is that in the days when I went to school, teaching was one of the few jobs women could aspire to, and that's no longer true. Half of our medical schools now are women.

And so we've got to pay more to get more people to want to be teachers who are choosing between options. It's a very difficult problem.

One thing would be to have some scholarships that incentivize students to be math and science teachers.

I think your issue about the community college is that they get lost in the shuffle in many ways, Chairman Horn. You know, you hear about the universities; you hear about K through 12, and then there's that 13 and 14. Well, they're doing a terrific job and a very needed thing for the society. I think it all too often drops through the cracks. Federal policy doesn't seem to focus on it. They sometimes get lost in the debate in Sacramento.

So I can't say any one thing. The people in the educational business that I've talked to, deans of schools of education, all say that. There's no one thing that will do it. It needs a lot of activity on a lot of different fronts.

Mr. HORN. Well, I think one of the main things is that basic liberal education, which includes science, social science, and the humanities, and that ought to be carried through all of the K–12 system, and it also ought to be carried through in the universities and the colleges because this is the type of interdisciplinary world we're going into, and you can't just be locked into some very narrow field because that narrow field is going to change dramatically.

So I thank you for a lot of the points you had made. I want to just ask a couple of things here. I was particularly fascinated by the disaster area in relation to the Red Cross as implementing it, and I guess, Mr. Davies, the disaster area, taking it from FEMA, I do not know. For the first time we have had a first rate person running FEMA, and so how do you deal with that?

I mean, if the Red Cross isn't there when the flood happens, FEMA has been so far, to my knowledge, in the 6, 7 years I've been in Congress, and they have done an excellent job.

Mr. DAVIES. Yes, sir. First off, let me give you some of my background. I am not a disaster manager. As of a few years ago, I was actually an expert in the intelligence community and got into this business because of the application of all source information.

Our interests are in the information network aspect of things. So that's what we're working toward. You talked about FEMA and the Red Cross. That is all under this Federal Response Plan. That document defines which Federal agency is responsible for doing which chore during the disaster.

A good example is clean-up, cleaning up debris after a hurricane or after an earthquake.

Mr. HORN. But isn't that coordinated by FEMA?

Mr. DAVIES. FEMA under the Stafford Act has responsibility for preparing the Federal response plan.

Mr. HORN. Right.

Mr. DAVIES. Like for clean-up, as I said, it's the Army Corps of Engineers. FEMA also has some lead responsibilities. I think there are 13 emergency support functions that are supported under the Federal response plan, and FEMA is lead in some of those. Other agencies are lead in others, and the American Red Cross is lead in the one.

That's where we suggested the possibility of establishing a disaster information network. We believe you need a dedicated disaster information network. The infrastructure exists. It's the Internet, but you have to partition part of that with an Intranet type of concept.

You need the security, and you need the dedicated system. The way I view the world and the disaster world is you have a bunch of end users, the war fighters, and again, I'm going back to my old career as the Defense Intelligence world.

After Desert Storm, there was this concept that suddenly appeared called the war fighter, and the intelligence community realized that they had failed in supporting the war fighter. Those were the ultimate end users, the folks in Desert Storm. We couldn't get them the intelligence information they needed.

Well, the war fighter in the disaster world is the first responder. It's the fireman. It's the police man. It's the first person on the scene the person who has to do the work.

Now, the last thing you want to do is to give him, you know, a gigabyte image satellite picture of the disaster scene. You want to give him useful information, something he can react on.

Well, there's a whole other world over here who knows how to generate that useful information. It's the USGS. It's FEMA. It's the universities who are the experts in that sort of domain. The two are not connected. Sure, they can go on the Internet. That's one of the rationalizations.

Sure, we'll just give the disaster manager a computer, give him the Internet, and he can go surf and find that information. He doesn't have the time to do that. He has no interest in doing in that.

So the disaster information network concept has evolved to say, "Well, this is what's going to link everybody together," and that's kind of what we're working toward.

Mr. HORN. Well, I think there is a lot to that. On the other hand, the way you get disaster aid is when the—in Paramount City in my district, the other day we had a tornado. Did anyone ever hear of a tornado in southern California?

Mr. DAVIES. Actually there was a tornado in Sunnyvale about 2 years ago.

Mr. HORN. Really? Well, you're way ahead of us. [Laughter.]

It's moving south is right.

Mr. DAVIES. Right.

Mr. HORN. Anyhow, it wiped out and wrecked many of the mobile homes in one mobile park, and last year we had a tornado that took the roof of the Lucky's store off in Long Beach, and usually when that happens, then the city will say, "Hey, we have got a real problem here," and it will either escalate to the county and they will say they have got a real problem and go to the Governor, and the Governor is the one that has to certify it to get FEMA moving on anything if there is a real problem with life and death and so forth, and not being able to get into your home.

Well, we did not have it that difficult. It is just an awful nuisance that people's homes had been hurt and they got off their foundation and all of the rest, but the question would be: does the Red Cross—can they do all of those functions that FEMA does or do they just have one little area of it?

Mr. DAVIES. The Red Cross just has one small responsibility, and they are the lead agency for disaster relief. So they provide——

Mr. HORN. What is that, a check?

Mr. DAVIES. No, it's housing.

Mr. HORN. With housing? OK.

Mr. DAVIES. Right. I think it is FEMA who comes in for, you know, if your house has been destroyed. It is FEMA and the Small Business Administration who come in and supply the loans.

Mr. HORN. Well, yes, and they have all done their thing. It is like housing with HUD and this kind of thing, and that is why I am just curious. It is the first I had heard of that, and you are saying that is now what, policy?

Mr. DAVIES. No. The Stafford Act is law. It has been law for a long time, and it very specifically defines which agency is both lead and supportive in this process.

Mr. HORN. Yes.

Mr. DAVIES. We also bring out the observation today if the Red Cross didn't exist, you know, it's one of those things we would say, "Well, of course, we need that," and we would all get together and invent the Red Cross, and that's the argument we're making about our disaster information network.

People kind of think it is already out there, but it's quite remarkable for somebody who just got into this community to see that there is no such thing, and the local disaster managers are really overwhelmed because of the changing world of technology. They just can't catch up.

Mr. HORN. Well, yeah. The Red Cross and the Salvation Army and a number of groups, such as HUD, they do a very fine job in many of these, but it just struck me that there is a matter of timing here, and when you have got a government-to-government, presumably they ought to be faster than going through a lot of other groups that might not be ready, might be on vacation. Who knows?

So I have one last question, and that is what the subcommittee is working on over the last few months and will be working on a few months more, and that is computer security, and that relates to every type of research and it relates to privacy, and the question is: what should the computers that are owned or leased or whatever by the Federal Government from various types of electronic action, whether it be computers or others, and the question would be what are the standards that should exist in any Federal, State, local computer where it is subsidized by the Federal Government that they have certain things they have done to control access to that computer.

And we all know we have got a problem, and one of the problems is nobody is willing to talk about it when they have had all of these hits by either the amateur 17 year old who wants to show he really knows how to get into a privately controlled or very—well, let's take the Department of Defense, for example, is a favorite of many of them.

And then you got foreign powers that also have the money and the computer capacity if they want to make mischief, and that would be perhaps to get into your venture capital aspects, and I do not know if any of you have had your own computers sort of raided by others, but the problem we face is trying to get some standards that the Federal Government executive branch part would have to conform to as a way to reduce the impact of the mischief makers.

And I would welcome any thoughts on that, and there are other questions we might have to send you. We would particularly appreciate it if you could spend a little time with us on the answers, and we will put them at this place in the record.

But on that standards, I would welcome any thoughts right now on that and any of you that are dealing with it.

Mr. Davies.

Mr. DAVIES. One of the outreach efforts we've been working on with the development of the disaster information network is the FBI Infraguard program.

Mr. HORN. Right. We have worked with them.

Mr. DAVIES. This is kind of a new outreach effort by the FBI to become friends with industry, universities, and government agencies, and the idea the FBI has is really to buildup a relationship. It's a relationship marketing effort that the FBI is going through, and they're going to have an Infraguard program in every regional office.

We are actively working with the San Francisco Infraguard program, and we approached this for two reasons. We wanted, one, to protect our disaster information network from these people, but we also felt that it is the disaster information network that can be used by the FBI to help distribute information, and that's one of their primary concerns now.

They're actually afraid to turn on the Infraguard Web site because they realize as soon as they do that, it will be the prime site to be hacked.

Mr. HORN. Yes.

Mr. DAVIES. That's one of the other things. As the public-private partnership, we've kind of offered them help in hosting that Web site, and we're not the FBI. So if we get hacked, it's part of the learning curve.

One of the things I've learned working with the development of this information network, the Federal Government is afraid to fail. A lot of the organizations within the government are afraid to fail. Well, industry is used to failing. So that's how you make success.

So you fail a few times and move forward. So we're kind of working with that with the FBI. They're afraid.

Mr. HORN. Any other thoughts on this, on the standard? Any of you been raided and now know how to diminish it a little bit?

Mr. SHANK. Well, certainly any national laboratory is under constant assault. I would like to caution against setting standards. I believe that each computing facility is sufficiently different, that the risk needs to be matched to whatever protection policy you have in place, and that one standard that applies to all computers could be more harm than good.

The rate at which the world is changing in computer security is such that a standard set today is almost irrelevant tomorrow. I think that performance metrics in protecting data certainly is something you should be concerned about, and I would be concerned about what your actual losses are and have you put enough resource to protect whatever needs to be protected.

If it's a Web site that just provides information, that's one level of worry. If it's information that's proprietary or government sensitive, that is certainly another level of protection.

And I'm very worried about having a standard that we put in today and one 15 year old kid makes it obsolete tomorrow, and we could be spending a lot of money doing things that really aren't allowing us to fight the battle.

So my encouragement is to say we have an expectation that you will protect the following things, and we would like to measure what your losses are and what your failure to protect is rather than trying to put together a standard because no one knows how to make a standard.

At our laboratory, we have invented something called an intrusion detector. We want our laboratory to be open. It's unclassified. We would like people to have access to what we have. We protect our data, and that's not connected. It's air gapped from the system, and the way we work is that we let people in, and then we watch their behavior, and if they're doing something like trying to go into a machine, we kick them off the network.

Another approach is to put a firewall up and not let people in. These tradeoffs between the ease of use and the standard of protection are almost a fungible quantity. You can have an extremely protected system which is very difficult, if not impossible, to use, and you can have one that's unprotected and easy to penetrate.

Making that decision point for each different computer is really the key issue, I think, in world class cyber security.

Mr. HORN. Mr. Louie.

Mr. LOUIE. Information security is one of the areas that we're spending a lot of energy in. A couple of pieces of information for the committee. Over the next 3 to 4 years there's probably going to be in the neighborhood of $30 to $40 billion invested in information security by the commercial marketplace.

I also agree with Dr. Shank that it's dangerous to set standards. The CIA tried to set a standard in the old days called the Orange Book. It was kind of an interesting exercise. The moment it got published, the book was pretty much irrelevant.

And one of the things that you learn in information security, that it isn't standards. It's processes and being able to communicate with other individuals about what risk assessments are.

There are some things that we could do as the Federal Government that could actually improve the overall security of our infrastructure. One is providing appropriate communications, what we call certs, to make sure that people discuss with each other what are the current vulnerabilities of the systems, report attacks as soon as they happen, begin to identify patterns.

The other areas that I think the Federal Government can encourage is industry to adopt standards, standards which certify different levels of performance based on the quality of protection against known attacks and to update that and provide necessarily additional funding if necessary to constantly change and update those certifications processes so that the people understand what they're getting.

The average person today who buys a home computer and plugs into a DSL or cable modem doesn't realize how vulnerable they are or how their personal computers can be used in a large scale attack.

A lot of this is education. A lot of this is communication, and I think that's an area that the Federal Government can take leadership in.

Mr. HORN. Any other thoughts here on the computer standard process issue?

[No response.]

Mr. HORN. Well, if you think of any, let us know.

Let me now thank those that really worked hard to set up this hearing. First I want to thank Dr. Henry McDonald, the Director of the NASA-Ames Laboratory, and his staff. We really appreciate the hospitality that they have provided here.

And I have thanked already Sam Venneri, but he is Associate Administrator, and he has done a fine job in Washington. I think those of you with NASA ought to know that Dr. Golden is without question one of the best administrators and visionaries in Washington, and I have known that every day I have been in Congress. So you do a great job with NASA.

And William Berry and Ken Christensen here, and Sheila Johnson, Lisa Lockyer and Laura Lewis have been very helpful in the hospitality area, showing us around your very important campus here.

And then for the Subcommittee on Government Management, Information, and Technology, J. Russell George, staff director. Well, he is to my left there, and Bonnie Heald to my left, professional staff member, director of communications, and then Brian Sisk on the right side here, the clerk for the subcommittee, and the court reporter this morning and this afternoon is Toma Brisbane.

So we thank the court reporter for this fine work because we have had a lot of witnesses, and we have had a lot of questions. So thank you all for spending this time with us, and I believe Ames has done that. You are invited to lunch, courtesy of the Ames Center here.

So with that, we are adjourned.

[Whereupon, at 2:50 p.m., the subcommittee was adjourned, subject to the call of the chair.]

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