Six Decades of Reducing Threats and Allaying Fears

Houston T. Hawkins

Los Alamos National Laboratory was established amid fears expressed by many knowledgeable people that our way of life might not survive. In its 60-year history, the Laboratory has been preserved because it has successfully welded science and technology to develop weapons intended to neutralize any such fears. Following the tradition of inquiry that is so much a part of our university heritage,[1] we have questioned to exhaustion the principles governing those weapons, which came to embody one of the greatest paradoxes in the history of humankind: Being intrinsically both destructive and safe, they are weapons of war designed to maintain peace. Because proper maintenance of those defining features of our nation's weapons must now be ensured without actual testing, the university environment is becoming increasingly important.[2] But at Los Alamos, we do more than develop weapons. We also use science and technology to hammer out plowshares that solve other intractable problems and contribute to making the world a better place.

[1] "A university… is a place where inquiry is pushed forward, and discoveries verified and perfected, and rashness rendered innocuous, and error exposed, by the collision of mind with mind, and knowledge with knowledge." (John Henry Cardinal Newman, *What is a University?* From a series of lectures delivered by Cardinal Newman between 1852 and 1854.)

[2] University of California employees have designed all the nuclear weapons tested and stockpiled by the United States since 1943. Los Alamos scientists have designed 75 percent of our enduring nuclear weapons stockpile, and the Lab therefore retains support responsibility for those nuclear weapons.

The Beginnings and Fear Itself

Following the infamous attack on Pearl Harbor, President Roosevelt assured the American people that they had nothing to fear but fear itself. Had Mr. Roosevelt fully understood advances that were occurring in nuclear physics, he might have added, "Of course, we should fear the real possibility that the Third Reich[3] might develop atomic weapons before we do." The scientists who came to this mesa top 60 years ago, many of whom

[3] The Imperial Japanese Government also had a nuclear weapons program that, at least with respect to understanding uranium systems, was likely more advanced than the German program led by Werner Heisenberg. In fact, many of the best nuclear cross sections used at Los Alamos during the war had been derived by Japanese scientists (Kikuchi et al. 1939). The Japanese program that was based on the electromagnetic separation of uranium suffered from a lack of resources, and only a few separation machines were available. Professor Paul Karoda, who worked on the Japanese program, reported that the program suffered financially because of a *faux pas* when it was briefed to the Japanese General Staff. Because the output was expressed in "gondola cars of anthracite" instead of tons of explosive, Minister of War Tojo Hideki was not impressed and wondered aloud why someone would drop that much coal on a city. (Private communication with Professor Paul Karoda, University of Arkansas, 1979.)

had escaped from the brutality of the Third Reich, were driven by that fear. We know that the researchers who worked here believed that one morning they would read in a newspaper that an atomic weapon carried by a V-2 rocket had destroyed London and dealt a mortal blow to the hope and future of human civilization. That rational fear motivated Los Alamos researchers to accomplish the impossible. In two short years, they solved all the intervening scientific and engineering problems, developed and built atomic weapons of two different designs, and proof-tested the more complicated atomic device near Alamogordo, in New Mexico.

This success came after the Third Reich had been defeated with conventional means. However, in the Pacific, we still faced a pernicious adversary whose atrocities in Asia matched those committed by the Third Reich in Europe. In the Pacific theater, the battles had grown increasingly violent and bloody as they were coming closer to the Japanese mainland. Casualties expected in a direct invasion of Japan were estimated at millions. Faced with this possibility, President Truman ordered that the atomic bomb be dropped over Japan. Days later, an atomic device developed at Los Alamos exploded over Hiroshima and another one, over Nagasaki. Although historians might debate Truman's decision, the indisputable fact remains that his action did bring about an immediate end to the war in the Pacific and that both sides avoided the inevitable, enormous carnage that would have been caused by an invasion. (See the box on the next page for a personal story related to this period in world history.)

The Cold War—“Duck and Cover”

Following the end of World War II, the free world faced a new fear. Since its expansion began in 1600, the Muscovy Principality had taken over territory the size of the Netherlands every year for 150 consecutive years, thus making Russia larger than the rest of Europe combined by 1750. Siberia, for example, was completely conquered by the end of the seventeenth century. That conquest alone doubled the size of Russia at the time. Up until the 1950s, acquisition of territory and people continued, regardless of the label on the authoritarian government in charge in Moscow. Richard Pipes (1974) has contended that this oppressive and authoritarian system, Tsarist or Bolshevik, could not create wealth but only acquire it through conquest. After 1945, the expansion led by Soviet communism was moving into Eastern Europe at an alarming pace. Occupied countries were stripped of their treasure and industry, and the plunder was shipped to Russia. This spread of Soviet communism, which had already murdered and enslaved millions of Russia's own citizens, became increasingly frightening because the regime was already engaged in the development of nuclear and thermonuclear weapons.

As a result, we accelerated our own thermonuclear weapons development, leading to Operation Greenhouse, a series of tests conducted by Los Alamos in the Pacific in 1951. Ultimately, the strategic race in nuclear arms led to the deployment of thousands of strategic nuclear weapons by both the Soviet Union and the United States. Peace was achieved by an unlikely concept—mutual assured destruction. However, even with stability at the strategic level, many military planners thought as early as 1945 that, given Soviet capabilities, intentions, and geography, stanching Soviet advances would be a very difficult, if not impossible, task. Space for all the tanks, airfields, materiel, and troops required by such a task was simply not available. A few planners, such as Secretary of War James Forrestal, were reportedly driven to psychological desperation, fearing that the Soviets would take over Western Europe and eventually the world.[4]

By February 1948, the Soviet Union had completed its network of proxy states in Eastern Europe, as communists supported by Moscow seized control in Czechoslovakia. In June 1948, the Soviets blockaded land routes from the western zones of Germany to Berlin, forcing the United States and its allies to provide supplies to Berlin by an extensive airlift. Elsewhere, the Soviets were fomenting other Marxist movements in Western Europe, Africa, South America, and Asia. In addressing this new threat, the United States initiated the rebuilding of Western Europe through the Marshall Plan and, working with its allies, established the North Atlantic Treaty Organization. Other regional pacts, such as the Central Treaty Organization and the Southeast Asia Treaty Organization, were also created to form a fence around the Soviet Union. These developments established the social, organizational, and political bases required to counter Soviet plans and strategies for acquiring more territory and proxy states.

However, the ultimate guarantor that the Soviets could not advance into Western Europe was the deployment of tactical nuclear weapons developed at Los Alamos and Lawrence Livermore National Laboratories. These weapons represented the most inexpensive and effective means for stalemating the Soviets and deterring any expansionism designs they might have harbored. Fundamentally, these

[4] Secretary Forrestal was the architect of much of the defense structure set up in the Truman Administration to counter the Soviet Union. He left office on March 28, 1949, and died tragically, taking his own life, less than two months later.

The Children's Milk Fund

At the 1986 Blacksburg Conference, "nuclear winter" became "nuclear autumn" and subsequently disappeared from public debate as an issue. Since our strategic force modernization had the effect of reducing the possibility of such an effect even further, I had been accused of high-jacking nuclear winter to support our modernization efforts. In any case, I had been invited to speak at the conference. When my session was over, it was lunchtime. I picked up my lunch and walked into the lunchroom. I noticed that former Senator Albert Gore, Sr., was sitting by himself over in the corner of the room. I walked over and asked Senator Gore if I could join him for lunch, and he replied, "Sure, general, sit down."

"Sir, I am a colonel."

"You should be a general, and I hereby promote you to that rank for the term of our lunch. What do you do in your present assignment?"

"Sir, I work in the Office of the Secretary of Defense as the Special Assistant for Air Force Nuclear Matters. That means I staff issues pertaining to Air Force nuclear weapons."

"I have always liked nuclear weapons. General, do you want to know why?"

"Yes sir, I would!"

"In 1940, I was a young congressman from Tennessee, serving in several committees that arranged funding for public services and works. One day, Speaker Sam Rayburn called me into his office. Albert, he said, I want you to hide a couple hundred million dollars in the federal budget. No questions asked, I left Speaker Rayburn's office and immediately started putting two million dollars here and five million dollars there. There was a spike in the children's milk fund, the highway program was accelerated, and more dam projects were authorized than we had water to fill them. I never stopped to ask how this money was really being used."

"In 1945, I and several other congressmen were on a trip to the Pacific to see how the war was going. Before landing on Tinian Island, we had flown over hundreds of warships and troop transports that were stacked up awaiting the imminent invasion of the Japanese mainland. I knew that those ships held thousands of good ole Tennessee boys, and I knew that many of those boys would never live to see the green hills of Tennessee again. I felt extremely saddened by that prospect. Upon landing, we were rushed into a large briefing room. A general officer, whose name I have forgotten, briefed us on plans for the invasion. He told us that the troops would hit the beaches first at Kyushu and then at Honshu. In defense of their homeland, the Japanese would put up intense resistance. Casualties on both sides were expected to number millions. The general told us that three large hospitals had been built on Tinian to receive the wounded. The central corridor in the largest of these hospitals was over a mile long. We sat stunned and silent. At this point, General MacArthur strode in as only he could do. MacArthur dismissed the other general. He looked at us and said, 'Gentlemen, the war will be over before you get back to California.' With that pronouncement, he left as suddenly as he had appeared. We went from stunned to confused. We thought, 'how can this be?' Millions of casualties filling up the Tinian hospitals, and the war will be over before we get home?'"

"We departed from Tinian and island-hopped east toward Hawaii. When we landed at Hickam Air Base, someone handed me a newspaper. The banner headline read, Secret Atomic Bomb Destroys Hiroshima. 'The children's milk fund,' I shouted, 'the children's milk fund!' By the time we left Hawaii, Nagasaki had been destroyed by a second atomic bomb. When we landed in San Francisco, California headlines gave us the news that Japan had unconditionally surrendered and the war was over. Those Tennessee boys would live to see the green hills of Tennessee again and possibly even vote for me. That, general, is why I like nuclear weapons."

"Senator, I also like nuclear weapons. My father was on one of those ships that your party overflew before landing at Tinian."

For me, hearing the elder Senator Gore relate this history is one of those precious moments that one never forgets. He doubted that such a secret enterprise could be accomplished in the political environment of today. He went on to say that he and his colleagues eventually hid over two billion dollars in the federal budget that he subsequently found out was used to build and operate Hanford, Oakridge, and Los Alamos. We were part of Senator Gore's children's milk fund, an interesting footnote in our 60-year history.

weapons confronted the Soviet juggernaut with the prospect that military aggression could result in an escalation to strategic levels and the total destruction of the Soviet Union. Once contained and its wealth-acquiring strategies thwarted, the Soviet Union began to atrophy and finally died from within. The Berlin Wall came down, and the nations of Eastern Europe and Russia joined the community of free nations. There is irony in this outcome. Because tactical nuclear weapons stood as silent sentinels of freedom, the critical role they played in establishing freedom in Eastern Europe and Russia is seldom understood or appreciated.

Of course, Los Alamos made other contributions to this outcome. The Laboratory, working mainly with Sandia National Laboratories, developed sensors launched on the Vela satellites to verify compliance with nuclear treaties such as the 1962 Limited Test Ban Treaty (refer to Figure 1 and the article "Eyes in Space" on page 152). These sensors provided data that helped build confidence that the treaties were working. They performed their mission in an outstanding manner, by detecting every atmospheric nuclear explosion within their field of view.

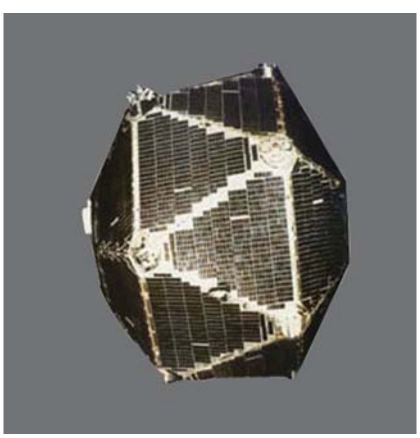

Figure 1. Vela Satellite
Launched between 1963 and 1969, the Vela satellites verified compliance with the atmospheric test ban.

Figure 2. The Berlin Wall
The Berlin Wall comes down in November 1989.

Significantly, none of those explosions was conducted by the Soviet Union. Other sensors followed, including those for the 1974 Threshold Test Ban Treaty and the 1988 Intermediate Nuclear Forces Treaty. In their own way, these verification systems helped reduce the atmosphere of fear and suspicion by increasing the opportunities for dialogue between the Soviet Union and the United States. Thereby, they helped achieve stability until the Berlin Wall came down (Figure 2).

"Interesting Times" after the Cold War

Once the euphoria over the end of the Cold War abated, the world had to face new realities. The times have been definitely interesting, but are we also sometimes reminded of the Chinese curse that says, "May you live in interesting times"? One of those new realities was that a nuclear weapons superpower, the former Soviet Union, was in an economic meltdown. The system of balanced agendas that had been in place for decades was gone, and regional tyrants that had been kept under a modicum of control by the old system began to act in irrational ways to establish regional hegemonies. Thus, the new age was more complex and unpredictable than the old bipolar world. Faced with these new realities, Los Alamos had to inventory its capabilities and redirect them, as appropriate, to address new threats and allay new fears. There were many strengths that we could muster. Immediately, we were asked to accelerate the use of Los Alamos safeguard systems to help manage and secure the very large inventories of excess special nuclear materials (SNM) that had been accumulating without the security nominally associated with nuclear weapons. These inventories had already been accumulating from the nuclear power industry. Plutonium, in particular, is being pulled out of spent nuclear fuel for easier long-term storage and for conversion into mixed oxide fuels. After the end of the Cold War, that inventory of SNM began to accelerate rapidly from the build-down of nuclear weapons inventories in the United States and Russia.

Within these new realities, we were also aware of the possibility of so-called "loose nukes." Whatever the old Soviet Union's proclivities were,

Figure 3. Kazakhstani-American Cooperation at Aktau
At Aktau in Kazakhstan, the Russians abandoned the BN-350 nuclear reactor, leaving unattended significant amounts of weapons-grade plutonium in its cooling ponds. This dangerous situation was averted in a cooperative Kazakhstani-American effort that secured the material under a system of safeguards and accountability. (Inset) Radiation sensor electronics built in the United States are being assembled at the reactor site. The sensor will be used by the International Atomic Energy Agency to monitor the movements of nuclear materials at the BN-350 nuclear reactor.

the Soviets did know how to protect their nuclear weapons. They had a very active program that combined their extensive and intrusive police powers and a robust transportation infrastructure with a disciplined, well-compensated cadre of warrant officers dedicated to the security of their weapons. However, after the collapse of the Soviet Union, the world was confronted with the possibility of nuclear weapons being sold or given to terrorists or proliferant states. This potential was particularly ominous in the early days of the collapse, when the economic situation was so dire that nuclear-armed units abandoned their weapons to forage for food. Although conditions have improved significantly since then and the Russian economy is on the upswing, the concern still remains.

It was concern over the situation in Russia that gave rise to the Nunn-Lugar-Domenici legislation.[5] Los Alamos scientists working under this legislation with their colleagues from other national laboratories have already accomplished some outstanding achievements in these areas, but much more remains to be done. We have had seminal successes at such places as Aktau in Kazakhstan and Novouralsk in the Russian Urals. At Aktau, on the Caspian Sea, for example, the Russians withdrew and abandoned a BN-350 nuclear reactor (see Figure 3). This site, not far removed from Iran, had enough weapons-grade plutonium in its cooling ponds for making a significant number of nuclear weapons. Now, that material is within secure boundaries under a system of positive safeguards and accountability. Working with the Russians in Novouralsk, we have been able to blend down a very large amount of highly enriched uranium (HEU) to a level of enrichment that cannot be used for nuclear weapons. Los Alamos developed the monitoring system for verifying that the feedstock was HEU. From the start of the blend-down program until September 2002, the inventory of HEU has been reduced by 150 metric tons. That amount equates to over 6000 nuclear weapons being taken off the table and permanently removed from the grasp of potential terrorists.[6] In the flow of Western history, we succeeded in this endeavor by working shoulder to shoulder with our Russian colleagues. Its magnitude can be compared with that of the Greek victory over the Persians at Plataea or Charles Martel's defeat of Islamic forces under Abd al-Rahman at Poitiers. Our accomplishment, expressed as a net reduction in military potential, is the most significant disarmament in history. However, it is seldom, if ever, mentioned in the public media. Of course, we are not yet where we need to be. Other weapons-usable material is still out there to be secured, and we cannot wait for laurels or applause. The battle for a safer world is a continuing one, and it is accomplished by dedicated scientists and engineers working under often difficult conditions to secure nuclear material kilo-

[5] The original Nunn–Lugar Bill (Soviet Nuclear Threat Reduction Act of 1991) was passed by Congress after the collapse of the Soviet Union to provide U.S. aid in denuclearizing and demilitarizing Soviet systems. The Nunn-Lugar-Domenici Program was authorized in the National Defense Authorization Act for fiscal year 1997.

[6] The Blend-down Program calls for 150 metric tons of HEU to be converted to low enriched uranium for use as reactor fuel. With that amount of HEU, 20,000 nuclear weapons could be made.

gram by kilogram to preempt possible future battles accomplished kiloton by kiloton.

Alabaster Cities and Human Tears

Terrorism experts have suggested (Jenkins 1987) that terrorists had a social contract with society not to kill a lot of people, just enough people to seize the headlines. The events of September 11, 2001, abrogated any such social contract and introduced us to an unstable world in which foreign nonstate terrorists attacked our core defense and financial districts, causing an enormous loss of life and property.[7] In this new, more convoluted world, it became clear that new battles would be fought without the relative isolation we have historically enjoyed. The battles would be engaged on new killing fields—possibly in our town squares and certainly abroad, in distant mountains without names, in dusty streets seemingly without end—on our laboratory benches as we develop technologies to shape the engagement of battle, and ultimately in our minds and hearts.

Within this more unstable world, the possibility of terrorism involving weapons of mass destruction (WMD) looms larger than ever before. Los Alamos has already been called upon to provide its many well-established capabilities to address this new threat. Among these capabilities are our in-depth understanding of nuclear weapons and materials, a mature program in detecting and characterizing pathogens, our demonstrated expertise in modeling and simulating complex infrastructures and systems, and our developments in detecting and neutralizing chemical agents. Success in preventing WMD terrorism requires developing an integrated approach to reduce the possibility that such an untoward threat against our people and facilities could occur. Whittling away at that possibility requires that we have concurrent and synergistic activities that multiply our efforts and investments. In the long run, occurrence of a WMD terrorist event can hopefully be reduced to manageable proportions. To that end, we must continue with preemption and dialogue, while not forgetting that an absolute assurance that such threats can be completely avoided would surely exhaust resources needed for addressing other pressing problems. Achievable or not, absolute assurance will certainly always be the goal, and Los Alamos science and technology will be essential in reaching that goal.

Role and Limits of Science and Technology

Fundamentally, the war against terrorism is a war of ideas. In this war, terrorists know that they cannot defeat the United States, but they can escalate violence to the point at which they hope we destroy ourselves. We lose automatically if we conclude that being free and being secure are mutually exclusive. Certainly, we cannot defeat terrorism if we continue to siphon profit out of our economy and sacrifice our freedom and liberties upon the altar of good intentions. Responses to terrorism must be designed and executed to make our economy stronger and more efficient and our freedoms and liberties more robust and expressive. If properly applied and planned, science and technology can help our country achieve security by avoiding unnecessary intrusion into civil liberties and privacy. As the following examples show, new technologies, many now available or under development at Los Alamos, coupled with innovative policies and appropriate implementation, can move us in the proper direction.

It is well known that repetitive manual security procedures at our airports are a significant overhead on the national economy. Adding one hour to the airport check-in procedures will rob the nation of 600 million hours of productive time each year, a figure that approximates the human productivity lost in the deaths that occurred in the collapse of the World Trade Center towers, not considering the horrendous human tragedy involved. Adding 10 minutes to the time it takes to download and transship individual cargo containers can be the difference between making a profit and incurring a loss. Such problems could be solved by an automated scanning system based on GENIE,[8] a genetic algorithm-based recognition technique developed at Los Alamos. (Refer to page 158 for a detailed description of how GENIE works.) GENIE can automatically process digital images fast and can ascertain potential threats at any viewing angle with very high confidence. For example, surveilling large areas for specific features with appropriate resolution requires extraordinary amounts of digital image data, but with the help of GENIE, human analysts can extract features of interest automatically, thus being able to keep up with the flood of high-quality imagery and technical data collected by satellites. In one test, researchers asked GENIE to locate every golf course of Professional Golfers' Association caliber in the United States. Normally, this task would have required a large

[7] The Aum Shinrikyo planned to produce sufficient sarin nerve agent to kill everyone in Japan. Arguably, the "social contract" would have been probated earlier had those plans been executed.

[8] GENIE (Genetic Imagery Exploitation) received an R&D 100 Award in 2002. These awards are given by the *Research & Development Magazine* for the best 100 innovations of the year.

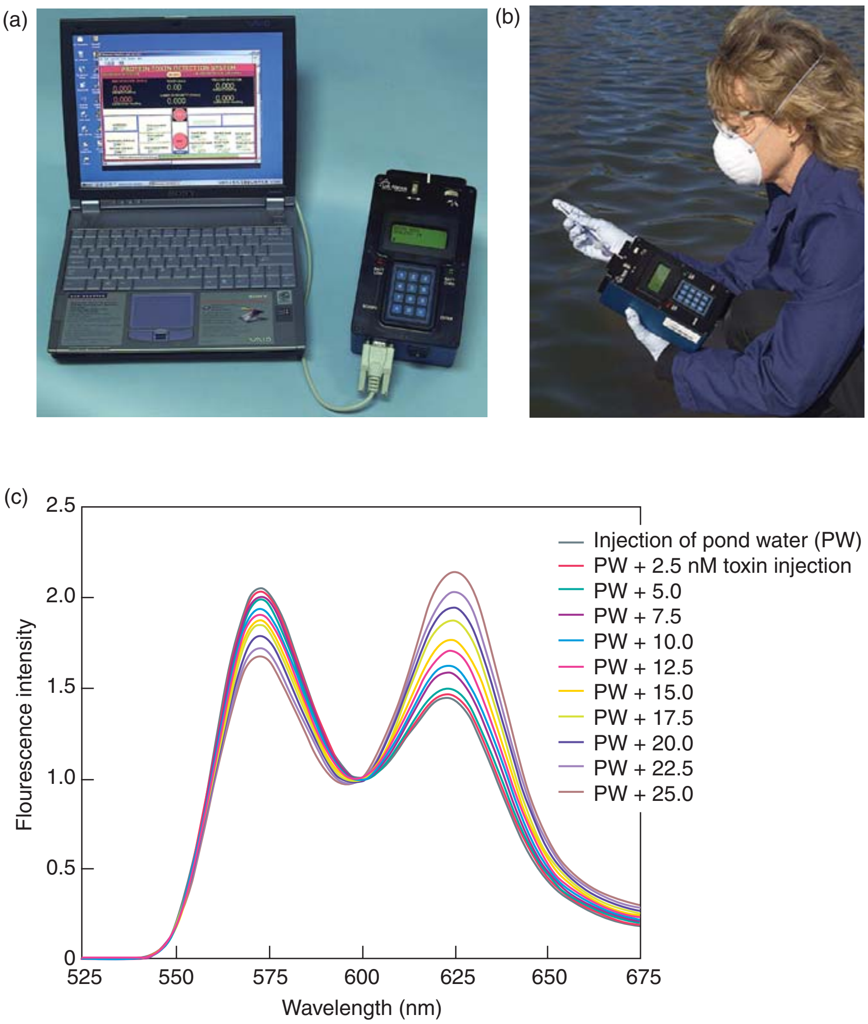

Figure 4. The Reagentless Optical Biosensor (ROB)
(a) ROB is a self-contained hand-held system that can detect pathogens and quantify the amount present. Samples are placed in a disposable sensor cartridge. Different cartridges will be designed to detect different protein toxins. Later, data can be downloaded for storage in our protein toxin database. (b) ROB was tested on pond water spiked with different amounts of cholera toxin. (c) The graph shows the fluorescence spectra measured by a fiber-optic spectrometer for different concentrations of cholera toxin.

team of photoanalysts and months of eye-straining work. GENIE finished the job in about one hour.

Similar to biological systems, GENIE's genetic-algorithm-based scanning system actually improves as it mutates, and it never becomes fatigued. Because each system mutates uniquely, terrorists will find it difficult to employ countermeasures because they will not know what specific criteria the system is using at any given time to find proscribed items. Using GENIE to scan luggage and persons will not require having another human to review results of the scan unless, of course, a proscribed item is identified. This feature is important in protecting privacy.

Science and technology applied as responsive actions to terrorism can be designed and implemented to result in a stronger society as terrorist attacks increase. For example, investments in our public health services aimed at dealing with acts of bioterrorism, if properly planned, can help ensure that more capacity will be available to deal with natural pandemics. We are developing systems, operating at the carbon/silicon interface, that combine the antigenic recognition capabilities of natural cells with the information processing speed of modern electronic systems. These detectors will permit rapid diagnosis of pathogens in the physician's office—no endless hours of waiting for results from pathogen cultures any longer. The reagentless optical biosensor (ROB) developed at Los Alamos is one such example (refer to Figure 4). ROB uses optically tagged natural receptors embedded within an artificial cell membrane to detect medical and environmental pathogens. Figure 4 shows ROB being used in the field to detect cholera, a pathogenic protein.

While detectors might be deployed to protect against bioterrorism, they can also identify such naturally occurring pathogens as the hantavirus. The hours saved in identifying this particular virus can be the difference between surviving the infection and dying from it.

Science and technology can be used to simulate complex situations—for example, those that permit national policy makers and legislators to authorize improvements designed to protect critical infrastructures against cyberterrorists. Such simulations might, at the same time, provide a more capable and secure information architecture for businesses and private citizens. For example, Los Alamos and Sandia National Laboratories have partnered to establish the National Infrastructure Simulation and Analysis Center in order to provide improved technical planning and decision support for the analysis of critical infrastructures. Simulation approaches developed at the center will permit effective routing of first responders, efficient allocation of resources, and effective defense options and strategies. This approach, although focused on counterterrorism, can be used to identify vulnerabilities that could grow out of natural disasters as well. The net result can be more robust and effective national infrastructures.

However, science and technology have limits on what they can accomplish. For example, they cannot deliver a solution proscribed by the laws of physics and chemistry. If we are required to assay a package passively for the presence of a radiological material, neutrons and gamma rays will behave like neutrons and gamma rays, and rates of radiological decay are fixed in nature. In like manner, detection of a lethal amount of some pathogens, such as *Yersinia pestis* or *hemorrhagic variola,* would require detection of a single microbe, a difficult task in any situation and an impossible one if the microbe were placed inside an airtight package. In addition, science and technology can present national policymakers with difficult choices. For example, detectors placed in the cargo compartment of a large airliner can, with enough integration time, locate and characterize SNM hidden in luggage. Because the detectors would probably not be able to define the configuration of that material, the national policymaker would have to decide what actions should be taken in the face of valid but inconclusive information. The consequences of making the wrong decision can be enormous. Finally, although all the examples discussed before are compelling proof of the key role of science and technology in preventing terrorist attacks, no combination of science and technology can provide absolute assurance that some clever or lucky terrorist will not succeed in carrying out a deadly attack against our citizens.

At the Crossroads

Comedian Woody Allen once remarked, “More than at any time in history mankind faces a crossroads. One path leads to despair and utter hopelessness, the other to total extinction. Let us pray that we have the wisdom to choose correctly.” Two futures certainly lie before the free world, but unlike those referred to by Woody Allen, at least one is not as bleak. However, one possible future is indeed bleak and frightening. This is a future in which terrorism fed by radicalism and hatred has become a more significant challenge to our society and its values. It is a future in which vehicle bombs—for example, tankers or aircraft loaded with fuel—and cyberterrorism have severely damaged or destroyed one or more critical national infrastructures. This future could also include terrorism involving chemical and biological agents with attacks that are increasingly lethal and the possibility that terrorists have acquired materials for nuclear weapons and stolen nuclear weapons. In this possible future scenario, terrorism will have fundamentally changed our way of life, and the rationale for sustaining our freedoms and liberties would certainly be questioned. This future will happen if we allow fears, real or imaginary, to drive us down irrational paths, to dim our support of democratic principles, to bind our response capabilities in endless minutiae and inane agendas, and to abandon our technological and scientific strengths.

But then, as we have done over the years, we can navigate successfully amid realistic fears toward a more desirable future. In this second scenario for the future, which is within our reach and abilities, science and technology have made acts of terrorism less probable and more costly to the terrorists and have reduced the consequences of possible terrorist acts. Science and technology have ameliorated the impact of counterterrorism measures on our basic freedoms so that we can be both free and secure. Science and technology have made the world safer with respect to terrorism and more robust and capable with respect to natural disasters and pandemics. Finally, the underlying factors and fears that made terrorism an option for achieving social change have been eliminated by the successful application of science and technology to improve dialogue, quality of life, and opportunity. This is the future in which Los Alamos skills and talents can and must play a role. That role, the reduction of threats and fears, has engaged Los Alamos throughout its 60-year history. ■

Further Reading

Jenkins, B. 1987. The Future Course of International Terrorism, *The Futurist* **21** (4): 8.

Kikuchi, S., H. Aoki, and T. Wakatuki. 1939. Angular Distribution of Fast Neutrons Scattered by Atoms. *Proc. Phys. Math. Soc. Japan* **21**: 410.

Pipes, R. 1974. *Russia under the Old Regime.* New York: Charles Scribner’s Sons.

For further information, contact Terry Hawkins (505) 665-1259 (hthawkins@lanl.gov).