12 Knowledge Management at Los Alamos

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This article will focus on the role of information as a strategic asset and as a component of our nuclear deterrent (in ways that most people have not thought about).

The core mission of Los Alamos is to maintain America's nuclear deterrent, a mission that has remained remarkably constant through the end of the Cold War. Nuclear weapons are in the words of every president from Truman to Clinton, in the supreme national interest of the United States.

Everything associated with a nuclear weapon is described by a superlative. They are the "hottest," the "dense-ist," and the "most powerful" weapons. They are instruments that make other countries deal with the United States in a very cautious manner. People tend not to think about other countries invading Florida. Although many times in this century countries have invaded one another, America's nuclear arsenal dissuades or deters countries from invading us. That deterrence is expected to continue. Officials of the United States government have said that they expect nuclear weapons to play a role in national security for some time to come, even though we are actively pursuing arms control treaties (when they are in our national interest, of course).

That core mission has remained constant, but the way in which we have pursued that mission has changed in at least two very fundamental ways. We originally developed nuclear weapons the same way people developed everything from toasters to rocket ships—through a process of design, testing, and production. But now, because the President has not identified a need for a new nuclear weapon design at this

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time, we are not actively pursuing the design of a new system. Also, because the President has signed the Comprehensive Test Ban Treaty, we are not actively producing nuclear weapons. As a matter of fact, the production line is in full reverse. We are taking weapons apart, as are Russia and some other countries.

So we have moved from a design, test, produce to an information-based or a knowledge-based method of maintaining the nuclear arsenal.

Why do we need to do anything at all? Nothing lasts forever. You would not put your car in the garage for 20 years and then say, "I'm going to bet the Nation on starting on the first turnover." Cars age. Materials need to be replaced and batteries wear out. You need to do all sorts of things. Each component has a finite life, although with proper attention the whole system may last for a long time. (We have the same situation with nuclear weapons).

I see four different aspects of knowledge. The first aspect is the utilization of existing knowledge. This is especially important when you can not get any more. The second aspect is the generation of new knowledge in certain aspects of the program. The third aspect is information as an instrument of deterrence. The fourth one is information as a generator of economic value, in addition to the value it has for national security.

In terms of utilization of existing information we are in an interesting position. When the Department of Energy downsized its production complex, Los Alamos National Laboratory inherited 25 million records about the weapons that had been built and are currently on alert. The challenge is that when you have 25 million of something it is almost as bad as having none of something. The government measures records in terms of cubic feet (I forget how many cubic feet we have). It almost gets to the point where you have a bulldozer pushing these records into a little corner and then someone asks, "Can I have the inspection data for this serial number part that was made in 1978?" Try to find it. Does it even exist? Can you read it? Is it on media you can deal with? Those are the challenges.

We also have data from 1,000 underground nuclear tests and some atmospheric tests. These data are irreplaceable since the United States is no longer conducting nuclear tests. We are not generating new information on the actual performance of weapons. This raises secondary questions of how we train new people who will never have the experience of doing nuclear tests.

The second aspect of knowledge, the generation of new knowledge relevant to nuclear weapons, includes filling in the gaps in our fundamental understanding of the physics of weapons. For a long time we used this design, test, produce mode. When you use that sequence you do not necessarily have to know everything there is to know about a subject. For example, if you are building automobiles you have to know, in general, how the metal behaves and so forth but you do not necessarily have to have the absolute best understanding at the atomic scale of how the fender is going to perform over time.

On the other hand if you are not permitted to do tests then the importance of that fundamental understanding increases tremendously. The whole basis behind the Department of Energy's Science-Based Stockpile Stewardship Program is that your confidence should go up as your knowledge goes up. The more you know the more confident you should be. So the generation of new and important information, new detailed data about things like plutonium and high explosives, is critically important to the future of the program. We are following the same kind of process that any scientific enterprise would use—a combination of theory, computation, and experiment. Computation now occupies that middle ground between theory and experiment. The role of large-scale computation has become considerably more important for us. The reason is very simple: If you cannot do a nuclear test, the only way to estimate the safety and reliability of a nuclear weapon is through very large-scale computations.

Los Alamos currently has the world's fastest computer at 1.608 tera-ops with a peak capability of three tera-ops. That is three trillion operations per second, with multi-terabytes of storage. These are gigantic machines. But they are not yet able to do first-principles calculations of what we need. They will be replaced in time by a ten tera-op machine at Livermore, a 30 at Los Alamos, and so forth. These machines open up tremendous scientific vistas. Some significant scientific challenges are associated with just using the data that come out of these machines.

Files that are multi-terabyte in size exceed the capability of a human being to absorb the data or information. You will not live long enough for your eye to absorb all of that information. So we need to look at how human beings interact with machines. It is a very interesting subject because until now almost the entire interaction has been on the machine's terms. That is, you learn how to use the machine and you type in commands or you click buttons or things and the machine tells you how to interact with it.

In the future we are not going to be able to do that. We are going to interact with the machine on human terms, using as many of our senses as possible. The machine is going to have to understand what we need and what we want. We may need to go as far afield as looking at art versus mere data management. For example a painting may not be as accurate as a photograph but it conveys the impression. High resolution is not the only thing required to learn what you need to from these very, very complex calculations.

The third aspect of knowledge is information as an instrument of deterrence and its role in defense. When the United States was conducting underground nuclear tests, perhaps one of the choicest assignments of foreign intelligence agencies was to go to Las Vegas, put a seismometer down, wait for the test, and watch the ground shake. It was clear to everybody that the United States was capable of producing significant yields in nuclear explosions.

We are not doing that now. So what is to prevent an adversary 15 years from now, after reading a series of articles in the *Washington Post* exposing how we are not taking care of America's strategic weapons and everything is turning sour, from taking his chance? How do we prevent him from doing that? We prevent him from doing that by projecting confidence in our abilities in as many areas as we can. We do that by publications and conferences. Having people from the weapons laboratories out in the community constitutes an element of risk from a security standpoint, but it is absolutely essential from a deterrence standpoint. If people from Los Alamos, Livermore, and Sandia are out there giving superb papers in science and engineering, hopefully the scientists in a (less-than-friendly) nation will go back and tell their leader about it. "These people are really good in what they tell us, and I can see the connection to nuclear defense. Perhaps they are also good on the other side of the fence." That is an important part of how we need to do our business in the future.

This idea also leaps over into conventional defense. A recent report questioned the utility of air strikes against Scud missile launchers in the Gulf War. Apparently Saddam Hussein set up a lot of fake launchers. They had crews and radio signatures that were associated with Scud launchers. The real ones never talked to anybody on the radio and were carefully hidden. Here the issue was not one of firepower. It does not take a very big explosion to destroy a missile. The critical issue was knowledge.

The fourth aspect of knowledge is the generation of information as an economic asset. There is enormous value to the Nation in the information resident at the Nuclear Weapons Laboratories. An illustration of that is the fact that a number of countries spend significant amounts of money trying to get that information. You can read about some of that in the newspapers. The knowledge is so valuable that when a problem is perceived it becomes an urgent national issue. The President becomes engaged and congressional committees become engaged.

But the laboratories do a number of other things, too, and these things generate economic value. We have always been on the forefront of a variety of diagnostic technologies and computing technologies. Economic value is generated by the activities of the laboratories and that must be protected as an investment of the taxpayers. We must also make sure that these advances benefit the United States rather than other countries. The reason for that is quite simple: American taxpayers supported it so American taxpayers should derive the value from it.

Knowledge is critical in maintaining the deterrence and keeping other governments confident that America's weapons will work if called upon to do so. It is important in how we structure our programs to add to our knowledge base in an ever resource-limited environment. And it is important in understanding how our activities create economic value for America.