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Ethics and Nuclear Weapons Research

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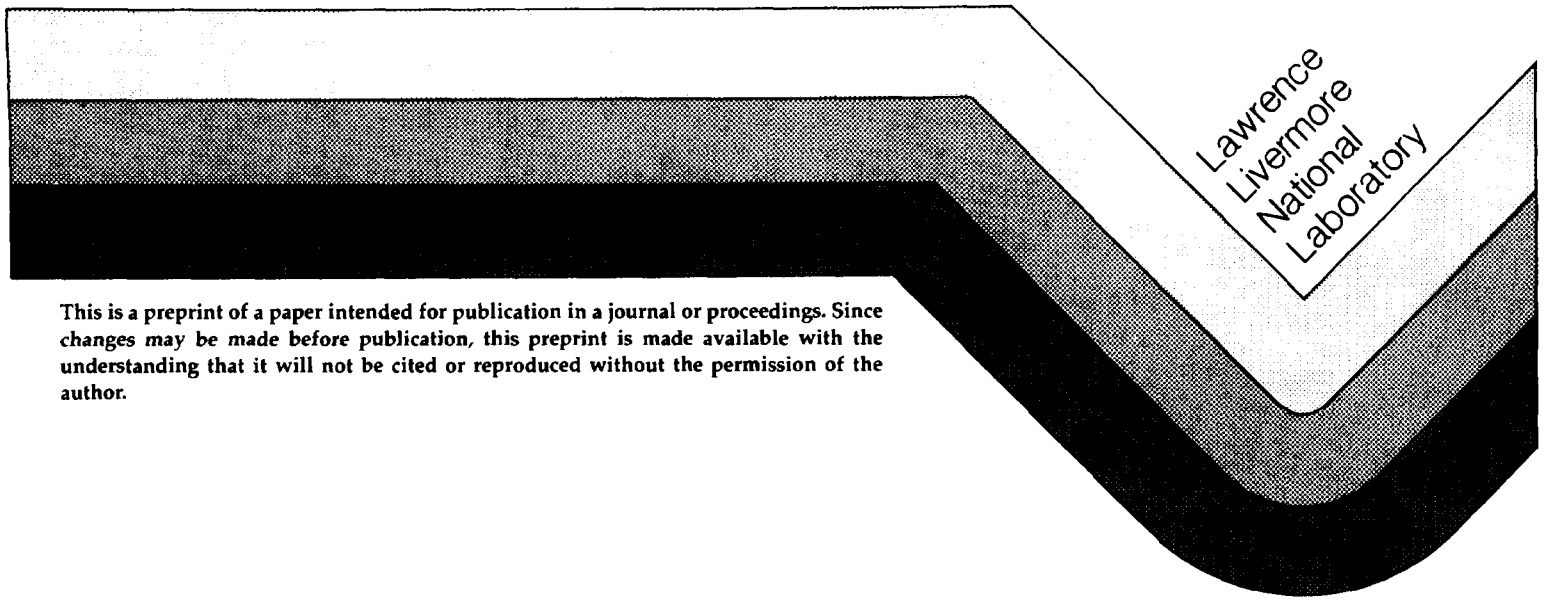

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Abstract

Nuclear weapons are the ultimate weapons. Hence, many believe that in the realm of military research and development, research on nuclear weapons represents the ultimate. Those of us involved in nuclear weapon research are frequently asked why we do what we do, rather than get involved in the more "peaceful" endeavors open to scientists and engineers. There is a variety of answers to this question.

Motivations for nuclear weapon research

Most weapon scientists with whom I associate pursue their careers as much out of a sense of doing something important for national security as having the opportunity to solve extremely complex physical problems. Our work is challenging and very large scale in nature. Working with first class facilities and first class colleagues, we are given tremendous responsibilities in assignments. And in the process of fulfilling our assigned responsibilities, we eventually realized that we had acquired an added responsibility—a responsibility for weapons which, if used, could affect the survival of civilization as we know it.

Nuclear weapon development involves multidisciplinary applied research. The theoretical and experimental problems are among the most intense in the field of science. Physicists work closely with material scientists, computer scientists, and engineers to translate concepts from mere ideas on paper to complex technological objects that can be manufactured, incorporated in a military system, and hopefully never used.

Weapon research and the national policy of deterrence

Why work on something that is never used? The answer is that nuclear weapons *are* used in a very direct way to implement the national policy of deterrence. There is a wide spectrum of views as to what deterrence really is. Deterrence means different things to different people, ranging from "minimum deterrence," to what some of us like to call "dynamic deterrence."

In minimum deterrence, the postulate is that the nation should maintain the minimum nuclear force capable of inflicting overwhelming harm on an aggressor who first attacks us with nuclear weapons. The threat of mutually assured destruction is sufficient to deter. Robert McNamara (1) described minimum deterrence very well when he said:

> The ultimate goal should be a state of mutual deterrence at the lowest force levels consistent with stability. . . . I know of no studies that point to what that number might be, but it surely would not exceed a few hundred, say five hundred at most.

Dynamic deterrence accounts for the constantly changing strategic relationship. The idea is to deter war, nuclear or conventional, at the minimum possible level of conflict. To accomplish this requires arms control and continuous modernization of our strategic arsenal, in order to respond to events that impinge on its effectiveness, hence, its deterrent value. Dynamic deterrence is stable deterrence. While seeking major reductions in strategic arms, we try to maximize the stable nature of what is left. That is where the weapon laboratories fit in.

We view the goal of our research as avoiding war, rather than preparing for war, with the ultimate goal being to avoid mutually assured destruction. The ethical consequences of our work should be viewed in light of this goal. Andrei Sakharov (2) was addressing this kind of deterrence when he said:

> . . .While nuclear weapons exist, it is also necessary to have strategic parity in relation to those variants of limited or regional nuclear warfare which a potential enemy could impose; i.e., it is really necessary to examine in detail the various scenarios for both conventional and nuclear war and to analyze the various contingencies.

Each passing year without a major war between the superpowers adds to the evidence that deterrence is working. This is most reassuring to those of us who work to promote the viability of the nation's deterrent.

Ethical implications of nuclear weapon research

Do we, as weapon scientists, think about the implications of what we do? Very much so. It would be difficult to avoid such thoughts in the face of the continuing pressures against weapon research that resumed in a very intense way with the nuclear freeze movement in the 1980's. My own thoughts become focused each time I pass through the barriers of demonstrators that periodically parade in front of the laboratory gates. Rather than dissuading me and my fellow researchers from continuing to do what we do, I believe the demonstrators cause us to consider the ethics more thoroughly. The result reinforces personal convictions of what our job is all about. In this sense, I believe the demonstrations are a good thing.

The true majority in the country are those who have voted in the national elections, expressing wishes for a strong national defense at the ballot box. The demonstrators actually represent a small minority, whose numbers have been declining over the years. Over 1200 out of 3000 were arrested at a Livermore Laboratory demonstration in 1982, although today we rarely see even 100 show up at the front gate. The issue is more complicated than wanting peace through strength. Director of the Center for Science and International Affairs at Harvard University and noted expert on strategic and nuclear issues, Joseph Nye (3) has remarked that the American public wants peace *and* strength, hence, the largely centrist positions that have evolved in political campaigns and in the U.S. Congress. If the

weapon laboratories represent anybody or anything in the country, I believe it is the largely centrist position that exists within the government. However, in truth, this is more of a populist than an ethical justification for nuclear weapons.

I believe that we as weapon scientists think a lot more about the policy issues than most people in the general public. After all, these issues are part of everything we do. We constantly reason, question, and debate. Being human, it is natural for us to react to questions about the morality of our work. Those who watch demonstrators on television can resume their activities where they left off. We go behind the gates and continue to think about the implications of our work.

What concerns me most about the demonstrators is one of their common assumptions about our motives, upon which Joseph Nye (4) has elaborated:

> Some who oppose nuclear deterrence discount the views of those who defend it as corrupted by 'the disease of nuclearism.' Instead of meeting their opponents' arguments, they make up a theory about their opponents' motives. They try to shrink their opponents' stature rather than refute their arguments. When they do that, they are involved in political caricature, not in moral reasoning. Without a degree of humility and charity, we are condemned to shouting such caricatures at each other, and the illumination of moral reasoning is snuffed out.

How do ethics enter into what we do? Ethics play a role in two general ways. First, we must do our research in an ethical manner. Ethical behavior is expected of all professionals, whether they be scientists or people involved in some other endeavor. There is, however, a difference for scientists who do weapons work because of the existence of bureaucratic and political pressures that are lacking in other fields. Second, ethics enter into our work in a consequential way. What are the consequences of the weapons we develop? Is it ethical to be doing the work in the first place, considering the terrible consequences if these weapons are ever used? Conversely, what are the consequences of not doing the research; i.e., why is the work important? I will discuss these two general subjects in turn.

Doing weapon research in an ethical manner

The influence of the weapons laboratories

Over the years, as critics have charged that the weapon laboratories exercise undue influence in pushing and selling their programs, serious questions of ethics have been raised. In point of fact, the Congress has chartered the laboratories very specifically each year in the Defense Authorization Act, to "explore and provide new technologies necessary to maintain U.S. nuclear deterrent forces. . ." and to conduct ". . . research on the feasibility of innovative applications of nuclear technology that may eventually be important." An extremely important part of this task is to communicate to the government what can be achieved; this process of communication is what many refer to as "influence."

I once heard a statement on the topic of the laboratories' influence that I feel puts the issue into perspective. Bryan Hehir, a Catholic priest, was a key architect of the American Bishop's Pastoral letter on war and peace (5). In that letter, the bishops gave a conditional, interim acceptance to nuclear deterrence. In February 1985, Father Hehir was invited to speak at a colloquium sponsored by the bishop of the Oakland Diocese, the second in a series of dialogs on nuclear weapons issues. I will say more about these colloquia later. In response to a question about the weapons laboratories' role in pushing technology and their impact on dominating policy, Father Hehir stated (5):

> It seems to me the weapons laboratories are going to do what they are designed to do. They're going to be totally involved in this process. They're going to put forward a whole series of propositions. They're going to try to push forward the frontiers of scientific research and they're almost inevitably going to push for technological transition. I'm not against people doing what they are designed to do. What I'm in favor of is political figures doing what they're designed to do. Which is to say, they ought to listen intently to what scientists and technological institutions propose and then they ought to decide on other grounds than the purely scientific or technological grounds what ought to be done. So, in my sense, I'm sure the weapon laboratories do drive the dynamics but I'm not positive I am arguing that they ought not to do it. I'm arguing that other people ought to do other things. . . .

In a recent lecture at Stanford University on the future of the nuclear debate, Father Hehir was asked whether people working on weapons should be persuaded to work on arms control and peace-related efforts. Hehir responded that the most important goal is to avoid nuclear war, and this requires proper strategic balance. He said it is just as important to have excellent people work on sensible strategic improvements aimed at improving stability, as it is to have excellent people work on arms control and peace initiatives. He said the Nation must do both.

Weapon scientists have a responsibility that goes beyond exploring new technologies. Advances in weaponry pose tremendous technological challenges and also introduce instabilities into the strategic relationship; multiple independently targetable reentry vehicles (MIRVs) are an example. It behooves us as scientists to do our best in working on a new technology, but we must also speak out on what is wrong with a technology, particularly when its implementation is apt to introduce serious instabilities. We indeed have been speaking out much more in recent years; some examples follow.

Technical objectivity as an expression of ethical behavior

The nuclear weapon laboratories have a broad set of technical missions. We primarily exist to do research and development on nuclear weapons. Our specific missions are to maintain the reliability of the existing stockpile of nuclear weapons; to modernize weapons for improved safety, security, survivability, and military effectiveness; and to maintain the high level of expertise necessary to

accomplish these other missions. We also work to determine what is possible for our potential adversaries in nuclear weapon technology. And we work to support national objectives in arms control. In fact, arms control is an integral part of everything we do, because the same expertise that is used to develop weapons is directly applicable to their control.

While our programmatic work is assigned by the Federal Government, which must be satisfied, as individual scientists we strive to maintain technical objectivity in carrying out that work. I believe we have been largely successful in accomplishing this, although as in any field, there is room for improvement. The facts that we are managed by the University of California (UC) and are University employees provide an environment that encourages technical excellence and freedom from political and bureaucratic pressures. University management provides an atmosphere where debate is possible and where intellectual reasoning is dominant. In a different atmosphere, such as government or industry, there would be less enlightened and independent-minded research, which could lead to cruder and more dangerous weapons or the pursuit of poorly conceived concepts.

The following example shows how the existing environment has served to bring reason into the strategic debate. In 1982, President Reagan set up a commission led by Prof. Charles M. Townes, a Nobel Prize winner in physics from UC Berkeley, to evaluate basing options for the MX (Peacekeeper) missile. The commission sought input from a variety of sources, including weapon systems analysts from LLNL. Livermore scientists had been studying various basing options for the MX and had concluded that all suggested basing schemes were flawed. The fact that such criticisms came from LLNL was somewhat ironic, because LLNL had also been assigned the task of developing the nuclear warhead for the MX. While the right hand was developing the weapon, the left hand was showing what was wrong with the overall system.

About the Livermore contributions to his commission's efforts, Dr. Townes (6) wrote to University President David S. Saxon:

> . . . It was clear that most of the industrial organizations were quite cautious about giving information or making conclusions which would be contrary to Pentagon policy. I was personally impressed that the many persons who helped us from Livermore seemed completely objective in examining the technical facts, in investigating what needed to be looked into, in looking for weaknesses as well as strengths in current proposals, and in being willing to state plainly, though diplomatically, where they did not agree. In most cases, I found individuals from academia also objective, though generally by no means so deeply knowledgeable.
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> I make the above point because I think, contrary to some opinions, Laboratory personnel are often important in giving helpful perspective and ameliorating U.S. nuclear policy, and that this is partly because they are protected by the

management structure from obvious pressures to which commercial companies or governmental laboratories are subjected. . . .

While the Townes Commission study took place seven years ago, the intercontinental ballistic missile (ICBM) basing debate goes on. The Winter 1988 issue of *International Security* contains an article (7) about rail basing of the MX missile. The authors—John Harvey, a LLNL physicist, and Barry Fridling, recently an arms control research intern at LLNL and jointly a MacArthur fellow at Harvard's John F. Kennedy School of Government—addressed the technical problems of rail basing. They identified a fundamental problem with the concept: its survivability depends on strategic warning, something which our nation has historically failed to recognize. While the article ran counter to Administration policy at the time, it did so with technical objectivity.

Another example in which Laboratory personnel have come to scientific conclusions independent of external policy considerations has to do with whether the Soviets are in compliance with the Threshold Test Ban Treaty (TTBT). The TTBT, negotiated and signed by the U.S. and U.S.S.R. in 1974, limits the yields of underground explosions to 150 kilotons (kt). Although the treaty has yet to be ratified, since 1976 both parties have agreed to observe its conditions. Monitoring compliance with the treaty is done by teleseismic means. Each country maintains seismometers on its own soil to measure the long-range seismic signals produced by nuclear explosions on the territory of the other country. There are large uncertainties in seismic monitoring of Soviet nuclear test yields (and, conversely, of U.S. test yields), and the Reagan administration has claimed the Soviets are in likely violation of the treaty. Yet, LLNL verification experts have concluded that the Soviets have been observing a yield limit, and that this limit is consistent with TTBT compliance, although a few tests might have exceeded the limit. We have stated our results publicly, have reported them in testimony by the LLNL director (8) and other scientific staff members (9) to the U.S. Congress, and have had a significant impact on the U.S. policy debate.

On the other hand, our stance on the TTBT has had its repercussions. In 1983, Roy Woodruff, then Associate Director in charge of the nuclear weapon design program, and Bill Scanlin, Woodruff's deputy, were interviewed by a reporter from the *Washington Post*. Woodruff and Scanlin expressed several views: they favored the 150-kt TTBT limit; the monitoring evidence because of its uncertainties failed to prove or disprove Soviet violations of the TTBT limit; and even if the Soviets had violated the limit, the small variances above 150 kt would not have given them any military advantage in weapons building. Woodruff reports that at 5:30 a.m. California time, he was awakened by a phone call from the Secretary of Energy asking how he dared oppose Administration policy on this matter. Roy reminded the Secretary that he worked for the University of California and *not* the Administration, and that he had every right to speak his own mind on the issues. Roy reports that the Secretary apologized and immediately invited him back to Washington to discuss the issues, and that those discussions were productive.

There are other examples. LLNL has analyzed the systems requirements for deployments of the Strategic Defense Initiative (SDI). These analyses have often provided a less optimistic basis for projecting what might be accomplished by potential SDI deployments than has been projected by other system analysts or by certain ardent proponents of SDI (both inside and outside LLNL). A good example of this is the recent study of early SDI deployments using space-based rockets. LLNL analyses show that while such early deployments may provide an effective defense against the current Soviet missile threat, ten times as many rockets would be required to defend against a modernized Soviet force. LLNL analyses also show that the Soviets could implement cost-effective countermeasures to the proposed early deployments over the same time frame as those deployments. In April 1987, George Miller, then head of the LLNL weapons program, reported on these analyses in testimony to the U.S. Senate (10).

Regarding the feasibility of SDI in general, at LLNL there is a wide spectrum of views as to what might be achieved. The national consensus seems to be that there should be a healthy research program. However, achieving extremely effective defenses has been described by one of my colleagues as something to be viewed with "healthy skepticism." With a few exceptions, virtually all LLNL technical staff members I speak to, including the senior program managers, believe that research should be done within the limits of the ABM Treaty. Nearly all the individuals I know are very supportive of the Treaty, that is, the traditional interpretation of the Treaty. All these views have been held in the face of unquestioning support for SDI by the Reagan Administration in Washington.

Some people nationwide and at the laboratories firmly believe in the promise of defensive systems. They view SDI as leading to weapon systems that are far preferable to those which we now rely upon for offensive retaliation against a potential enemy. They argue that it is more moral to build defensive weapons than offensive weapons. It is difficult to refute such an argument. A broader view on this issue was recently expressed by the American Catholic Bishops in a later Pastoral letter (11), which reviewed the progress made since the first letter (5). The bishops stated that the moral character of SDI must be judged more on its consequences than on its intent. Indeed, the concerns expressed by our scientists about SDI do address the consequences of that program.

The above examples of independent thought and action typify the technical objectivity that exists among the scientists at the weapon laboratories. This technical objectivity has often run counter to bureaucratic pressures in the Government but is squarely consistent with proper professional ethics. For the most part, we have tried to do what is technically correct, rather than what is politically expedient.

Room for dissenting views

Technical objectivity and professional ethics in any research establishment demand room for dissenting views. As expected, some scientists at the laboratories do question whether technical objectivity exists across the board. At LLNL, for example, a few physicists have been openly critical of

how the laboratories do their business. They believe the laboratories have been overly aggressive in pushing technical programs at the expense of technical objectivity. Specifically, they are highly critical of the approach to designing weapons. Among other things, they state that the weapons designed for the stockpile should have been more conservatively designed with a comprehensive test ban (CTB) in mind and that the laboratories have used their influence to fight a CTB, intentionally developing weapons requiring further nuclear tests to keep them reliable. They infer that the laboratories do this just to stay in business and say that the laboratories have placed obstacles in the way of achieving a CTB and other arms control measures, and are only interested in developing exotic new weapons like those for SDI.

In 1987, six Congressmen asked the director of LLNL to make Ray Kidder, one of the scientist-critics, available to do a study (12) on stockpile reliability, and the director agreed. The weapons program provided Kidder with the information he requested to do his study. A corresponding study (13) was simultaneously done under the direction of the head of the LLNL weapons program. I believe this was the first time that an internal critic has been asked to do such a study; the fact that it happened illustrates the latitude that exists for freedom of expression of alternate points of view.

Although the dissenting scientists have exerted a lot of leverage on the debate, I disagree with what they have been saying. I believe the fact that they are free to express their ideas—and to criticize—is a healthy situation made possible by the University management of the laboratories.

Sometimes, the sacrifices are quite high

There have been news stories about disputes between Roy Woodruff and the LLNL management concerning overly optimistic x-ray laser assessments made by Edward Teller and Lowell Wood to high-level policy makers. Roy resigned his position three years ago because of that dispute. A key issue then was who had the right to represent a Laboratory program — in this case a program that Roy was in charge of. Roy wanted to write letters to the same policy makers to present his and the program's views about the technical possibilities; but he was told by his management (14) that they preferred he not write those letters and instead brief the policy makers in person. Roy disagreed with the management decision and resigned his position.

Roy set his principles high. In doing so, he put his extremely promising career in jeopardy. What we are dealing with here is more than a question of who was right or wrong about the technical assessments. There always have been disagreements among scientists in the past and there always will be some in the future. What concerned Roy was how the assessments got carried forward and influenced the policy debate. I believe he was right to be concerned.

Now, some critics have used this example to discredit the x-ray laser research program. It is important to note, however, that Woodruff has been a strong supporter of the x-ray laser research at LLNL and has stated so publicly. The critics of a program will always use to their advantage

whatever publicity is available. That is a risk of being technically objective. However, I believe it is a risk we must accept.

The ethics of doing nuclear weapon research at all

Having discussed doing weapon research in an ethical manner, I now return to the question of why do it at all. Nuclear weapons are not unique when it comes to ethical considerations of weaponry and war. The debate about what is "just warfare" has gone on for centuries. Nuclear weapons do add a new dimension to the problem, considering the threat they pose for the survival of civilization. War can no longer be restricted to direct combatants, because innocent civilian populations are now vulnerable to annihilation.

How do we in the weapon laboratories justify the role we play in developing weapons which have such dire consequences for civilization? Our laboratory has over 8000 employees, who would probably give 8000 different answers to this question. I'll give you my view, which I believe is fairly well shared by many of my colleagues.

Some scientists believe in the technological fix almost as a religion. Fortunately, I have found few such scientists at LLNL. Perhaps we who appreciate the limits of technology are less willing to put complete faith in what it can do. Take SDI as an example. From the surveys and polls I have seen, it appears the general public is much more optimistic about SDI than those in the scientific community, including those of us in the weapon laboratories, as borne out by the examples already given.

We also realize the limitations of nuclear weapons. Because they exist to deter, their use implies failure of other political and military approaches. I personally believe that the solutions to today's problems will have to be political and social. The role of technology is to help us to survive until we achieve the necessary political and social solutions, to "buy time" as one of my close colleagues puts it.

In his book, Joseph Nye (4) discusses the moral pros and cons of nuclear deterrence. He endorses the morality of a nuclear deterrence that properly accounts for the risks of various policies and their alternatives. In addressing the "means" of deterrence, he says (4):

> . . . if there is absolutely no possibility of the use of nuclear weapons, or if that is believed to be the case, they will have no deterrent effects. Thus deterrence depends on some prospect of use, and use involves some risk that just war limits will not be observed.

The weapon laboratories work to develop the means of deterrence, to improve it constantly, and to help minimize the risks associated with deterrence policy. Although many accuse the weapon laboratories of fostering a war-fighting mentality, we strongly believe that developing survivable, safe, secure, and effective weapons enhances the means of deterrence and reduces the risk of war. Perhaps it is

developing weapons that are "effective" against "real" targets that causes the most concern about warfighting. It is good to keep in mind what Nye (4) has said in this regard:

> Thus credible targeting seems necessary for deterrence. Yet the effort to identify credible military targets has raised a heated debate over the legitimacy of planning for 'war-fighting' as opposed to nuclear deterrence. In one sense this debate is spurious, for some planning for the delivery of nuclear weapons against military targets is both planning for 'war-fighting' and a necessary means of deterrence.

The work of weapon scientists supports the dynamic deterrence concept described earlier, and is vital to that form of deterrence. I believe the consequences of not doing the kind of work we do would be greater instability in the world and a weakening of a policy that has worked for 43 years.

The weapon laboratories have become very involved in arms control activities over the past few years, and our involvement is growing. The same knowledge that is used to develop nuclear weapons can be applied to their control. Arms control is an integral part of everything the laboratories do. Arms control also has helped the weapon laboratories by providing an endeavor that is more acceptable to those who criticize the weapon development activities.

Arms control is just one political process that can help us reach a better world. Arms control can serve a variety of purposes, such as increasing stability, saving money on expensive weapon systems, reducing the damage that might occur in war, lessening the threat each side poses to the other side, and reducing the risk of accidental war. It has done all of these things with varying degrees of success, as well as something even more important. As a political process, arms control gets the two sides talking to each other, working together to reduce tensions and build a better relationship. We are at a very good time in the history of arms control, with much progress over the past year and more to be made when arms control negotiations resume in 1989.

Getting ethics into the weapons debate

While we can justify to ourselves the ethics of our work, some people still question those ethics. When I hear them question our motives, I feel compelled to communicate with the questioners and convince them of the importance of our work, as well as of its ethics. I believe that my goals and the goals of the questioners are really the same; we simply have different approaches to solving the problem. Michael M. May, a recently retired Associate Director at LLNL, said it very well in an editorial piece (15):

> Wittingly or not, the demonstrators are doing much the same thing as the U.S. government does in maintaining a nuclear deterrent: putting on a show of war to avoid a much worse war. Of course, the stakes are different. But the range of

> feelings and the range of attitudes are not so different. The relation of either activity to peacemaking is the same.

Because we are concerned, we communicate. The fact that I am standing here today, is part of that communication. I believe continuing the dialog on these issues is one of the most important things that we can do.

The Bishop's Colloquia on the Ethics of Deterrence

As I mentioned earlier, the American Bishop's Pastoral letter on war and peace (5) has sparked an ongoing dialog between members of LLNL, the University of California (UC) and the Bay Area religious community. The dialog started four years ago when several LLNL scientists who are Catholics were speaking with John Cummins, the Bishop of the Oakland Diocese, about the Bishops' Pastoral letter (5). They pointed out that there were two nuclear weapon laboratories (LLNL and Sandia), a large university, and a major theological seminary in the diocese. They convinced the bishop it would be very valuable to have a dialog on the issues raised by the Pastoral letter. The bishop funded the colloquia at first, and a few years ago the UC Institute on Global Conflict and Cooperation began funding these events. This dialog seems to be taking the advice that Nye stated (5):

> All too often moralists and strategists tend to talk past each other as though they lived in separate cultures of warriors and victims rather than fellow citizens of a democracy. The moralists formulate fine principles that seem to the strategists about as relevant to foreign policy as a belief in the tooth fairy is to the practice of dentistry. The strategists, on the other hand, tend to live in an esoteric world of abstract calculations and a belief in a mystical religion called deterrence, which is invoked to justify whatever is convenient. Strategists would do well to realize that there are no experts, only specialists, on the subject of nuclear war, and to listen more carefully to the moralists' criticisms. At the same time, philosophers and moralists would do well to pay more heed to the strategists' arguments and to realize that they will need to work with more realistic assumptions if they wish to be effective in a dialogue between ethics and strategy.

The Colloquia have had a host of distinguished speakers from diverse backgrounds, including defense policy, defense research, political science, pacifism, ethical philosophy, and religion. Considerable interchange has resulted between the speakers and the participants, and between the participants themselves. Although at first we frequently talked past one another, now we are beginning to communicate. I believe that our most important achievements are listening to each other's concerns and thoughts and gaining an appreciation for the perspective of others.

Initially, there was concern that sparks would fly at a meeting of such a seemingly disparate group of individuals. This has yet to happen. Our success, in part, may be due to the fact that the press is

excluded in order to remove barriers to open expression and to avoid grandstanding by those who might be so inclined. The seventh colloquium, held last month at LLNL, was attended by almost 100 people. In his welcoming speech, Michael May captured the spirit of the colloquia by stating, "We have all come here to worry about nuclear weapons together."

The Colloquia have addressed a broad variety of subjects: the Bishop's Pastoral letter and its intent; the future of nuclear deterrence; alternatives to deterrence; whether the Pastoral letter did too little, was about right, or went too far; deterrence in the next ten years; nuclear testing and how it relates to the mission of the laboratories; and most recently, the ethics of deterrence.

When we began the Colloquia, we tended to be suspicious of one another's motives—to talk past one another. It takes time to build an atmosphere of trust, and I believe we are succeeding. I have found the planning committee meetings to be especially valuable in this regard, perhaps because these meetings are smaller and more private. Now, for the Colloquia as a whole, we are finding that the dialog is getting more precise. That is, people get many more direct answers to the questions they ask; indeed, some of the tough questions strike right at the heart of the matter. I would like to see our policy makers exposed to such a dialog. The experience might make very little difference, but at least they would have the information to think of their decisions in a different context.

Getting More Ethics into the Policy-Making Process

The question remains as to how we might instill more ethics into the policy making process. At a recent seminar at Stanford, Father Hehir was asked whether the debate about ethics could make a difference. He replied that in order for the debate to have an effect, people like himself would have to continue to push, would have to make themselves "more convincing," and he intended to keep pushing. He said that people generally perceive the role of ethics in one of four ways: ethics is superfluous, it is decisive, it is corruptive, or it is complementary. I believe that ethics should play a complementary role to sensible strategic planning, which itself should be based on an ethical policy.

I believe that ethics will play an ever greater role in the nuclear debate in the future. As weapon scientists, we will continue to have the task of designing the hardware that forms the means of deterrence. While we will do the best technical job possible in developing that means, we must continue to say what is wrong or destabilizing about that means.

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