Wolfgang K. H. Panofsky

Between physics and politics – observations and experiences of an involved physicist

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Wolfgang K. H. Panofsky

BETWEEN PHYSICS AND POLITICS — OBSERVATIONS AND EXPERIENCES OF AN INVOLVED PHYSICIST

Before politics

Ich bin ein Hamburger. My father with whose work you are well acquainted left Berlin for Hamburg a few months after I was born. My father taught at this University from 1919 to 1934 and established the Kunstgeschichtliches Seminar. I received my school education here until age 15. At that time, before I graduated from the Gelehrtenschule des Johanneum, my family was forced to leave, and we settled in the United States. I studied physics with many experimental opportunities at Princeton University and then at the California Institute of Technology where I received my doctorate degree in 1942. By that time World War II overtook most activities in basic science and I, like most other American physicists, became involved in war work. At Caltech, I worked on shockwave measurements from supersonic projectiles, but then it was agreed that I would assist the nuclear weapons program at Los Alamos in adapting the technology of shockwave measurements to determine the explosive power of the nuclear weapons when tested or used. The devices incorporated a condenser microphone directly controlling the frequency of a radio transmitter. I participated in the Trinity test, flying over the first nuclear explosion at Alamogordo, New Mexico. Similar to most young participants in the wartime nuclear weapons program, I initially entertained no fundamental reflections on the implication of my involvement. Forty-five million people died in World War II and ending the war seemed an overriding priority at the time.

After the end of the war, I moved to the University of California at Berkeley to help build the proton linear accelerator at that institution and I carried out numerous experiments including those on the fundamental properties of pi-mesons. Since then, my physics activities have concentrated on accelerator design and construction and using accelerators for experiments in elementary particles physics. Our colleagues here at DESY are fully familiar with the subsequent developments at Stanford University on linear accelerators followed by the establishment of SLAC, the sister institution of DESY.

Politics in physics versus physics in politics

Securing support for SLAC and later assuming responsibility for its operation and research indeed involved many activities 'between physics and politics.' However, the discussion to follow will focus on those interactions which relate to the input of physics to politics in general, and to national security in particular, not to the support of physics by governmental agencies.

While during my war work I paid little attention to the long range implications of the new technologies, this changed with the end of the conflict. The message imparted to me through the work during the war induced me to maintain not only an interest in military technology but also to become actively involved in moderating the consequences of the new dramatic technical developments. Initially, I gave public presentations to persuade lay audiences that nuclear weapons are drastically different from other means of warfare; indeed they can increase the destructive power which can be carried by munitions of a given size and weight by factors of over a million; and the effects, if nuclear weapons are used, can be long-lasting. It has been difficult, particularly in recent times, for political leaders and citizens to comprehend the enormous consequences of these physical facts. When numbers describing performance increase by a large enough amount, they imply qualitative changes.

Because fortunately, nuclear weapons have not been used for over 60 years in combat since two ‘small’ nuclear weapons killed a quarter of a million people in Hiroshima and Nagasaki, the present generation of policy makers tends to treat nuclear weapons as symbols of political strength or as components of national prestige. Thus the awesome physical reality tends to be submerged in policy deliberations, and this is a danger in itself. Communicating the consequences of the physical reality of nuclear weapons is a responsibility which I have attempted to undertake ever since. Thus I became a ‘double hatted’ individual: pursuing basic physics while interacting with the political leadership in the United States and getting involved in discussions with representatives of other countries.

Offense versus defense in the nuclear age

My first such experience was in a committee of the Scientific Advisory Board of the U.S. Air Force dealing with the vulnerability of the United States to nuclear weapons. That experience led to my conviction that the balance between offense and defense in the nuclear age has changed drastically: since a single nuclear weapon can kill on the order of one million people when detonated in a metropolitan area, an active defense must achieve almost 100 % intercept to be effective. In more quantitative terms, if defenses are deployed at a certain cost in order to decrease the vulnerability of a country or some of its installations, then the offense can in almost all cases augment its power at a cost much less than that of the defense and leave the vulnerability just as high. In other words, in the nuclear age, defenses will generally escalate the levels of armaments without decreasing the real vulnerability of society. This general conclusion, which can of course be supported by detailed analysis for specific weapons systems, is difficult to convey to policy makers, and the issue of offense versus defense continues to resurface over and over again. I have often introduced the technical realities of the offense-defense situation into high-level discussions, including in Congressional testimony.

Nuclear weapons testing

Then came the effort to stop nuclear weapons testing, an effort strongly supported by President Eisenhower. The President had the idealistic concept that scientific discussion and political discussions could be separated in the international discourse. This implied that scientists who were citizens of countries of adversary interest could get together and reach objective conclusions which could then lay the foundation of subsequent political negotiations. This basic concept led to the "Conference of Experts" in 1958, followed by two Technical Working Groups; the participants in these negotiations were physical scientists from the two countries charged with establishing the principles to underlie a control system designed to verify a negotiated cessation of nuclear weapons tests. I participated in the two technical Working Groups, including serving as chair of the group charged with examining the possibilities of monitoring nuclear weapons tests conducted in outer space.

These negotiations demonstrated that the idealistic concept of separating physics and politics did not work in the real world. While the charge to the Technical Working Groups did not include the design of a control system, the implications were clear: the Soviet interest was to make it appear that verification of a nuclear test cessation treaty would be easy because in that case, the intrusiveness of a potential inspection system would be less. As a result, the disagreements between Soviet and American scientists were always in the same direction, reflecting the political interests of their respective governments.

We were able to break this bias at times but it kept resurfacing throughout the negotiations. Nevertheless agreement on final reports was reached resulting from these negotiations among scientists.

Science input to security policy

Subsequent to this ‘baptism of fire’ into the political implications of technical reality, I participated in the national security work of the President’s Science Advisory Committee which was established through Eisenhower’s initiative. In that role, the Committee had frequent occasion to dampen projected military ‘requirements’ in moderating the excessive projections as to what technological developments could do in the military sphere. In fact, this experience made it clear that scientific advice to the highest levels of government is absolutely essential if excesses and outright mistakes are to be avoided which would be the case if scientific advice was filtered through the objectives of lower-level governmental departments. I am greatly honored to participate in the opening of the Carl Friedrich von Weizsäcker Center for Science and Peace Research, and I hope that this Center will be instrumental in generating scientific input related to International Security to the highest levels of policy makers.

Notwithstanding the demonstrated usefulness of scientific advice at the highest governmental level on matters of military security, the voice of Science in reaching the top decision makers has been progressively muted over subsequent American administrations; the extent to which such scientific input can be available to policy makers in other countries is highly variable. It is essential that such communication be strengthened and that channels be open and unbiased in reaching the highest levels. A younger generation of independent scientists must become acquainted and experienced in matters of national security in order to make such communication credible. Towards that end I joined in the work of the JASON group whose membership is recruited from academics who are willing to work on national security issues interspersed with their regular academic activities, and which continues to acquire younger participants. JASON has been highly successful in diversifying its interests by attracting biological weapon talent and in inspiring a younger generation of members.

I played a leading role in establishing and working with the Committee on International Security and Arms Control of the U.S. National Academy of Sciences. That standing committee of the Academy is composed of natural and social scientists and retired military officers. It forms a bridge to similar bodies of other countries, even during the depths of the Cold War and other periods of tension.

Nuclear weapons: dangers and control

Let me now reflect on how these past experiences relate to some of the current threats posed by nuclear weapons. Throughout the Cold war, nuclear weapons served primarily to deter direct armed conflict between the Soviet Union and the United States and in retrospect they probably succeeded in doing so. However, deterrence had a large variety of interpretations. In general, deterrence implies to hold those assets of the opponent at risk which he values to a degree sufficient to persuade him that initiation of hostilities followed by retaliation would result in an unacceptable loss. But what is to be held at risk? And what is to be done if deterrence fails? Since these two questions do not have clear answers, successive political leaders both in the United States and the Soviet Union diversified the missions which nuclear weapons were to accomplish.

Immediately after World War II, the United States' military leaders deployed nuclear weapons mainly for punitive extensive anti-population attacks, while scientists advised to pursue more limited objectives. Over time these positions reversed. Some military leaders maintained that 'nuclear war fighting' at a variety of levels of nuclear violence would be possible, and that if war broke out, the West should prevail in a protracted nuclear exchange. In turn, most scientists advised that such a course would lead to escalation with devastating results and that 'finite' or even 'minimum' deterrence without anticipating actual military use of nuclear weapons would be a prudent approach. At the same time, most military doctrines supported 'extended deterrence,' that is, not only deterring a nuclear attack by others but also using nuclear weapons to deter a variety of non-nuclear aggressive moves. In particular, American and NATO doctrine largely promoted the role of nuclear weapons in compensating for the perceived inferiority of NATO conventional forces during the Cold War in Europe, thereby using nuclear weapons to deter conventional aggression by the Soviet Union. As a remnant of that policy about 500 United States nuclear weapons are still based on aircraft in Europe today, principally in Germany. This makes the U. S. the only nuclear weapons state known to base nuclear weapons abroad.

These ambiguities or varieties of deterrence concepts when translated into military requirements led both the Soviet Union and the United States to what I consider an insane build-up of nuclear weapons which peaked at a total of about 70,000 weapons during the Cold War. That number has now shrunk to somewhat below 30,000 warheads – still a vastly excessive and dangerous number; a substantial number of nuclear weapons remain on 'hair trigger' alert, increasing the risk of a nuclear release through failure of correct communication and control. This build-up was counteracted by negotiated arms control efforts in which I extensively participated, but which are now being deemphasized and replaced by more limited arrangements. The latest such agreement is the Moscow Treaty of May 2002 signed by the United States and Russia. That Treaty has little substance; there are no verification provisions; it is limited only to operationally deployed strategic warheads which constitute only a minority of the nuclear warheads owned by Russia and the U. S. Moreover, the Treaty has no time-table for its implementation; the planned reductions must be reached only at the date of expiration, the year 2012, of the Treaty. The agreed limitations in the previous Treaty, START II, have been abandoned and the U. S. has withdrawn from the Anti-Ballistic Missile Treaty. So the Arms Control Process is in urgent need of revival and strengthening.

The mission of nuclear weapons after the Cold War

But now the Cold War is over and we must squarely face the question "what are nuclear weapons for?" Nuclear dangers remain in several categories distinct from those faced during the Cold War. First, there is the danger that release of nuclear weapons might be triggered by erroneous information or miscalculation or because of lack of control. Then there is the danger that nuclear weapons might be deliberately used in regional conflict such as that between Pakistan and India. Third, there is the risk that nuclear weapons or the material to make them fall into the hands of non-state actors which might then lead to a terrorist detonation of one or a small number of nuclear weapons in a populated area. And then finally, there is the risk of nuclear proliferation which if it became more extensive might prove uncontrollable.

The United States and the other states possessing nuclear weapons have, in my view, failed to critically reexamine the mission of nuclear weapons responding to these vastly changed circumstances. The nuclear weapons states are facing many issues in managing their nuclear arsenals. I have participated in the recent debates in the United States on the technical factors relating to using nuclear weapons to attack underground targets, on the best way to maintain a reliable and safe, but aging, stockpile and on infrastructure and personnel issues affecting the nuclear weapons program. But addressing such issues would be enormously eased if a clear and restricted mission for nuclear weapons were agreed on.

Notwithstanding the convoluted arguments in the nuclear posture reviews and other documents promulgated by the United States, the nuclear weapons stockpiles as now deployed, while diminished, are still in essence a heritage of the Cold War. The effort to stem the proliferation of nuclear weapons that is enshrined in the nuclear Nonproliferation Treaty (NPT) which came into force in 1970, and was changed to an agreement of indefinite duration in 1995, is now under severe stress. The NPT was intended to be a balanced bargain between nuclear weapons states and non-nuclear weapons states: the non-nuclear weapons states are obligated not to acquire nuclear weapons and the nuclear weapons states are required not to transfer such weapons or the means to make them to non-nuclear weapons states. To balance this discriminatory aspect of the Treaty, non-nuclear weapons states are given the inalienable right to develop nuclear energy for peaceful purposes, and at the same time, nuclear weapons states must in good faith pursue steps to reduce and eliminate nuclear weapons. While no time scale is provided towards this end, the Treaty clearly requires the de-emphasis of nuclear weapons in international relations.

In addressing 'between physics and politics,' we must be reminded that stemming the spread of new technical achievements which might serve destructive purposes over the entire globe has never succeeded in the past of human history. Thus, successful measures to prevent proliferation cannot follow traditional political lines. A system designed to preserve indefinitely a division among the world's nations between the haves and have-nots in respect to nuclear weapons cannot endure for long. Nuclear weapons are the 'great equalizer' between the now most powerful nations and the lesser states. Thus the leading nations should have the strongest motives to reduce the role of nuclear weapons. Non-Nuclear Weapons States must be persuaded that their National Interest and Security are better served without nuclear weapons than with them. On the long run, this is only possible if the nuclear weapons states take leadership in diminishing the prominence of military force or the threat of military force in their international relations.

In this situation, I maintain that the only justifiable residual mission for nuclear weapons is to deter the use of nuclear weapons by others. Such a restricted purpose is equivalent to a no-first-use doctrine in respect to nuclear weapons. Yet, among the current possessors of nuclear weapons, including the five official nuclear states under the NPT and India, Pakistan and Israel, only China has adopted such a doctrine. In my view, the United States, as the most powerful of nations measured by conventional armaments should take leadership in promoting such a restricted mission of nuclear weapons. Failing such leadership, it will become increasingly more difficult to answer the question: if the United States with its uniquely powerful non-nuclear arsenal still needs nuclear weapons, why should lesser nations not require them in the interest of their security?

If the mission of nuclear weapons is restricted to the only function of deterring the use of nuclear weapons by others, then the number of nuclear weapons required for that purpose becomes very small, much smaller than those in the arsenals of the United States and Russia today. Such reduced numbers would go a long way in limiting the damage which might accrue in case of inadvertent use and the smaller stockpiles of nuclear weapons and the materials to make them would be much easier to protect against diversion to terrorists.

Science and Politics need one another, but scientific realities cannot be coerced by policy. As a physicist, I agree that nuclear weapons cannot be uninvented, but once their function is reduced as indicated, then the path is eased to their eventual prohibition. I note that prohibition has now been achieved for chemical and biological weapons, but prohibition and elimination are not identical; evasion on a small scale of a prohibition which might be undetected is still feasible. But reducing the role of nuclear weapons to the single function of deterring their use is a necessity if their spread across the globe is to be inhibited, if the other nuclear dangers are to be contained, and if the damage which nuclear weapons can cause is to be minimized. We can do no less.