

17 Genetically Engineered Bioweapons

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We can identify eight essential elements against which nuclear weapons research had to proceed that played important roles in the control efforts. First, the weapons were born in war and secrecy. Because of the wartime issue and the national security issue countries kept the work secret from the very beginning. Pre-1940 physics was largely open, but as you moved into the weaponization stage, critical issues like neutron cross-section analysis were born behind the fence in government facilities. They were subject to strict government security regulations.

Second, funding was heavily federal or government-dominant. While the science of the 1930s was not, the nuclear science of the 1940s, 1950s, and 1960s was heavily federally funded. This meant that the federal government had control. This would not have been possible if there had been alternative funding sources.

Third, the research was dominated by national security concerns. At Los Alamos, the tension between General Leslie Groves and his military security regime and Dr. J. Robert Oppenheimer and his scientists was a constant factor. Ultimately the national security forces strongly dominated both the development and the control efforts.

Fourth, the weapons research took place mostly in government facilities (notably the Los Alamos, Sandia, and Lawrence Livermore National Laboratories). The threat was overwhelming and security had to be at a high level. I think we often forget that.

Fifth, the initial efforts to develop nuclear weapons and to control access to that technology took place against the background of Hi-

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roshima and Nagasaki and the specter of global nuclear war that was widely prevalent in popular culture and in policy culture of what would be the consequences of an exercise of the Strategic Targeting Plan (SIOP) of the United States and the Russian equivalent (RISOP). The threat was so overwhelming that people were prepared to accept a large number of controls. Plus, the work took place in a global conflict (us versus them; them versus us). The controls that came with this national security threat permeated society. And society accepted them. (In the 1940s and 1950s universities and research establishments were able to work their way through this heavy national security emphasis.)

Sixth, nuclear research, particularly in those days, was large, expensive, and (basically) visible. Ernest O. Lawrence's first cyclotron was built on University of California research funds. It was physically small and was disassembled during the days of the Manhattan Project so it could be used on the classified military program. By the mid-1940s, with research on plutonium and highly enriched uranium, the work involved very large capital-intensive experiments. No one worried about a university, individual, or even foreign country easily doing this work without being noticed.

Seventh, the work had few real benefits for the general public. It is embarrassing to read what nuclear scientists said about the benefits of a peaceful atom immediately after 1945. We were all going to be driving nuclear cars and flying in nuclear airplanes. The biggest benefit was going to be electricity that was too cheap to meter.

Eighth, most importantly, the work took place within the old science paradigm. We often overlook this as we move beyond it. The decade of the 1930s was a much more leisurely time. Before World War II, science fellowships began with leisurely cruises to Europe. Physics problems were solved on long walks with your distinguished academic advisers. Knowledge was spread through letters between researchers and then published in the journals. But this pace now looks very quaint to us. This pace had a lot to do with how control mechanisms worked.

Control Mechanisms

Beginning in 1940-41, and certainly by 1942 and late 1943, controls were imposed on nuclear research. Some of them are hard to understand unless you work in the nuclear establishment. I find one control the oddest because it has never been challenged in a U.S. court. For scientists working in nuclear research in a U.S. national lab, anything they do or write is classified. The presumption is that the very act of performing that research inside that facility makes the work classified and therefore under government control. You have to prove that it does not need to be classified in order to move it outside that environment. This is the opposite of how scientists in other areas work. But no scientist has ever challenged that, despite the fact that a number of lawyers thought there was a fair chance at a successful legal challenge. (Perhaps not true post-September 11.)

There are other control mechanisms in which a great deal of freedom is given up. For example, scientists getting a "Q" clearance must sign a form saying that they will never publish anything even related to whatever they learn or do during this period without prior clearance from the government. This agreement goes with you to the grave. But, it is often ignored, and seldom prosecuted.

We also had import-export controls on knowledge established throughout the 1940s, 1950s, and 1960s, which started to decay.

Results of the Control Mechanisms

By the mid-1950s, all the essential scientific knowledge of first-generation nuclear weapons was in the open literature. What remained secret were engineering techniques and know-how, but not the scientific principles. By the mid-1960s, all the essential scientific secrets of a thermonuclear device were in the open literature. Amazingly, a Soviet scientist published in the open literature the techniques for focusing X-rays, which remained classified in the United States until well into the 1970s. The Soviet scientist was lucky. The classification officer did not understand the implications of being able to focus X-rays (in terms of being able to get a primary in a thermonuclear device).

The most important engineering secret is how to scale down the basic plant necessary to produce fissile material. The plant still remains large, expensive, and by and large (although not always, as Iraq proves), visible if you look for it.

Genetics Research

Genetics research varies from nuclear research in a number of ways. First, there is considerable lack of agreement on the extent and seriousness of the genetic threat, or even if the threat is there. There is also disagreement on the targets that would in fact be the threat. We do not have a Hiroshima or a Nagasaki, that is, a visible event to make it real. Plus, it is played out against a background, at least in the American public and the policy-making community, that is increasingly shrill. It is a threat that has not developed. Lacking a demonstrated threat that is visible to policymakers means you don't have enough emphasis to impose control. I think the American public is largely disinterested in this threat and somewhat confused.

Second, even more important, science has now become truly international and this has changed the paradigm of communication. The speed of communication of colleagues reporting results, as well as proposals they are submitting and the anticipated results, creates a flood of communication. We watch this information ricochet around the world. Genetics research is truly capable of taking place almost anywhere in the world. It is hard to believe that anyone can dominate and control that information in the way we did in the nuclear area using a national security paradigm.

Third, genetic engineering leads to bioweapons. Bioweapons are commercial and research-dominant. A tremendous amount of research is being carried out for either research purposes at universities or commercial purposes at research establishments. This science is far more international, far more spread out, and far more diverse than nuclear science. Researchers communicate much more rapidly with one another by means that no government can control. This was not true in the nuclear era.

Fourth, genetic research is small, not usually expensive, and by and large not very visible. People working in national security worry about these things. You simply do not know, and cannot know, what others are doing in this area.

But we have a very large scientific and technical community that can stop the flow of information. We can take an example from nuclear research. DuPont developed a membrane technology for enriching uranium. That membrane became a closely held scientific secret. It could be controlled because it is highly difficult for other countries to develop that same technology. But this is generally not true in genetics. The materials are not hard to get and they are easy to transport. Also, we have dual-use potential in this area, a lot more than we had in the nuclear area.

Finally, genetics research is benefits-heavy. Genetic engineering offers possibilities of curing diseases. This issue tugs at the heart-strings of policy makers. This was not the case in the nuclear area.

Where We Stand on Genetic Research

Can we halt some of the research? No. The genie is out of the bottle. We do not have the tools to halt this research. And, it does no good to tighten the work on our continent without doing it internationally. You are probably not going to get an agreement to stop it significantly around the world. Internationally, I think, this would be hopeless.

Can we track the research? This is a more hopeful possibility, but it is not without problems. If you were doing this research for a weapons purpose from the very beginning you might not report your research. For example, the Soviets pursued chemical weapons that could be formulated using commercial chemicals that were not in the proposed list for the chemical weapons convention and that would penetrate normal protective measures that were being used by North Atlantic Treaty Organization countries. Nowhere in the literature was that reported. Only after the fall of the Berlin Wall did you begin to see scientific literature reporting their results.

Can we control dissemination of research results? A lot of people resort to this strategy. This was especially true after the Australians reported an unfortunate result of their work to find a new method for delivering contraceptives. In the course of this work, monkey pox had accidentally become extremely virulent to humans. Reporting accidents like this as the result of research seldom happens.

In the literature, you may read how you can piggyback on viruses to deliver various other organisms. But that is for human health purposes. It is not for bioengineering weapons, but it is essential to bioengineering weapons. Editors of scientific journals need to look more closely at this issue.

Can we internationalize control of the research? If this research is so dangerous, why do we not say it has to be conducted within an international organization? The work could be supervised by good bureaucrats from many countries so we could know what is going on. But this idea does not match up with the economics or the politics. It did not happen with the Baruch Plan, and I think it is impossible here.

Everyone engaged in this research has the responsibility to recognize the consequences of it and to not purposely engage in research that would be harmful to the human population. Frankly, I worry more about what genetically modified organisms (GMOs) can do to agriculture than I do about what humans can do. GMOs present a much larger, more immediate threat.

Is internalizing control possible? Yes. Is it a panacea? No. But it does help. It gives you something to work with against regimes that refuse to sign an agreement, or whose scientists sign it and then operate against it.

Can we criminalize some of the research? Yes, if we can define what the crime is. In this area it is going to be extremely difficult. It is illegal to kill, kidnap, maim, or assault an individual under federal and state law regardless of what your motive is. You never carry out murder for the benefit of the party being killed. You should, of course, criminalize murder. I think it is an important step toward

putting it beyond the panoply. We could have much discussion about what to criminalize other than the use of the actual weapon itself. But, by that point, you are probably too late to have any impact.

What We Need To Do

Steps need to be taken. The cost and penalties for use must be raised. The most important step is to increase the tools of attribution. Forensic science needs to be able to determine if an event has occurred. (This applies to genetically engineered events as well as events that are not genetically engineered, such as a bioweapon.) Forensic science should be able to trace back as rapidly as possible where the material was manufactured.

The anthrax investigation illustrates. It has been time-consuming, scientifically uncertain in terms of results, and has not yet come to a conclusion. We could do a much better job. If some of the money in homeland security were invested in this, it would probably make a large difference. If individuals who might engage in the use of bioweapons understood that they could not do it without detection and attribution and that they would suffer the most terrible, swift, and lethal penalties possible, we might control their behavior.

Conclusion

I am extraordinarily pessimistic that we will take any of the necessary steps to avoid the threat of bioweapons absent their first actual use. This threat remains in that realm in which people can say we are hyping the actual threat. We are uncertain. We cannot agree on whether the consequences would be that great and we certainly cannot agree in the absence of the probability.