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"IDEOLOGICALLY CORRECT" SCIENCE

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Introduction

The historical study of science and ideology is really a twentieth-century phenomenon, for it is only after the First World War that stark differences appeared in political ideology and regime: liberal capitalist democracy, Marxist-Leninist communism, fascism and National Socialism. Furthermore, as the introduction to this volume argues, this historiography has been profoundly influenced by the Cold War, with the result that certain themes have been dominant. This essay will investigate perhaps the most striking examples of science being influenced by ideology, which here will be called "ideologically-correct-science" (ICS). The French Revolution will be included because, as the above-mentioned introduction also describes, it was both the first case study for the interaction of science and ideology, and a surrogate for other Cold War case studies. Not all relevant types of ICS will be, or even could be covered here. Indeed, this article will sacrifice depth in favor of breadth and use the comparative approach in order to provide a suggestive analysis of science under different ideological regimes.

Scholars have generally assumed that a political environment can influence science, but relatively little is known as to how this functioned in particular circumstances or across national boundaries. ICS refers to attempts by the state (or at least some representatives of, or forces within the state) to not only use science, but also to transform it into a more ideologically acceptable form, both with regard to scientific content and institutions. These efforts were often inconsistent, and not always entirely rational, but they existed all the same. Jacobins called for a "democratic," not "aristocratic" science in the French Revolution. Bolsheviks called for a "Marxist," not a "bourgeois" science in the Soviet Union. National Socialists in Germany called for an "Aryan," not a "Jewish" science. Ideologues in Second World War Japan demanded a nationalistic, "Japanese" science and technology. During the McCarthy era in the U.S.A., politicians and some scientists tried to reshape science to help win the Cold War, sometimes calling for what Jessica Wang

has described as an "anti-communist" science.[2] Finally, the Red Guards demanded a "people's science" during Mao Zedong's Cultural Revolution in China.

ICS often followed the same pattern: (1) purge of unacceptable scientists and purge or transformation of unacceptable scientific institutions; (2) the enlistment/recruitment of acceptable scientists; (3) the training of new scientists and creation of new institutions; and (4) the production of ICS. This essay will examine this admittedly ideal pattern in order to shed light on ICS in particular and the interaction of science and ideology in general.

In cases of ICS, the state often rewarded scientists and sciences that were, or appeared to be, politically and ideologically correct, while those who deviated from the prescribed path might receive punishment. This pressure was sometimes overt, as during the Chinese Cultural Revolution, or subtle, as in the McCarthy era of the American national security state. ICS could also be self-imposed. Some scientists, voluntarily or otherwise, sought to apply what they viewed as the official ideology in their scientific work. Finally, ICS could also provide "protective coloration,"[3] whereby a straightforward piece of research was wrapped in the official ideology for self-protection or self-promotion. These attempts to make a science that had merely the forms and trappings of ideology should be distinguished from efforts which were made to influence the content, but which fell short and only had an external effect on the social position of the sciences.

Undoubtedly the classic examples of ICS are the "Aryan Physics" *(Deutsche Physik)* movement during the Third Reich and the "Lysenko Affair" in the Soviet Union. Indeed, these are two of the most-studied examples of ideology influencing science. But A$_{ry}$an Physics, like its counterparts in other sciences under National Socialism, was neither typical of science in the Third Reich, nor ve$_{ry}$ successful. A search for ICS under Hitler would certainly include "A$_{ry}$an Science," but must also go beyond it. Similarly, Lysenkoism was not typical of science under Stalin. Although it is debatable whether or not it was "successful," it did not spread from plant breeding and genetics to other sciences, and like A$_{ry}$an science, it did not go unchallenged.

Furthermore, the histo$_{ry}$ of "ideologically-correct-science" is not merely the sto$_{ry}$ of the perversion or destruction of "good" science. Although this was sometimes the case, it is equally true that there are many examples in which ICS either failed to have a particularly harmful effect, or even produced benefits and positive scientific results. This latter case can be made both for a direct effect, as Loren Graham has argued with regard to dialectical materialism sometimes facilitating scientific progress, and an indirect effect, such as Mark Walker's thesis that the fight against A$_{ry}$an Physics actually strengthened the hands of some in the German physics community.

ICS is a useful concept, and was very real, but it is also something to be used carefully, for it can also be seen as a straw man. If by ICS one means the total, coordinated, systematic, and intentional implementation of an ideologically

determined program in science by the state, then ICS never happened, indeed never came close. But interesting and important things did happen. This article will therefore examine several case studies, comparing and contrasting them, with an eye towards gauging the limits and usefulness of this concept.

France

The varied fortunes of science in the French Revolution, like the other case studies, is a story of complexity and nuance, which can hardly be given adequate justice here. The two most celebrated incidents of the "attack" on science during the Jacobin Terror - the closing of the Academy of Sciences (*Academie des* Sciences), and the execution of the chemist Antoine Lavoisier - both fall short of being conscious attempts to impose an ideology on science.

Jacobin ideology was only dominant for about a year, and was not synonymous with the French Revolution. Moreover, all sciences were not treated equally: important Jacobins were hostile to abstract, theoretical, and mathematical science, but were favorable to natural history. After much debate about how to reform education and how to structure expertise in the Republic of Virtue, in 1793 the Academy was closed as an institution and its resources dispersed. But the issues here were not just science, and even not centrally science. Resentment of royal privilege and corporate prestige were mainly responsible for the closing of the Academy.4 While the Academy was eliminated as a vestige of royalist corporatist elitism, the Jardin du Roi was kept intact.5 Moreover, Academy scientists (for the most part) were subsequently employed by the government of Revolutionary France.

The case of Lavoisier, on the surface the purge of an unacceptable scientist who was hardly a strong advocate of Robespierre's government, upon inspection had even less to do with science than the closure of the Academy. Lavoisier was executed by the machinery of the Terror, but not for any reason connected to his positions in science. His association with the Tax Farm sealed his fate. Similarly, Condorcet died at the hands of the Revolution, not because of his mathematics, rather because of hostility to his rationalist Enlightenment views.[6]

The Terror prematurely ended the lives of several prominent scientists, and interrupted the careers of many others, forcing twenty academicians out of forty-eight into "exile" (most went to the provinces, and only about four actually emigrated during the Jacobin Republic). But other natural scientists in educational institutions, government branches, and other venues were actively recruited by the regime. In the case of the Jardin des Plantes an old royal corporate research institution was maintained, albeit with profound alterations (see below). During the period of revolutionary wars, members of the Academy of Sciences received government contracts to fulfill old academic projects like the metric system, gunpowder production, and military engineering. Most aided the Revolution with little grumbling, or even with little attention to other political events once the guillotine lost its central prominence.[7] In contrast, some

scientists, like the chemist A. Fourcroy (1755-1809), not only did not resent the Jacobins, they were active members of the state administration.

During Napoleon Bonaparte's Empire, the state recruited scientists even more avidly than before, and many scientists were quite eager to serve Napoleon's "technocratic" regime and appreciated the return to stability he represented in their eyes. The state now poured an enormous amount of money into military institutions, and scientific and technical expertise were richly rewarded in new institutions like the Ecole Polytechnique, which was founded under the Directory and blossomed under Napoleon.8 Given the prominence of scientists in the advisory apparatus of the Old Regime, especially in the form of the Academy of Sciences, this development under the Directory and the Empire can be seen as a continuation of previously established practices. The persecution of "unacceptable" scientists seems more the aberration from French practice, and the recruitment of those old specialists who were acceptable continued as before, albeit in new institutions.

Since it is difficult to discern a clear ideology in the French case governing the selection of acceptable as opposed to unacceptable scientists, it is also difficult to find an ideological criterion for training new scientists. After the ideological excesses that led to the closure of the Academy had passed and some of the dust of the Terror had settled, France still faced a series of foreign wars, and sorely needed technical expertise and noticeably lacked qualified young practitioners.

The solution was the creation of a new system of Grandes Ecoles, headed by the Ecole Polytechnique, designed to inculcate military discipline into young minds drawn from all comers of France with the necessary technical and mathematical skills required by the emerging modem bureaucratic state and a conscripted army.9 The plans for such a system of education originated in the Old Regime, whereby places in military schools would be attained through nationwide competition and nominations by local authorities. The subject matter of all schools, especially the Polytechnique, was heavily imbued with mathematics applied to concrete problems of military necessity.

The results were impressive: a new generation was trained, filling the officer ranks of the army, the upper levels of the bureaucracy, and other positions at the top of the modem nation-state. The ideology of discipline through mathematical scholarship and service to the State has been so well inculcated into French society that it is scarcely noticed how large an influence this, the most ideological of Napoleonic institutions, still plays in modem France.

The attack on Newtonianism and the retention of the Jardin du Roi as the Jardin des Plantes after the dissolution of the Academy of Sciences are the two most prominent candidates for ideology affecting science. Charles Gillispie and L. Pearce Williams have made the most forceful case for an anti-Newtonianism, arguing that an ideology of anti-elitist Romanticism, deriving from Rousseau and Diderot, motivated the Jacobins' hostility to an atomized, mathematized, Newtonian universe.10 Many of the individuals in question expressed hostility

to some aspects of the Newtonian worldview, and specific examples of ideology did seep into the way debates about the content of science were conducted.11 Similarly, because of the French Revolution, an exact, scientific biology was displaced by a discursive descriptive natural history within the Jardin des Plantes.12

But these examples of ideology and science do not cut to the actual core of the politics of science during the French Revolution. It is unclear how much of a case can be made for the application of specific Rousseauvist anti-Newtonian ideals during the height of the Terror. Even the leading anti-Newtonian ideologue of the time, Marat, was motivated less by an ideological stance towards Newton than by revenge against the Academie des Sciences for its treatment of him during an earlier scientific dispute.13 Perhaps more startling is the fact that these trends were not followed up once the Academy was closed and Lavoisier had been executed. Laplace wrote his great Newtonian masterpiece after the debates recorded by Williams and Gillispie, for example. But the fact that the attempt to reject or replace Newtonianism did not succeed does not mean that it should be dismissed.

The reformation of the Jardin du Roi into the Jardin des Plantes was more successful during this period. It is noteworthy that, despite the rhetoric of anti-corporatism that led to the demise of the Academy, the Jardin remained well financed and continued to perform the same sort of botanical research as it had under the Old Regime.14 The secret of this persistence was the articulation by the botanists of a natural historical program they favored that also seemed to accord with the hostility to abstraction noted by Williams and Gillispie. As a result, this kind of empirical botany was encouraged. A particular type of ideologically-correct science was indeed adopted as a form of basic research, but basic research led the way here in defining what it meant to be ideologically correct.

ICS during the French Revolution was fleeting and superficial. At the same time that the Reign of Terror reached its height in Paris and de-Christianization was ravaging the French countryside, most scientists, who were products of the Old Regime, were put to work for the Revolution; others needed only to repackage their research in an ideologically congenial wrapper. The scientific community did have to make concessions to the new political order, and a few individual scientists (for example, Condorcet and Lavoisier) suffered and died, but in general French science and scientists benefited from the French Revolution and Napoleon. The push for ICS did not produce a significant change in the content of research. However, ICS and the greater political and ideological currents of the French Revolution did create new scientific institutions and influence research programs and thereby led the way in terms of political control of scientists and scientists' accommodation.

The Soviet Union

The reconstruction of Russian science was well on its way to a socially more useful instititution before 1917, but the chaos of the First World War and the

transformation of Russian society by the Bolshevik Revolution also brought profound change to Russian science. Perhaps surprisingly in a nation where science had never penetrated much farther than a vanishingly small percentage of the literate intelligentsia, the Bolsheviks and their allied parties saw reform of higher education, and therefore indirectly, science as one of the first tasks on their agenda. At almost the first opportunity they approached the Imperial Academy of Sciences in Petrograd with both carrot and stick in hand. [15] On the one hand, the largely bourgeois membership of the Academy was reluctant to extend a badly needed hand to the new regime's quest for rapid economic improvement and technical expertise. On the other hand, compelling reasons kept the vast majority of Russian scientists from emigrating and induced them to cooperate, however reluctantly at first, with the regime.

It was by no means certain that the regime would last, and there seemed to be every hope of the regime moderating its rhetoric against bourgeois specialists (as indeed it did). Such hope gave those with a sincere patriotic bent an opportunity to actually put some of their practical suggestions to work. The thrust of the early period of science policy in the Soviet Union was more the establishment of new scientific institutions rather than the destruction of older ones. Moreover, the Bolsheviks offered unheard-of blandishments in the form of prestige, equipment, and funding in an effort to persuade the academicians to lend some assistance. [16] Finally, the Bolshevik regime seemed the lesser of several evils, as rabidly "anti-specialist" movements like *Proletkul't* hovered on the horizon.

During the period of War Communism (1918-21), *Proletkul't* was a vibrant cultural movement, one that marked the first effort to establish ideologically-correct-science in the Soviet context. *Proletkul't* was by no means directed exclusively, or even principally, towards science. It argued that a proletarian state required a proletarian culture, not the realism of capitalist art, the individualism of capitalist literature, or the technocracy of capitalist science.17 Technocratic specialists and other remnants of tsarist capitalist culture would have to go, and a more democratic and proletarian science would be imposed in its stead. [18]

Thus for quite some time, bourgeois specialists did not know how they would be treated by the Bolsheviks, especially since there was now a "Communist Academy" alongside the traditional Academy of Sciences. But Lenin had little patience for such efforts to alienate much needed specialists, and his eventual suppression of *Proletkul't* and the closing of the Communist Academy served as a signal to bourgeois scientists that their kind would be tolerated as long as they were amenable to the new regime's demands. [19] In fact, except for an exile of some 200 dissident intellectuals, there was not much of a purge in science until the period 1928-31.

What it meant to be an "acceptable" scientist in the early Soviet Union fluctuated widely with the attitudes and needs of the fledgling regime. During the period of War Communism, bourgeois specialists were (officially) "unaccept-

able," but were nevertheless used. As the Soviet economy began to falter, the regime began to accommodate those in possession of needed technical skills. The heyday of the bourgeois specialist - the period of the New Economic Policy (NEP, 1921-27) - induced many scientists who were ideologically opposed to Bolshevism to make a temporary peace, while giving the Soviet regime time to lick its fiscal wounds and gear up for socialist industrialization.

The essence of the NEP attitude towards bourgeois scientists and engineers had already been expressed by Lenin in his opposition to the iconoclastic fury of *Proletkul't.* Technical expertise would always be necessary, and as long as those who had the knowledge would only share it if given sufficiently high salaries and ideological breathing room, then they should be afforded those luxuries.[20] This did not mean, however, that ideological constraints were put on hold. Ideologically "acceptable" scientists, like the young Lev D. Landau, for example, were actively encouraged by the regime and promoted over old bourgeois specialists who staffed the old universities.[21] Indeed, the communists made a fundamental distinction between research institutes where scientific ability was most important, even if not accompanied by appropriate political conviction, and the universities, where only politically reliable scientists would be used to train young scientists. It is interesting to note that National Socialists in Germany and to a certain degree the Communist Party in China made the same distinction.

For the time being, the Soviet state only mildly harassed those who chose to hold to their old views - provided their skills were truly indispensable to the industrialization of the new regime. The Shakhty trial of 1928 changed all this, however, when bourgeois specialists were accused of "wrecking" and industrial sabotage designed to cripple Soviet power.[22] The honeymoon had ended, and under the rising power of Joseph Stalin, bourgeois specialists were not tolerated during the years 1928-31. Thereafter the term "bourgeois specialist" was no longer used, and many former "specialists" quietly returned to the positions of prominence in science they had enjoyed before. The Soviet nuclear weapons project, which used both former specialists and younger scientists trained under the Soviet educational system, was typical in this regard.[23]

The generation of new cadres of ideologically suitable scientists and technicians constituted one of the most important aspects of early Soviet science policy. The splitting of research and education was the first stage in this development. Education was placed entirely in the hands of ideologically sanitized pedagogues within the People's Commissariat of Popular Enlightenment *(Narkompros).* Research institutes were left under various economic Commissariats, and permitted a more eclectic personnel. At the same time, the State transformed the research institutes, borrowing some aspects of Western organization for individual labs, but placing them all into a Soviet framework.[24]

While some bourgeois specialists were prominent in this framework, by the early 1930s and the conclusion of the first of Stalin's Five-Year Plans, most had either blended into the woodwork and adopted appropriate idea-

logical colors or had been executed or exiled during the purges.[25] However, as late as the 1950s, non-Party scientists, former "bourgeois specialists," occupied the majority of high-level administrative positions in Soviet scientific research.

The Soviet Union grudgingly used its "bourgeois specialists" while simultaneously training new cadres of "red" scientists. But these new ideologically correct scientists had the same professional aspirations as their "bourgeois" mentors - concern for international scientific standards, the need for international contacts - and therefore sometimes clashed just as forcefully with the Stalinist regime's desire for ideologically fidelity.

The growth of cadres of communist researchers in the various fields of science was really quite extraordinary.26 As more and more competent (and ideologically "clean") individuals were generated, they began to take over positions held by disgraced members of the older generation.27 By the onset of the Second World War, Stalinists had essentially completed the ideological purification and installation of "red" specialists in almost all levels of the Soviet research empire.

Dialectical materialism, the official philosophy of science of the Soviet Union, complemented historical materialism - the Marxist theory of historical and economic development - to compose the complete orthodox set of beliefs about the social and natural world. The nature of dialectical materialism and the extent of its epistemological and ontological grasp had been a source of debate since the early interpretations of Engels' and Lenin's writings on the natural world during the 1920s.[28] But unlike the meaning of dialectical materialism, the unwritten "requirement" that scientists hold to some of its tenets (or at least not openly contradict them) was more or less constant through Soviet history - and reached some disastrous consequences during the Lysenko years. Yet the historian Loren Graham has pointed to another side of dialectical materialism, which he calls the "authentic phase."[29] Graham argues that dialectical materialism was sometimes used by scientists freely as a positive force for scientific reasoning.30 Graham's persuasive argument thus makes the intriguing point that scientists often adopted ICS as basic research in the Soviet Union voluntarily (or semi-voluntarily) and occasionally used it to produce significant results.

Whereas dialectical materialism provides the most important example of ICS as basic research in the Soviet Union, the most famous instance of ICS as applied research is the well-known case of Lysenkoism.31 Scion of a Ukrainian peasant family, Trofim Denisovich Lysenko began his work as an agronomist in the 1920s in an agricultural station near Baku. While there, he claimed to have discovered a biological process he dubbed "vernalization" *(iarovizatsiia):* the treatment of germinated seeds of various plants with abnormal conditions of heat, cold, and other forms of environmental exposure, in order to make plants develop in a more appropriate way - essentially a neo-Lamarckian biological program. Lysenko's attempts to present his results to the Soviet agronomic and

genetics community were rebuffed as contrary to all known facts about genetics. The famed geneticist N.I. Vavilov initially supported Lysenko's research as potentially producing innovations in agronomic practice, but broke with Lysenko when he started to push his neo-Lamarckian views on plant breeding and genetics in the mid-1930s.

In the early 1930s, Lysenko teamed up with ideologist I.I. Prezent, who convinced Lysenko to link his neo-Lamarckian views of inheritance with Darwinism, and to couch both in a Marxist framework. This marriage of dialectical materialism and agronomic practice in opposition to genetic theory caught the attention of Stalin in the late 1930s, who praised Lysenko openly in various contexts as a means of supporting the regime's disastrous and bloody collectivization campaign in the countryside. Lysenko grew in power, becoming president of the Lenin All-Union Academy of Agricultural Sciences (VASKhNIL) while its former president, Vavilov, was arrested on grounds of counter-revolutionary and anti-Soviet activity, and died of malnutrition shortly before being released from prison in the early 1940s. The actual banning of genetics did not happen until after the Second World War, when Lysenko's star actually seemed to be waning and the Cold War got underway. But in 1948, Lysenko read a speech (toned down but supported by the personal editing of Stalin)[32] condemning genetics as a "bourgeois" science and banning almost all research on it in the Soviet Union.

While Nikita Khrushchev liberalized much of the terror apparatus of Stalin's state after the latter's death in 1953 and especially after the Twentieth Party Congress in 1956, he liked Lysenko personally and continued to fund him lavishly and support a series of disastrous agricultural programs which his favorite proposed. After Khrushchev's fall in October 1964, however, Lysenko's days in power were numbered. Genetics was restored in 1965, but the recovery process was painful and the loss of Vavilov hard to forgive. The scars caused by Lysenkoism remain to this day.

Lysenkoism, which influenced Soviet science for decades, was obviously ideologically-correct-science. But it was eventually overthrown by forces within Soviet science and society, and the science it had discredited and dismantled, genetics, was reinstated and rebuilt. Lysenko and his followers also failed to extend their influence to other Soviet sciences. In particular, physics was able to rebuff Lysenko-inspired attacks on certain aspects of modern physics, both because of the relevance and irrelevance of physics to Stalin's foreign and domestic policies. At first physics was not very important to the Soviet leadership, for in contrast to Lysenko's theories, it promised neither to solve the country's problems, nor fit particularly well into Soviet ideology. When the Second World War began and the potential of nuclear weapons was clear, physics became far too important to purge or distort. Thus Lysenkoism was arguably exceptional, and reveals little about the other major purges of Soviet intellectuals that were attempted in the period after the Second World War.[33]

Germany

During the first year of National Socialist rule in Germany, a significant percentage of scientists (perhaps as much as 15 percent) were forced out on racial and political grounds.[34] This purge was not aimed particularly at scientists or science - the campaign against Albert Einstein is the exception that proves the rule - but rather was a consequence of the National Socialist "cleansing" of the entire civil service. This larger purge was itself apparently a largely unplanned, if not spontaneous reaction to the failure of the nationwide boycott of Jewish businesses in April 1933. The effect on science was tremendous, but this purge does not demonstrate any plan or intention on the part of the National Socialist leadership to create an Aryan science.

There is evidence for more direct interest by Hitler's government in the transformation of scientific institutions, but again a close look reveals different priorities. The universities were purged and transformed right away because they were educational institutions charged with the training of German youth.[35] Their transformation was profound, but also hidden. The structure of the university remained largely intact, at least on paper, but most autonomy was robbed by the introduction of the "leadership principle": a strict hierarchy, whereby one had to obey everyone above, but could order about everyone below. In principle, the faculty still met and voted, prepared lists of candidates for positions, and so on, but in practice the deans and rector - political appointees, of course - often had almost dictatorial power. Other scientific institutions, including the Kaiser Wilhelm Society and its research institutes, as well as the various Academies of Science, were transformed in a similar way, although significantly later in the Third Reich.[36]

The dates by which all Jewish members had been purged provides one of the most telling indications of how relatively unimportant these research institutes and academies were for the National Socialist leadership. Whereas most Jewish scientists in the universities had lost their positions in 1933, other Jewish scientists managed to remain at research institutions for many years. The Prussian Academy of Sciences, for example, under pressure from the Ministry of Education, finally asked the last Jewish member to resign in 1938, shortly before *Reichskrystallnacht,* the nationwide orgy of violence against German Jews. In 1933 the Education Ministry had been k en to publicize its treatment of Einstein. After he had already resigned from the Prussian Academy, the Ministry pressured its leadership to issue a press release, essentially saying good riddance. But in 1938 the Ministry wanted to keep the final purge of Jewish scientists quiet, so as not to publicize the fact that there were still Jews in the Prussian Academy.[37]

The purge of German science by the National Socialists makes clear how little interest Hitler and his followers had in scientific research. Their interest was aroused only when scientists demonstrated that modem science could serve National Socialism. It is striking and depressing to see how quickly the vacancies caused by the purge were filled by generally competent, racially and

politically acceptable scientists eager to serve the new regime. For those who were already in place, it usually sufficed to demonstrate Aryan status and an apolitical attitude to keep their jobs, although they were pressured to yield greater political and ideological cooperation with the National Socialist movement.

Those moving u p - i.e., who did not already have permanent positions - had to be both Aryan and willing participants in the political and ideological rituals introduced by the National Socialists into the universities. Such rituals included or encompassed attendance at "political" indoctrination camps, membership in National Socialist organizations, including, of course, the National Socialist German Workers Party (NSDAP), and other forms of participation in National Socialism. The authorities paid little attention to their research when it came to judging political acceptability, although this might well enter into whether or not they were hired.

Rearmament, especially beginning in 1936, offered great opportunities to scientists who had something to offer the regime; similarly, the new racial hygiene policies (sterilization, "euthanasia," restrictions on marriage) provided great opportunities for physicians, biologists, anthropologists, psychologists, and psychiatrists.[38] In general, most scientists did not make the transition to the racist, Aryan science, but did adapt themselves and their research in order to work under National Socialism.

Perhaps the greatest failure of National Socialist science policy concerned the training of the next generation of scientists. The politicization of education and emergence of National Socialist youth organizations like the Hitler Youth eroded both the quality and the quantity of scientific education. The creation of new institutions was not much more successful. The National Socialists did not really try very hard to create new scientific institutions. Even the *Ahnenerbe* ("Ancestral Heritage"), the scientific research arm of the SS, relied mainly on research contracts in order to encourage certain types of scientific work.[39] Most truly new research institutions created by the National Socialists had little to do with science, and were so ideological and politicized that they were really incapable of producing significant basic or applied research. Scientific work was done for the National Socialists, but it usually took place in institutions Hitler's movement had inherited. The rocket project is the exception that proves the rule: Army officers and engineers, not National Socialists, created and developed it during the Third Reich.

The politicization of the universities was compounded by the carnage of war, as very many students were offered up as cannon fodder during the Second World War. The result was a generation lost to German science: with few exceptions, only scientists who had entered the university system during the Weimar Republic survived the Third Reich. Despite the regime's attitudes towards women, by the middle of the war women made up a large percentage of university students because so many of their male counterparts were fighting and dying on the front.[40]

The regime wanted the help of scientists and physicians in order to provide a scientific basis for their racist, and eventually murderous race hygiene. But despite the active participation of scientists and physicians in this program, and the infamous experiments carried out at Auschwitz and elsewhere on unwilling concentration camp inmates,41 researchers could not deliver scientific proof of the supremacy of the Aryan race. In retrospect, this was revealed by the infamous Nuremberg Laws in 1935. When the National Socialist State finally issued the binding legal definition of what "non-A$_{ry}$an" meant, it had to fall back on to a religious, not racial definition of who was a Jew.

However, there were also scientists who claimed to be practicing A$_{ry}$an science when car$_{ry}$ing out their basic research. These were not race hygienists - although a biologist claimed to be fighting for an "A$_{ry}$an Biology" *(Deutsche Biologie)* - but rather physicists, mathematicians, psychologists, chemists, and engineers. These Aryan movements in German science and technology[42] eventually failed in their efforts to seize control of their disciplines precisely because they were barren in the National Socialist sense. The rulers of Germany wanted science useful to them, and it was the leaders of the established scientific communities, not the A$_{ry}$an scientists, who were able to gain and retain the backing of influential patrons in the National Socialist state.

Thus the calls by the Nobel laureates and "A$_{ry}$an Physicists" Philipp Lenard and Johannes Stark to eliminate the influence of Jews in physics, and the "A$_{ry}$an Mathematician" Ludwig Bieberbach's assertion that A$_{ry}$ans and Jews made different types of mathematics eventually fell on deaf ears, while the applied mathematician Ludwig Prandtl and the theoretical physicist Werner Heisenberg offered their expertise in designing wind tunnels and nuclear weapons, respectively. Established scientists like Heisenberg and Prandtl were thereby able to sideline or neutralize their "A$_{ry}$an" colleagues by convincing political leaders that their basic and applied research might facilitate both milita$_{ry}$ conquest by creating new and improved weapons[43] as well as the racial engineering of Europe by providing new methods for distinguishing A$_{ry}$ans and non-Aryans.

Ideologically-correct-science had a profound effect on German science, far beyond the well-known case of the ideological attacks by A$_{ry}$an Physics on modern physics. But the end effect was almost always defeat for the ideologues, as the established scientific communities sought refuge and support from leading National Socialists. The main effect of "Aryan Science" was to drive most other scientists further and faster down into the arms of National Socialism, making themselves more useful and relevant for the often murderous policies of the regime.

The very anti-intellectual climate within the ranks of leading National Socialists worked against the advocates of A$_{ry}$an Science. A National Socialist ideologue disdainful of science also had little interest in its A$_{ry}$an variant, while the technocrats scattered throughout the National Socialist hierarchy naturally threw their support behind established scientists who could deliver the goods.

Scientists helped build rockets[44] and jet planes,[45] researched new biological and chemical weapons (which fortunately were not used), and dangled the prospect of "Wonder Weapons" like the atom bomb[46] before leading National Socialists. Researchers ranging from physicians, biologists, psychiatrists, psychologists, anthropologists, economists and geographers[47] helped implement the murderous race hygiene policies of "euthanasia" and "Germanization," and finally murder and genocide by helping to select the victims and create new and more effective ways to torture and kill them.

Japan

During the Second World War in Japan there was no need for a racial or ethnic cleansing in the sciences because, with the exception of a few notable Koreans, all scientists were Japanese and shared essentially the same racial, ethnic, and cultural identity. Moreover, because of the relative paucity of scientists with advanced scientific training in Japan, even Koreans - whose homeland Japan had occupied before the war and who were considered second-class citizens in Japan - were allowed to retain their positions at the university.[48]

There were also few incidents in which scientists were jailed for expressing anti-imperialist views. In one case, several members of an academic research group, including the physicist Taketani Mitsuo, were arrested for advocating resistance to Japanese imperialism through their serial publication, *Sekai bunka(World* Culture). Taketani was detained- allegedly for his research activities on natural dialectics - accused of helping to promote the Communist Party in Japan, and forced to state that he had acted under instructions from the Comintern. The judge who reviewed his case, however, suspended prosecution and released him to the custody of his colleague and close friend, Yukawa Hideki.[49] On the whole, such instances were rare.

Under military influence, the government enacted numerous laws in the 1930s to acquire greater control over the people and the economy. As part of the militarization of the nation, institutions of scientific research, such as the imperial universities and the prestigious Institute for Physical and Chemical Research (also known by its Japanese acronym "Riken"), were also brought under the aegis of the military. By influencing budget allotments for basic and applied research, as well as the production orders for the resulting manufactured items, the military began to have a significant impact on scientific research. As a result, there was no need to transform such institutions; only greater administrative and economic control proved necessary.so

Nevertheless, the recruitment of first-rate scientists became a critical problem for the military. Nearly all of the nation's most famous and competent scientists had spent years abroad studying in Western nations, and they were thus considered suspect by the military leadership, which was by and large xenophobic in its worldview. Moreover, most scientists at the university had little interest in suspending their own research for military projects.SI Out of

necessity, however, the military consulted leading scientists at the universities when those in uniform - who were usually little more than higher-school educated technicians - proved incapable of advanced level research. Both the army and navy, for example, turned to physicist Nishina Yoshio, Director of the Physics Department at the Riken, to complete a feasibility study of the possible exploitation of nuclear energy for military purposes.[52]

Like Nazi Germany, Japan proved terribly shortsighted in preparing the nation's scientific infrastructure for a prolonged and total war. One particularly notable area of failure was in the training of new scientists and the creation of new institutions of science and technology. The military continued to draft students from university science programs and departments throughout the war. This was halted only through the concerted efforts of senior scientists like Nishina, who insisted upon military deferments for designated students of exceptional ability in exchange for agreeing to conduct research for the military. Only by such means was the older generation able to preserve the next generation of scientists.[53]

As for new institutions of science, by the early 1940s, the resources for their construction and maintenance were dwindling and the move was toward consolidation and rationalization, not expansion or the creation of new scientific institutions. The capstone of the trend came in early 1942 with the establishment of the Board of Technology. Roughly analogous to the Office of Scientific Research and Development in the United States, the purpose of the Board of Technology was to coordinate scientific research and development of new technologies between civilian and military institutions, as well as between the army and navy.

The organization looked impressive on paper, but in reality, the Board of Technology proved a dismal failure. It never acquired sufficient authority or capability to supersede the numerous administrative boundaries that such a task entailed. It could not overcome the substantial compartmentalization of civilian and military research. Neither could it redirect the complex network of financial arrangements, production contracts, and social ties that each military service had to its preferred *zaibatsu* (industrial combines) and university cliques. The board had little success in overcoming the bitter enmity that existed between the army and navy to convince them to collaborate on key projects until the war was already all but lost.[54]

There was no single ideology in wartime Japan comparable to Aryan Physics in Nazi Germany, nor was there any ideological movement in the sciences that gained such comprehensive state support and promotion as Lysenkoism did in the Soviet Union. Beyond the ubiquitous rhetoric of national militarism that emphasized sacrifice and service to the Emperor and nation, there was no prevailing ideology to impact science as there was in Germany or the Soviet Union. Yet there was a call for a distinctly Japanese form of technological development based on the nation's situational imperatives, that is, the rise in demand for military production in the face of rapidly diminishing raw materials.

Japan's progress in science and technology had been dependent upon the cooperation of Western nations and foreign teachers since the late nineteenth century, but as the military leaders of Japan drove the nation inexorably toward world war in the 1930s, increased hostility toward the West compelled bureaucrats and intellectuals alike to question the West as a model for Japan's technological development. Having no indigenous model as a substitute, a distinction had to be drawn between American and German paths of development. The rationalized "German path," it was argued, was better suited to Japan, as it aimed to limit the use of raw materials and promoted the use of substitutes. When its German ally proved niggardly in technology transfers, however, Japan was forced again to look inward.

Imitation of the West was to be rejected in favor of a uniquely Japanese path of technological development in accord with the nation's paucity of natural resources.55 As one ideologue stated:

> The resources of the Greater East Asia Co-Prosperity Sphere are awaiting the creation of the new technologies that will make most effective use of them. It is only then that these resources will acquire value. The existence of scientific research, which may give birth to this new technological creativity, will provide a firm basis for the cultivation of the Co-Prosperity Sphere, and for this reason the promotion of such research is currently an urgent necessity.56

Despite the flurry of mobilization and rationalization laws and measures that were enacted to realize this vision, no distinctively "Japanese" science emerged, nor was Japan able to free itself of its pattern of technological borrowing and dependence upon the West. Toward the end of the war, when necessity and desperation drove the nation's leadership to extremes, the government and military called upon scientists and engineers to draw inspiration from Japan's traditional past and the unique characteristics of the Japanese people, all in the effort to create an ideological rallying point for Japanese scientists in the development of some new weapons technology that could tum the tide of war in their favor.[57]

By 1943 the National Socialist state was also calling upon its scientists, engineers, and even inventors to create "wonder weapons" which would use qualitative superiority to overcome the quantitative superiority of its opponents. The Japanese military's answer, however, was no miracle weapon of science, such as a rocket or an atomic bomb. Rather, it responded with crude suicide craft, such as the *Ohka* piloted missile and the *Kaiten* midget submarine. No "Japanese" style science emerged from the war, and the ultimate "Japanese path" of technological development resulted in death for many of the nation's youth.

In the case of Japan, there was no readily identifiable ideologically-correct-science. Rather there was only a vague policy objective to guide technological development that was in accord with the nation's situational imperatives. The

lack of natural resources, coupled with the nation's Spartan industrial infrastructure and its limited scientific and technological capacity, predestined Japan's fate in a total war against the United States. Japan proved incapable of producing such wonder weapons as the atomic bomb, long-range guided missiles, and advanced radar, but its army did, for a time, strongly support the development of biological weapons and made significant advances in this field.58

Biological weapons were easy to mass-produce with few resources, and thus fit within the military's vision of a new weapon derived from a "Japanese technological path." Ultimately, however, the fear of a response in kind from the United States and the ever-present possibility of a boomerang effect appear to have deterred Japan's use of biological weapons on a wider scale beyond the war in China. As a result, biological weapons never became a significant factor in determining the outcome of the Pacific War, and the military never acquired a uniquely Japanese wonder weapon of his own.

United States

If communism served as a powerful ideology of science in the East, especially in the Soviet Union and China, did anti-communism play the same role in the West during the Cold War? Since American McCarthyism in the late 1940s and 1950s represented the peak of this political and cultural phenomenon, we might expect to see signs of the search for an ideologically correct science.59 However, there were very few unambiguous examples of efforts to influence scientific content that were motivated or constrained by anti-communism as a political ideology. Rather, what does emerge clearly is the pervasive influence of anti-communism on the *political* roles of scientists whose professional identity assumed significant but not overwhelming importance.

Scholars now generally agree that the two characteristics of McCarthyism, domestic anti-communism and the denial of due process to those accused of communism, existed both before and after the period when Senator Joseph McCarthy made the cause his personal crusade in 1950 - 4.60 The Cold War ideology of anti-communism not only saw a direct threat to American security in potential Soviet expansion on the international front, but also from perceived communist subversion at the domestic front. The national security state organized national life around national defense and fed on the Cold War ideology of anti-communism. It dominated science and technology policy, and thus indirectly but powerfully shaped American scientists' political and scientific activities.

On the one hand, a large number of American scientists engaged directly in the making and testing of nuclear weapons in the national laboratories of the Atomic Energy Commission (AEC). Those in academic and industrial settings also came to depend on the defense establishment for funding. As Paul Forman has argued, this dependence tended to make scientists choose, consciously or

unconsciously, research directions that would benefit their patrons.61 On the other hand, scientists were persecuted during the McCarthy era because their past association, political opinions, or policy advice deviated from the political orthodoxy prevailing at the time.

The security clearance case of J. Robert Oppenheimer was perhaps the best-known example of McCarthyist attacks on scientists. As the famous director of the Los Alamos laboratory that created the atomic bomb during Second World War, Oppenheimer was nevertheless stripped of his security clearance in 1954 by the Atomic Energy Commission (AEC). The AEC decision cited past association with radical causes, opposition to the hydrogen bomb, and "defects in character."62 Hundreds of other, less-well known scientists suffered similar or worse treatment both before and after the Oppenheimer case.63 The U.S. State Department denied passports to a number of American scientists with liberal reputations so they could not travel abroad. It also refused to issue visas to some foreign scientists who wanted to visit the U.S.A.64

The Oppenheimer case evoked a most vehement protest from the scientific community, which generally blamed the injustice on a paranoid security system.65 It undoubtedly marked a profound deterioration in the relationship between many American scientists and the national security state. The far-reaching repercussions did not escape the top government officials. Eisenhower, while agreeing with the AEC's decision, nevertheless worried about the case's effect on scientists in various defense projects. Aware of the potentially explosive impact on scientists and dangerous exploitation by McCarthy, Eisenhower told his aides that "we've got to handle this [Oppenheimer case] so that all our scientists are not made to be Reds."66 Eisenhower wrote to New York writer Robert Sherwood shortly before the AEC decision, stating that because he was "so acutely conscious of the great contributions the scientists of our country have made to our security and welfare," he shared the hope that Oppenheimer could be cleared.67

It was to the President's and the AEC's relief that the "mass exodus" from weapons laboratories, as predicted by various scientific groups, failed to materialize in the wake of the Oppenheimer case.68 While Eisenhower may have feared losing the services of scientists, there was no lasting damage to the Cold War partnership between science and the State. Scientists had warned since the late 1940s that unfair security procedures would lead scientists to desert government positions, but the threat was more rhetoric than reality.69

The fact that few scientists lefr their government research positions in the aftermath of the Oppenheimer case indicates that scientists, especially younger scientists, learned to live with the new Cold War political economy of science, what Eisenhower would call the "military-industrial complex." As physicist Herbert York, first director of the AEC's Livermore Laboratory on nuclear weapons in the 1950s, later reflected, young scientists had the practical needs of finding jobs that matched their training and supported their families.70 Others simply recognized the need to combat two "Joes," both Joe McCarthy and Joe

Stalin, especially after the outbreak of the Korean War.71 In any case, since the newly-founded National Science Foundation only slowly gained substantial budgets, the funding structure of American science was skewed toward the military, which left few alternative sources of financial support to scientists, including the training of new ones.72 Consciously or unconsciously, scientists were integrated into the national security state.

In the United States during the McCarthy era, there was a general acceptance, either tacit or explicit, by both individuals and institutions, of loyalty oaths and security clearances. Most universities, for example, refused to hire known communists. In 1950 the regents of the University of California adopted a requirement that all university employees had to sign a loyalty oath stating that they were not members of the Communist Party. As a result, dozens of faculty members, many of them scientists, left for other institutions in protest while some others, including tenured professors, were fired from the university.73

The same year, scientific organizations such as the Federation of American Scientists and the National Academy of Sciences fought successfully to remove amendments in the National Science Foundation Bill which would have required applicants to the foundation for unclassified research to undergo security clearance and an FBI background check. But, with dismay, they felt that they had to accept the requirement of loyalty oath in the bill as a compromise to get it passed.74 There were a few nuclear scientists who deliberately switched to fields where they did not need security clearance. Leo Szilard, for example, turned to molecular biology.75 Others, like Philip Morrison, continued in their fields but avoided work that would have required them to apply for a security clearance.76

Without belittling the pains and the injustice that the victims of Cold War anti-communism suffered, a distinction should be made between Stalinist/Maoist communism and American McCarthyism. Few American scientists were persecuted through State-sponsored violence for their particular beliefs in science, in contrast to what happened in Stalinist Russia and Maoist China, although they were repressed in other ways. While Vavilov starved to death in Stalin's prison for resisting Lysenkoist theory and while dozens of prominent Chinese scientists were killed during the Cultural Revolution for being bourgeois "reactionary academic authorities" (see below), the worst that happened to American scientist-victims of anti-communism was, with few exceptions, that they lost their jobs, or as in Oppenheimer's case, their security clearances.

The consequences of McCarthyism went beyond the harm done to individuals, however. In fighting dictatorial communism, American anti-communist crusaders adopted the same anti-democratic tactics employed by the enemy. The American left, including that in science, was largely silenced and social reforms aborted. Fearing the charge of "being soft on communism," Cold War liberals energetically led the U.S.A. into a costly and misguided war in

Vietnam.77 Few of those American scientists who served as major advisors to the government in the 1950s and 1960s, for example, represented the liberal and left-wing positions briefly influential in the immediate post-Second World War years.78 The significance of McCarthyism "may well have been in what did not happen rather than in what did."79 In science, for example, we will never know what scientific research could have been pursued during the Cold War had there not been pressure to work in the national security state system. Likewise, we can only speculate on whether scientific research more closely related to civilian technology could have been advanced further and earlier than it did.

Scientists, especially nuclear scientists associated with government labs, were certainly subject to special scrutiny from the government because of their perceived access to "atomic secrets." Yet, the ideological impact of anti-communism on American science was only general and indirect. In contrast to Marxism, which attempted to function in Stalinist Russia and Maoist China as an all-encompassing ideology with specific doctrines governing science and philosophy, American anti-communism was primarily a political ideology. It guided American foreign policy and influenced domestic politics, but never set down a number of doctrines to be followed in science and philosophy.

The excesses of the McCarthy era in the United States had a profound effect on scientists and their relationship with the state, but it did not lead directly to a new type of an ideologically-correct "anti-communist" science like Aryan Physics or Lysenkoist biology. In the United States, ICS manifested itself as the connection between research and the goals of the State, in particular the integration of science into the national security state, rather than the establishment of ideological tests for the content of science. Not even the "Oppenheimer affair" could halt or even slow the flow of scientists into military-related research.

China

As with the Soviets, science occupied a special position in the ideology of the Chinese Communist Party. The founders of the party in the 1920s turned to Marxism as a "scientific" explanation of history and communism as a natural course of social changes. Mao Zedong later developed an essentially instrumentalist ideology of science that might be called "revolutionary utilitarianism." "Revolutionary" referred to the goal of the Communist Party's science policy to ensure the political loyalty of the scientists, while "utilitarian" spoke to the pressure on scientists to produce immediate, practical results.

Even before their take-over of mainland China in 1949, Mao and his followers had launched a notorious "rectification" campaign in their stronghold in Yanan during the early 1940s. It resulted in a complete re-structuring of the scientific establishment under communist control. A number of scientists and science administrators had insisted on the priority of basic science in education

and research. Now they were removed from their positions and punished in favor of those who advocated the re-orientation toward meeting immediate needs in production and military technology. Some of those suspected of harboring bourgeois thoughts - that is, thought not sufficiently revolutionary - were "sent down" to the countryside to learn from the peasants and thereby set an ominous precedent. As the historian James Reardon-Anderson points out, the narrow enforcement of revolutionary utilitarianism marginalized fundamental science "with long-term repercussions on the modernization of China."[80]

Ideological purification of the scientists, often Western-trained, started almost immediately in the People's Republic of China (PRC), and intensified during the "thought reform" campaign at the height of the Korean War in 1952-3. In a scene paralleling that in the U.S.A., war hysteria turned into a hunt for internal enemies, resulting in the suicides of a number of scientists in Shanghai.[81] Many scientists were accused of following bourgeois scientific theories, such as Mendelian genetics, cybernetics, resonance chemical theory, and Gestalt psychology, and forced to renounce them. The Anti-Rightist Campaign of 1957, however, outdid all these previous purges. Attacking those scientists who had criticized the party's mishandling and distrust of scientists as part of a conspiracy to overthrow the new government, Mao ordered the purge of hundreds of thousands of intellectuals, including scientists.82 Many of the brightest scientists were thus taken away from science and education and placed in forced labor for many years. Despite periods of relaxation, the pressure on scientists for ideological purification never completely relented over the next two decades.[83]

Mao's distrust of scientists reached a crescendo during the Cultural Revolution of 1966-76. He and his supporters unleashed a harsh reign of terror by the radical Red Guards against anyone, including scientists, who could be accused of deviating from Mao's correct political line. Along with other intellectuals, scientists were again purged for their bourgeois ideology and their elitism; they had to be cleansed and reformed. Red Guards and other rebels took over scientific and educational institutions and stopped virtually all research. Scientists, especially those formerly in administrative positions, were criticized and persecuted, and sometimes beaten, tortured, and killed. By 1969, many scientists who survived the ordeal were sent to the countryside or factories to perform physical labor and help make a "people's science." Only after Mao's death in 1976 was it possible for a full-scale restoration of utilitarian science policy under the leadership of Deng Xiaoping.84

Scientists were usually purged in the Mao era not so much for the ideological content of their scientific theories as for their political opinions and even personal background, such as training in the West and working under the Nationalists before 1949. Yet, in a few cases, notably Lysenkoism, persecution did fall on those with the "wrong" beliefs. There were numerous cases where the pursuit of basic research by itself could bring on the indictment that one was

ignoring the practical duties of a scientist and thus deviating from the correct Maoist model of integrating theory with practice. Perhaps the most striking feature of the treatment of Chinese scientists under Mao was the wide swings between liberalization and harsh tightening, which reflected the divisions within the Communist party leadership over the future course for China and the complexities of modernization.

In 1948-9, communist leaders encouraged scientists who had worked under the rival Nationalists to stay where they were, instead of following the fleeing Nationalist forces to Taiwan. After the establishment of the PRC in October 1949, many of these carry-over scientists attained important administrative positions in the reconstructed scientific institutions of the new regime, including the Chinese Academy of Sciences. Characteristically, however, the most important policies on personnel and research directions were determined by party officials and the few scientists who were also party members.[85] In the early 1950s, the party and government pursued a policy of encouraging scientific research and education, in part to persuade those who had worked under the Nationalists to stay with the new regime, and in part to attract those Chinese students and scientists training or working in the West to return to their homeland. Despite the various political purges in this period, by and large, the latter succeeded as thousands of them overcame obstacles in the West to return to China.[86]

Distrusting these carry-over and returnee scientists, however, the party launched efforts to train its own "red" experts almost immediately following the establishment of the PRC. Typically, the new recruits undertook narrowly focused undergraduate studies in one of the Chinese universities, which were radically restructured in the early 1950s according to the Soviet model to emphasize specialized technical fields, such as metallurgy or geology. The best of these students - in terms of both technical competence and political loyalty - were sent to the Soviet Union for graduate study. Upon their return, they were expected to become leaders in the Chinese scientific enterprise. For example, Zhou Guangzhou, a physics student, followed this path. He would later become a leader in the Chinese nuclear weapons project and president of the Chinese Academy of Sciences in the 1980s.[87]

During the early stage of the Cultural Revolution, there was little effort to train new scientists, except for what existed in the nuclear and military space projects. Most of the universities were shut down from 1966 to about 1971, with no students admitted or graduated. In 1971, universities were re-opened and operated under a radical new direction: freshmen were to come not from high school graduates based on national entrance examinations, as before, but from peasants, workers, and soldiers with practical experience but with junior high school preparation, selected on political criteria. The standards in this new educational regime proved so low that years later, following the end of the Cultural Revolution, the so-called peasant-worker-soldier students had to be retrained after graduation to reach university level.[88]

The experiment in recruitment and enlistment in science turned out to be a complete failure: it may have produced a "red," but not by any means "expert," generation. When the pragmatist party leader Deng Xiaoping, who was purged by Mao during the Cultural Revolution, returned to power following Mao's death in 1976, he brought the returnee/carryover generation of scientists back into power. The older scientists often bypassed the peasant-worker-soldiers of the Maoist era and began to train a new generation of scientists who came through a restored educational system. Many of the latter also began to pursue studies abroad, especially in the U.S.A. and Western Europe.

Deng's advocacy of utilitarianism continued to dominate Chinese science policy in the 1980s and 1990s as market-driven economic reform brought another wave of structural changes to Chinese science. A number of scientists did run afoul of the regime in this period, but, again, because of their political beliefs and activities, not their scientific theories. Fang Lizhi, the prominent astrophysicist and political dissident, lost his position as vice president of the University of Science and Technology of China, Hefei, and was expelled from the party when he was blamed for student unrest. However, in a move that echoed that of the Soviet Communist Party, Fang was allowed to work at an observatory in isolation from students. In fact, the regime intentionally publicized his research to indicate that it continued to value science although it discouraged political dissent.89

Despite the claims by the Red Guards and other Maoists at the time, the Cultural Revolution produced few, if any, ideologically correct scientific theories. Much of the energy of the radical Maoist theorists was focused on attacking what they viewed as bourgeois scientific beliefs within and outside of China, rather than constructing new ones. These included Albert Einstein's relativity theory, which the Maoists denounced as politically capitalistic and philosophically idealistic.90 Perhaps the only plausible case of ideologically-correct-science in China took place on the eve of the Cultural Revolution.

On August 18, 1964, Mao Zedong invited several Chinese philosophers of science to his residence in Beijing's Forbidden City to chat about the philosophical implications of new theories of elementary particles. "The world is infinite," he asserted, "time and space are infinite. Space is infinite at both the macro and micro levels. Matter is infinitely divisible." Mao's comments, which were prompted by a recent article on elementary particles written by the Japanese Marxist and physicist Shoichi Sakata, led to widespread, officially sponsored discussions on philosophy of science. A number of physicists participated in the discussion, at the end of which they concluded that, based on Mao's version of dialectical materialism, elementary particles were not "elementary," but could be further divided into constituent parts - stratons - to signify the infinite stratification of matter.91 Starting in 1965, these physicists, many of whom had participated in the making of the Chinese hydrogen bomb, began to construct a theoretical model of how stratons made up hadrons (protons and neutrons).92

At the time, there were already models of hadrons in the West, which assumed that they were composed of quarks, but it was not clear whether quarks were merely mathematical devices or real particles. The Beijing group claimed that its model differed from the quark model in that it was relativistic and assumed that there were real sub-particles that were made up of hadrons. However, the model was essentially compatible with, and later subsumed under the quark model, which eventually did assume that quarks represented not merely mathematical constructs but real physical entities in what is now called the Standard Model.93

There seems little doubt that the initiation and the philosophical interpretation of the straton theory had much to do with Mao's pronouncements on the infinite divisibility of matter in the Chinese context. Maoism provided both the political and ideological justification of a fairly esoteric branch of science that could easily have been branded a bourgeois exercise in an ivory tower. One might argue that these scientists would probably have received protection due to their contributions to the Chinese bomb project, as in the case of Soviet nuclear physicists described by David Holloway. But the fact that some of these scientists were criticized and not allowed to present the theory to an international gathering of scientists in Beijing after the start of the Cultural Revolution, despite the apparent ideological correctness of their work, seems to indicate that the "nuclear umbrella" worked less in Maoist China than in Stalinist Russia.94 The straton model was thus more a case of protective coloration than a genuine scientific creation of dialectical materialism. Yet, perhaps more than any other scientific endeavors in China in the Maoist years, the straton model represented an attempt at ideologically-correct-science.

Not surprisingly, in comparison with the often critical reception of theoretical research by Maoist "revolutionary utilitarianism," applied research fared much better. In addition to the nuclear weapons project, which was both politically correct and utilitarian to the extreme, a number of other fields also received ample moral and material support in the Mao era. The pivotal Twelve-Year Plan in Science and Technology, formulated by hundreds of scientists under the leadership of Zhou Enlai in 1956, for example, identified about fifty-six applied research areas for heavy investment in resources and personnel. Only as an afterthought was "major theoretical problems in natural sciences" tagged on as the last item in the plan. Even in these basic research fields, applications were the major motivation.95

The Communist Party provided lavish rewards for achievements in applied research. Since the early 1990s, the faith in science and technology as the basis of China's modernization has flourished in China under Party leader Jiang Zemin, who had trained as an engineer. By applying modem science and technology to the economy and management, Jiang and his supporters hoped for both a robust economy and a stable social order under Communist rule.

Perhaps no modem state has purged and persecuted its scientists as ruthlessly and repeatedly as the People's Republic of China, but these waves of purges, as well as the intervals of relative tranquility which followed them, had little to do

with ideologically-correct-science. Mao and his successors have wanted first and foremost obedience from their scientists. Ideologically correct conduct is part of this, but in this regard scientists have been no different than other Chinese.

Conclusion

If one assumes that the state (or forces or individuals within it) was imposing ideology on science and scientists, then this implies that science and ideology are separable. In fact, as the above examples demonstrate, even in the case of ICS science is not being determined by ideology, but also is not free of it. No political regime has ever tried consistently and comprehensively to impose ICS on its scientists. There have been individuals or portions of a regime that have tried to impose some ideologies on some aspects of science and on some scientists. However, such individual cases are often "overdetermined": there are alternative explanations other than ICS, both for the specific ideological attacks and the efficacy of the victims' resistance. On the other hand, ICS did happen. Just because the entire state was not behind it for the entire period does not contradict that. Although ICS in the ideal sense always failed, it also always had a significant effect, whether an intended one, or not.

No single ideology, including liberal democracy, has historically proven more effective than another in driving science or leading to intended results. Communist regimes appear to have been more likely to try and impose ideological standards on their science, perhaps because Marxism is so comprehensive a political philosophy. In other regimes, ideological attacks on science remained more crude and overt, like National Socialist calls to eliminate "Jewish Science" or anti-communists in the United States during the 1950s denouncing "internationalism" in science.

Although communist regimes were sometimes the most ruthless oppressors of their own scientists, they were also sometimes more flexible and pragmatic.96 Thus in the Soviet Union and the Peoples' Republic of China, scientific representatives of the ideological enemy, the "bourgeois specialists," were kept on for a while, sometimes even pampered, in order to bridge the gap of time between the beginning of the revolution and the point at which the new regime had trained its own, ideologically acceptable (or more ideologically acceptable) scientists. In some cases, these holdovers from the previous regime held on long enough to shed their label and remain productive and sometimes integral parts of their national scientific efforts.

This would have been inconceivable in Hitler's Germany. The few exceptions of Jewish or part-Jewish scientists who managed to survive the Third Reich working for the regime are the exceptions that prove the rule. The overwhelming majority of "non-A$_{ry}$an" scientists were purged because of their race and irregardless of their expertise or the scientific needs of the regime. Similarly, scientists suspected or accused of communist sympathies during the McCarthy period were damaged goods and not to be used by the government. It should

also be noted that, whatever the actual loss of scientific manpower to Hitler's Germany and Eisenhower's America, in both cases there were sufficient numbers of ambitious, competent, and politically and ideologically acceptable scientists to fill the vacancies.

It is probably no coincidence that all of these examples also deal with military conflict or preparations for it. The French Revolution and National Socialism unleashed war, the Soviet Union and the People's Republic of China were born of war, Japan was fighting the Second World War, and in the 1950s America and the Soviet Union were battling in the Cold War. The militarization of society and of science bring the two closer together: the farmer's chances for success may hinge on the military potential of its science and technology; while the latter's service to its nation at war may entangle and immerse it more deeply in the regime's political and ideological goals. One pattern thus emerges quite often in the examples studied by this essay: the military potential of science and scientists outweigh and overrule attempts to purify science ideologically.

It was never easy to introduce ideologically driven and compliant science and technology. Purges of scientists or attacks on scientific theories on ideological grounds were often self-defeating and short-lived. Scientists sometimes suffered, but not because they were scientists, rather because they were part of a greater ideological or racial group perceived by the regime to be a potential threat. When challenged, scientists did not defend themselves by claiming the ideological neutrality of their work and demanding intellectual freedom. Instead they strove to blunt attacks by either winning over their critics or enlisting other patrons. Of course, this meant that they had to work closely, or at least more closely with at least some forces in the state and demonstrate their usefulness to them.

The end result was usually partial success for the established (and now sometimes embattled) scientific community, for their critics were eventually silenced and they did safeguard some of their professional prerogatives, but also partially entailed an accommodation to, and collaboration with ideological aspects of the regime, sometimes directly related to their scientific work, other times in a more general form

This is not what the sociologist Robert Merton or physicist Samuel Goudsmit predicted in the aftermath of the Second World War and the beginning of the Cold War.97 Science is not especially suited to democracy, as Goudsmit claimed, and is able to compromise some of Merton's norms for scientific work. Indeed it is striking, that, despite the great differences between these often very different examples, most of the scientists responded in a similar way when their apolitical science was threatened. ICS tells us that (1) no matter how ruthless, totalitarian, racist, or intolerant a regime might be, when it needs its scientists, it will do what it has to in order to harness them; and (2) whether they support the regime whole-heartedly or not, most scientists, or perhaps better put, scientific communities, will do what they have to in order to be able

to do science. Thus science is independent of particular political and ideological regimes: just not in the way most people believe it is.

Notes

1 Society of Fellows, Harvard University and History Department, Princeton University; Department of History, Bowling Green State University; Union College; California State Polytechnic University, Pomona. We would like to thank the colleagues who read and commented on a preliminary version of our manuscript: Mitchell Ash, Charles C. Gillispie, Loren Graham, Alexei Kojevnikov, and Jessica Wang.

2 Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anti-Communism, and the Cold War* (Chapel Hill, NC: University of North Carolina Press, 1998).

3 Doug Weiner, *Models of Nature* (Bloomington, IN: Indiana University Press, 1988).

4 Harold T. Parker, "French Administrators and French Scientists during the Old Regime and the Early Years of the Revolution," in Richard Herr and Harold T. Parker (eds), *Ideas in History* (Durham, NC: Duke University Press, 1965), 85-109.

5 Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803* (Berkeley, CA: University of California Press, 1971); Charles C. Gillispie, *Science and Polity in France at the End of the Old Regime* (Princeton, NJ: Princeton University Press, 1980), 81–99.

6 Keith Michael Baker, *Condorcet* (Chicago: University of Chicago Press, 1975), 350-2.

7 Henry Moss, "Scientists and Sans-culottes: The Spread of Scientific Literacy in the Revolutionary Year II," *Fundamenta Scientiae,* 4 (1983): 101-15; Gillispie, *Science and Polity in France at the End of the Old Regime,* 143-84.

8 Ken Alder, *Engineering the Revolution: Arms and Enlightenment in France, 1763-1815* (Princeton, NJ: Princeton University Press, 1997), ch. 8; Terry Shinn, *L'Ecole Polytechnique, 1794-1914* (Paris: Presses de la fondation nationale des sciences politiques, 1980); Ambroise Fourcy, *Histoire de !'Ecole Polytechnique* (Paris: Belin, 1987); Nicole et Jean Dhombres, *Naissance d'un nouveau pouvoir: Sciences et Savants en France, 1793-1824* (Paris: Payot, 1989); Janis Langins, "The *Ecole Polytechnique* and the French Revolution: Merit, Militarization, and Mathematics," LLULL, 13 (1990): 91-105; and Janis Langins, La *Republique avait besoin de savants* (Paris: Belin, 1987).

9 For a short account, see Langins, "The *Ecole Polytechnique".* More detailed treatments are provided by the Alder and Langins works cited above.

10 See Charles C. Gillispie, "The *Encyclopedie* and the Jacobin Philosophy of Science: A Study in Ideas and Consequences," in Marshall Clagett (ed.), *Critical Problems in the History of Science* (Madison, WI: University of Wisconsin Press, 1959), 255-89; and L. Pearce Williams, "The Politics of Science in the French Revolution," in Clagett, 291-320.

11 Jessica Riskin, "Rival Idioms for a Revolutionized Science and a Republican Citizenry," *Isis,* 89 (1998): 203-32.

12 Charles C. Gillispie, "De l'Histoire naturelle a la biologie: Relations entre les programmes des recherche de Cuvier, Lamarck, et Geoffrey Saint-Hilaire," in *Collecter, observer, classer* (forthcoming).

13 J.W. Dauben, "Marat: His Science and the French Revolution," *Archives Internationales de l'Histoire des Sciences,* 22 (1969): 235-61; Gillispie, *Science and Polity in France at the End of the Old Regime,* 290–330.

14 See Hahn, *passim,* for references to primary literature on the Jardin.

15 Loren R. Graham, *The Soviet Academy of Sciences and the Communist Party, 1927–1932* (Princeton, NJ: Princeton University Press, 1967); and Alexander

Vucinich, *Empire of Knowledge: The Academy of Sciences of the USSR (1917–1970)* (Berkeley, *CA:* University of California Press, 1984).

16 Graham, *The Soviet Academy of Sciences,* 24-79; and Kendall E. Bailes, *Technology and Society under Lenin and Stalin: Origins of the Soviet Technical Intelligentsia, 1917–1941* (Princeton, *NJ:* Princeton University Press, 1978).

17 Lynn Mally, *Culture of the Future: The Proletkult Movement in Revolutionary Russia* (Berkeley, *CA:* University of California Press, 1990). Katerina Clark, "The Changing Image of Science and Technology in Soviet Literature," in Loren R. Graham (ed.), *Science and the Soviet Social Order* (Cambridge, *MA:* Harvard University Press, 1990), 266-67.

18 Mally, chapter 6.

19 On specialists during this period, see Bailes.

20 Jeremy R. Azrael, *Managerial Power and Soviet Politics* (Cambridge, *MA:* Harvard University Press, 1966). On the economics and politics of the NEP period, see Stephen F. Cohen, *Bukharin and the Bolshevik Revolution:* A *Political Biography, 1888-1938* (Oxford: Oxford University Press, 1980), and Robert V. Daniels, *Conscience of the Revolution: Communist Opposition in Soviet Russia* (Boulder, CO: Westview Press, 1988).

21 On the tense compromise between ideological promotion of young Soviet acolytes like Landau and the surviving tsarist professorate, see Karl Hall, "Purely Practical Revolutionaries," (Ph.D., Harvard University, 1999).

22 For a detailed account of the Shakhty Trial and the subsequent Industrial Party Affair, see Bailes, chapter *3.*

23 David Holloway, *Stalin and the Bomb* (New Haven: Yale Universiry Press, 1994).

24 On the education system generally in this period, see Sheila Fitzpatrick, *The Commissariat of Enlightenment: Soviet Organization of Education and the Arts under Lunacharsky, October 1917–1921* (Cambridge: Cambridge University Press, 1970). On the reform of institutes, see Loren R. Graham, "The Formation of Soviet Research Institutes: A Combination of Revolutionary Innovation and International Borrowing," *Social Studies of Science,* 5 (1975): 303-29. On Leningrad Physico-Technical Institute in this period, see Paul Josephson, *Physics and Politics in Revolutionary Russia* (Berkeley, CA: University of California Press, 1991).

25 See Graham, *The Soviet Academy of Sciences,* 24-79; Vucinich, 72-129; and Azrael, chapters 3-4.

26 Bailes.

27 Sheila Fitzpatrick, *The Cultural Front: Power and Culture in Revolutionary Russia* (Ithaca, NY: Cornell University Press, 1992).

28 David Joravsky, *Soviet Marxism and Natural Science, 1917-1932* (London: Routledge and Kegan Paul, 1961).

29 Loren R. Graham, *Science in Russia and the Soviet Union:* A *Short History* (Cambridge: Cambridge University Press, 1993), ch. 5.

30 Loren R. Graham, *Science, Philosophy, and Human Behavior in the Soviet Union* (New York: Columbia University Press, 1987), chaps 1-2.

31 David Joravsky, *The Lysenko Affair* (Cambridge, *MA:* Harvard University Press, 1970); Krementsov; Valery N. Soyfer, *Lysenko and the Tragedy of Soviet Science* (New Brunswick, NJ: Rutgers University Press, 1994); Zhores A. Medvedev, *The Rise and Fall of* T.D. *Lysenko,* (New York: Columbia University Press, 1969); David Joravsky, "Soviet Marxism and Biology Before Lysenko," *Journal of the History of Ideas,* 20 (1959): 85-104; Dominique Lecourt, *Proletarian Science? The Case of Lysenko* (Norfolk, VA: NLB, 1977); Nikolai L. Krementsov, *Stalinist Science* (Princeton, NJ: Princeton University Press, 1997).

32 Kirill 0. Rossianov, "Stalin as Lysenko's Editor: Reshaping Political Discourse in Soviet Science," *Configurations,* 3 (1993): 439-56; and Kirill 0. Rossianov, "Editing Nature: Joseph Stalin and the 'New' Soviet Biology," *Isis,* 84 (1993): 728-45.

33 Alexei Kojevnikov, "Rituals of Stalinist Culture at Work: Science and the Games of lntraparty Democracy circa 1948," *Russian Review,* 57, 1 (1998): 25-52.

34 Mitchell Ash and Alfons Sallner, "Forced Migration and Scientific Change after 1933," in Mitchell Ash and Alfons Sallner (eds), *Forced Migration and Scientific Change: Emigre German-Speaking Scientists and Scholars after 1933* (Cambridge: Cambridge University Press, 1996), 1-19.

35 Alan Beyerchen, *Scientists under Hitler: Politics and the Physics Community in the Third Reich* (New Haven, CT: Yale University Press, 1977).

36 Rudolf Vierhaus and Bernhard vom Brocke (eds), *Forschung im Spannungsfekl von Politik und Gesellschaft–Geschichte und Struktur der Kaiser-Wilhelm/Max-Planck-Gesellschaft* (Stuttgart: OVA, 1990); Kristie Macrakis, *Surviving the Swastika: Scientific Research in Nazi Germany* (Cambridge, MA: Harvard University Press, 1993).

37 Mark Walker, *Nazi Science* (New York: Plenum, 1995).

38 Robert Proctor, *Racial Hygiene: Medicine under the Nazis* (Cambridge, MA: Harvard University Press, 1988); Paul Weindling, *Health, Race, and German Politics between National Unification and Nazism, 1870–1945* (Cambridge: Cambridge University Press, 1989); Uwe HoBfeld, "Staatsbiologie, Rassenkunde und Modeme Sythese in Deutschland wahrend der NS-Zeit," in Rainer Bramer, Uwe HoBfeld, and Nicolaas Rupke (eds), *Evolutionsbiologie von Darwin bis heute* (Berlin: VWB, 2000), 249–305; Uwe HoBfeld and Thomas Junker, "Synthetische Theorie und 'Deutsche Biologie': Einfiihrender Essay," in Bramer, HoBfeld, and Rupke, 231-48; Thomas Junker, "Synthetische Theorie, Eugenik und NS-Biologie," in Bramer, HoBfeld, and Rupke, 307-60.

39 Walker, *Nazi Science.*

40 Jacques Pauwels, *Women, Nazis, and Universities: Female University Students in the Third Reich* (New Haven, CT: Greenwood Press, 184).

41 Alexander Mitscherlich and Fred Mielke, *Doctors of Infamy: The Story of the Nazi Medical Crimes* (New York: Henry Schuman, 1949); Robert J. Lifton, *The Nazi Doctors: Medical Killing and the Psycholo$_{gy}$ of Genocide* (New York: Basic Books, 1986); Benno Muller-Hill, *Murderous Science: Elimination by Scientific Selection of Jews, Gypsies, and Others, Germany 1933-1945* (Oxford: Oxford University Press, 1985).

42 For biology, Ute Deichmann, *Biologists under Hitler* (Cambridge, MA: Harvard University Press, 1996); for physics, Beyerchen, David Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (New York: Freeman, 1991), Mark Walker, *German National Socialism and the Quest for Nuclear Power, 1939-1949* (Cambridge: Cambridge University Press, 1989), and Walker, *Nazi Science;* for mathematics, Herbert Mehrtens, "Ludwig Bieberbach and 'Deutsche Mathematik,'" in E. Phillips (ed.), *Studies in the History of Mathematics* (Washington, DC: American Mathematical Association, 1987), 195-247; for psychology see Ulfried Geuter, *The Professionalization of Psycholo$_{gy}$ in Nazi Germany* (Cambridge: Cambridge University Press, 1992), Mitchell Ash, "From 'Positive Eugenics' to Behavioral Genetics: Psychological Twin Research under Nazism and Since," *Historia Pedagogica - Intemational]oumal of the History of Education, Supplementary Series,* 3 (1998): 335-58, and Mitchell Ash, "Constructing Continuities: Kurt Gottschaldt und Psychological Research in Nazi and Socialist Germany," in Kristie Macrakis and Dieter Hoffmann (eds), *Science and Socialism in the* G.D.R. *in Comparative Perspective* (Cambridge, MA.: Harvard University Press, 1999), 286-301, 360-65; for chemistry Ute Deichmann, *Fluchetn, Mitmachen, Vergessen* (Weinheim: Wiley- VCH, 2001); for technology, Karl-

Heinz Ludwig, *Technik und Ingenieure* im *Dritten Reich* (Di.isseldorf: Droste Verlag, 1974) and Helmut Maier, "National sozialistische Technikideologie und die Politisierung des 'Technikerstandes': Fritz Todt und die Zeitschrift 'Deutsche Technik,'" in Burkhard Dietz, Michael Fessner, and Helmut Maier (eds), *Technische Intelligenz und "Kulturfaktor Technik"* (Munster: Waxmann, 1996), 253-68.

43 Cassidy; Walker, *Nazi Science.*

44 Michael Neufeld, *The Rocket and the Reich: Peenemunde and the Coming of the Ballistic Missile Era* (New York: Free Press, 1995).

45 Helmuth Trischler, *Luft- und Raumfahrtforschung in Deutschland 1900-1970* (Frankfurt am Main: Campus Verlag, 1992); Ulrich Albrecht, "Military Technology and National Socialist Ideology," in Renneberg and Walker (eds), 88-125, 358-63.

46 Walker, *German National Socialism and the Quest for Nuclear Power.*

47 For physicians, Lifton, Weindling, Proctor; for biologists, Deichmann, Junker; for psychologists, Geuter, Mitchell Ash, "Denazifying Scientists and Science," in Matthias Judt and Burghard Ciesla (eds), *Technolo$_{g\,y}$ Transfer out of Germany* (Amsterdam: Harwood, 1996), 61-80; for anthropologists, Hossfeld; for geographers, Mechtild Rossler, "'Area Research' and 'Spatial Planning' from the Weimar Republic to the German Federal Republic: Creating a Society with a Spatial Order under National Socialism," in Renneberg and Walker (eds), 126-38, 363–6.

48 Two examples are Dr. Pak Ch'ul Jai, an X-ray physicist, and Dr. Lee Tai Kyu, a professor of chemistry, both of whom held positions at Kyoto Imperial University during the war. See Walter E. Grunden, "Hungnam and the Japanese Atomic Bomb: Recent Historiography of a Postwar Myth," *Intelligence and National Security,* 13 (Summer 1998): 32-60.

49 Yukawa was awarded the Nobel Prize in physics in 1949. Taketani Mitsuo, "Methodological Approaches in the Development of the Meson Theory of Yukawa in Japan," in Nakayama Shigeru, David L. Swain, and Yagi Eri (eds), *Science and Society in* Modern *Japan: Selected Historical Sources* (Tokyo: University of Tokyo Press, 1973), 24-38.

50 Hiroshige Tetu, "The Role of the Government in the Development of Science," *Journal of World History,* 9 (1965): 320-39. ltakura Kiyonobu and Yagi Eri, "The Japanese Research System and the Establishment of the Institute of Physical and Chemical Research," in Nakayama, Swain, and Yagi (eds), Science *and Society in Modern Japan,* 158-201. Kamatani Chikayoshi, "The History of Research Organization in Japan, *Japanese Studies in the History of Science,* 2 (1963): 1-79.

51 S. Watanabe, "How Japan Has Lost a Scientific War" (September 1945), File: "Historical Information," RG 38, Box 111, U.S. National Archives, Washington, DC.

52 Yomiuri Shimbunsha (ed.), "Nihon no genbaku" (Japan's Atomic Bomb), in *Showa shi* no *Tenn6* (The Emperor in Showa History), vol. 4 (Tokyo: Yomiuri Shimbunsha, 1968), 78-229.

53 John W. Dower, "'NI' and 'F': Japan's Wartime Atomic Bomb Research," *Japan in War and Peace: Selected Essays* (New York: New Press, 1993), 55-100. Morris Fraser Low, "Japan's Secret War? 'Instant' Scientific Manpower and Japan's World War II Atomic Bomb Project," *Annals of Science,* 47 (1990): 347-60.

54 Walter E. Grunden, "Science under the Rising Sun: Weapons Development and the Organization of Scientific Research in World War II Japan" (Ph.D., University of California at Santa Barbara, 1998).

55 Tessa Morris-Suzuki, *The Technological Transformation of Japan:* From *the Seventeenth to the Twenty-First Century* (Cambridge: Cambridge University Press, 1994), 144-5.

56 Morris-Suzuki, 145.

57 Excerpts of Lieutenant-General Tada Reikichi, President of the Board of Technology, from Captain George B. Davis to Major Francis J. Smith, "Transmittal of Items from the 'Daily Digest of World Broadcasts'" (27 July 1945), "Japan, Misc" RG 77, Entry 22, Box 173, Folder #44.70, U.S. National Archives, College Park, MD; See also, Major H.K. Calvert to Major EJ. Smith, "Japanese Militarists Want Miracle Weapon" (29 May 1945) "Japan, Misc" RG 77, Entry 22, Box 173, Folder #44.70, U.S. National Archives, College Park, MD.
58 Peter Williams and David Wallace, *Unit 731: Japan's Secret Biological Warfare in World War II* (New York: The Free Press, 1989).
59 For a concise treatment of McCarthyism in general, see Ellen Schrecker, No *Ivory Tower: McCarthyism and the Universities* (New York: Oxford University Press, 1986) and Ellen Schrecker, *The Age of McCarthyism: A Brief History with Documents* (Boston: Bedford Books, 1994).
60 Lawrence Badash, *Scientists and the Development of Nuclear Weapons:* From *Fission to the Limited Test Ban Treaty, 1939-1963* (Atlantic Highlands, NJ: Humanities Press, 1995), 102.
61 Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," *Historical Studies in the Physical and Biological Sciences,* 18 (1987): 149-229.
62 Richard G. Hewlett and Jack M. Holl, *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission* (Berkeley, CA: University of California Press, 1989), ch. 4, "The Oppenheimer Case," 73-112.
63 Wang, *Anti-Communism,* 289-95.
64 Wang, *Anti-Communism,* 274-9.
65 "Scientists Affirm Faith in Oppenheimer," *Bulletin of the Atomic Scientists,* 10 (May 1954): 188-91. "Scientists Express Confidence in Oppenheimer," *Bulletin of the Atomic Scientists,* 10 (September 1954): 283-6.
66 Steven E. Ambrose, *Eisenhower: The President* (New York: Simon and Schuster, 1984), 166.
67 Eisenhower to Robert E. Sherwood, April 21, 1954, in *The Diaries of Dwight* D. *Eisenhower,* reel 4, 193. See also Dwight D. Eisenhower, *Mandate for Change, 1953-1956* (Garden City, NY: Doubleday and Company, Inc., 1963), 314.
68 Hewlett and Holl, 111-12.
69 Wang, *Anti-Communism.*
70 Interview with Herbert York by Zuoyue Wang, La Jolla, CA, July 18, 1992.
71 Daniel Kevles, "Cold War and Hot Physics: Science, Security, and the American State, 1945-56," *Historical Studies* in *the Physical and Biological Sciences,* 20 (1990): 239-64.
72 Wang, *Anti-Communism,* 261-2, 281.
73 Schrecker, No *Ivory Tower,* and Schrecker, *The Age of McCarthyism;* interview with Wolfgang Panofsky by Zuoyue Wang, Stanford, CA, March 5, 1992.
74 Schrecker, No *Ivory Tower;* Wang, *Anti-Communism,* 254-261.
75 William Lanouette, *Genius* in *the Shadows: A Biography of Leo Szilard, the Man Behind the Bomb* (Chicago: University of Chicago Press, 1994).
76 Wang, *Anti-Communism,* 277.
77 Wang, *Anti-Communism,* 289-295, Schrecker, *The Age of McCarthyism,* 92-94.
78 Zuoyue Wang, *In the Shadow of Sputnik: American Scientists and Cold War* Science *Policy* (forthcoming). Wang, *Anti-Communism.*
79 Schrecker, No *Ivory Tower;* Schrecker, *The Age of McCarthyism,* 92.
80 James Reardon-Anderson, *The Study of Change: Chemistry* in *China, 1840-1949* (Cambridge: Cambridge University Press, 1991), 339-64, on 359.
81 Yao Shuping *et al., Zhongguo kexueyuan* (Chinese Academy of Sciences), 3 volumes (Beijing: Contemporary China Press, 1994), vol. 1, 26-7.

82 Jonathan Spence, *The Search for* Modem *China* (New York: W.W. Norton, 1990), 572.
83 Yao *et al.,* 87-9.
84 See, for example, Peter Neushul and Zuoyue Wang, "Between the Devil and the Deep Sea: C.K. Tseng, Ocean Farming, and the Politics of Science in Modem China," *Isis,* 91, 1 (2000): 59-88.
85 See, for example, several articles in the Chinese official journal *Bai nian chao* (Hundred Year Tide), June 1999, especially Li Zhenzhen, "Interview with Yu Guangyuan and Li Peishan," 23–30, and "Interview with Gong Yuzhi," 31-27.
86 See Jin Chongji, *Zhou Enlai zhuan(A* Biography of Zhou Enlai), 2 volumes (Beijing: Central Documentation Press, 1998), vol. 1, 234.
87 Dai Minghua, *et al.,* "Zhou Guangzhao" in Lu Jiaxi (ed. in chief), *Zhongguo xiandai kexuejia zhuanji* (Biographies of Modem Chinese Scientists), 6 volumes (Beijing: Science Press, 1991--4), vol. 6, 187-96.
88 Wu Heng, *Keji zhanxian wushinian* (Fifty Years on the Scientific and Technological Front) (Beijing: Science and Technology Documentation Press, 1992), 348-9.
89 See H. Lyman Miller, *Science and Dissent in Post-Mao China: The Politics of Knowledge* (Seattle: University of Washington Press, 1996).
90 Xu Liangying and Qiu Jingcheng, "Guanyu wuoguo 'wenhua dageming' shiqi pipan ai-in-si-tan he xiangduilun de chubu kaocha" (A Preliminary Study of the Movement to Denounce Einstein and Relativity During the Period of the Great Cultural Revolution in Our Country), in Xu (ed. in chief), *Ai-in-si-tan yanjiu* (Einstein Studies), 1 (1989): 212-50.
91 Gong Yuzhi, "Mao Zedong yu zhiran kexue" (Mao Zedong and the Natural Sciences), in Gong, *Zhiran bianzhengfa zai zhongguo* (Dialectics of Nature in China) (Beijing: Peking University Press, 1996), 87-112.
92 He Zuoxiu, "A History of the Establishment of the Straton Model," *Yuanshi zhiliao yu yanjiu* (Documentation and Research in the History of the Chinese Academy of Sciences), 1994, issue no. 6, 16-30.
93 He.
94 Holloway.
95 See "1956-1967 nian kexue jishu fazhan guihua gangyao" (Outline of a Long-Term Plan for the Development of Science and Technology, 1956-1967), in Chinese Communist Party Central Documentation Institute (ed.), *Jianguo yilai zhongyao wenxian xuanbian* (Selected Key Documents Since the Founding of the Country) (Beijing: Central Documentation Press, 1992-), vol. 9, 436-535.
96 Also see for the example of the German Democratic Republic the following articles: Mitchell Ash, "Wissenschaft, Politik und Modemitat in der DOR: Ansatze zu einer Neubetrachtung," in K. Weisemann, P. Kroener, and R. Toellner (eds), *Wissenschaft und Politik: Genetik und Humangenetik in der DOR (1949-1989)* (Munster: LIT Verlag, 1997), 1-26; Mitchell Ash, "1933, 1945 und 1990 - drei Bruchstellen in der Geschichte der deutschen Universitat," in A. Sollner (ed.) *Ostblicke - Perspektiven der Hochschulen in den neuen Bundeslandem* (Opladen: Westdeutscher Verlag, 1998), 212-37; Mitchell Ash, "Scientific Changes in Germany 1933, 1945 and 1990: Towards a Comparison," *Minerva,* 37 (1999): 329-54.
97 See the introduction to this volume, as well as Jessica Wang, "Merton's Shadow: Perspectives on Science and Democracy since 1940," *Historical Studies in the Physical and Biological Sciences,* 30, No. 1 (1999): 279-306, and David Hollinger, "The Defense of Democracy and Robert K. Merton's Formulation of the Scientific Ethos," in David Hollinger, *Science, Jews, and Secular Culture: Studies in Mid-Twentieth Century American Intellectual History* (Princeton, NJ: Princeton University Press, 1996), ch. 5.