"Ideologically-Correct" Science: The French Revolution

By Mark Walker[*]

(1) Introduction

In 2003, together with several colleagues, I published a paper entitled "Ideologically Correct Science".[1] This phrase, of course, is meant to be analogous to "politically correct," which different dictionaries define in various ways, for example:

> The avoidance, often considered as taken to extremes, of forms of expression or action that are perceived to exclude, marginalize, or insult groups of people who are socially disadvantaged or discriminated against.[2]

However, this definition does not capture the potential for dishonesty in political correctness, whereby actions or statements are justified by the concerns listed above, but in fact were for other reasons. Most important for this article, this definition also does not include the modification of behavior or speech, not out of the concern mentioned above, but rather in order to avoid criticism for transgressing or even appearing to transgress against the accepted conventions of political action and speech.

This is the sense in which "ideologically correct science" (ICS) is meant here: scientists and scientific institutions were accused of being out of step or worse with political or ideological principles and sometimes responded by actually or apparently modifying their speech and conduct in order to avoid this criticism. We compared several case studies in this regard, including the French Revolution, the Russian Revolution and subsequent Stalinist regime, National Socialism in Germany, Imperial Japan during the Second World War, the McCarthy period in the United States, and the Cultural Revolution in Communist China.

Our treatment of the French Revolution was hindered by the available secondary literature. In particular, we were waiting for Charles Gillispie to publish his second volume of his history of science and polity in Old Regime and revolutionary France. In the mean time, this

book has appeared. This article draws upon Gillispie's two-volume history[3] to revisit ICS in the context of the French Revolution, and briefly compare this with our other examples.

There is a pattern that recurs, at least in large part, throughout our examples. Each begins with science in an "Old Regime," before the respective political and ideological transformation. Science, scientists, and scientific institutions are an important part of the state, and well-integrated into it, although the role they play may be quite different from what will come. Just as there is little if any hint during the last years of the Old Regime of the political and social change that will come, the scientific community and its relationship with the state also do not appear to be anticipating or preparing for change.

When the political revolution does come, for example in late eighteenth century France, Russia at the end of the First World War, Germany between the world wars, and China under Mao, or when there is a profound shift in the political climate, as in the Second World War in Japan, or during the McCarthy error in the United States, these bring with them a political and ideological threat to the established, orthodox scientific community. This threat includes, but is not limited to, a call for a different type of science (thus the title of this paper), one that is compatible with the politics and ideology of the movement. These calls are often made by a rebel subset of the scientific community, sometimes by outsiders, sometimes by both.

This is what is meant by an "ideologically-correct" science. In France, revolutionaries denounced "aristocratic" science. More than a century later in Russia, a "proletarian" science should replace a "bourgeois" one. National Socialist scientists in Germany attacked "Jewish" science in favor of "Aryan" science. Japanese leaders called for a distinctly Japanese form of technological development based on the nation's imperatives during the Second World War. During the Cold War American politicians denounced "international" science and demanded instead an "anti-communist" one. Finally, during the Chinese Cultural Revolution, "bourgeois" science was supposed to be replaced by a "people's" science.

There was much more to ICS than mere calls or denunciations, however. Scientists were purged in all of these examples except perhaps Japan, and in France, Russia, and China sometimes executed. In some cases this was because of their position as scientists, other times scientists fell victim to more general purges of their society. Where the push for a "purer" science was spearheaded by rebel members of the scientific community, these often took the place of the colleagues who were now gone. The purges itself shook the entire scientific community.

Just as important, if not more so, was the transformation of scientific institutions, for these are the main vehicles for science interacting with the state. This also took several different forms. Some institutions were shuttered, with new ones created in their place. Others were taken over by scientists loyal to the new political constellation. Still other institutions were transformed. In the end, the result was the same: both the scientific community and its institutions were thereby yoked more tightly to the political and ideological goals of the state.

After this initial phase of political attacks, purges, and takeovers of institutions, the established, orthodox scientific community, or rather what was left of it, responded by entering into a closer cooperation or collaboration with elements in the state or government in order to counter the rebel threat, beat back calls for ICS, and secure their position. With the help of the state, the initial, radical threat was silenced, both because--which is often not appreciated, either at the time, or subsequently--this radical threat was never equivalent to the political or ideological movement as a whole, and because the state recognized that the scientific community can make a valuable, indeed sometimes necessary contribution to its policies.

The result was a tighter integration of the scientific community and the state, for the benefit of both--at least in some respects. Scientists are dependent on the state, for only it can provide the material and institutional support necessary for modern science, including the educational system. Along with material support, for scientists and their institutions, professional autonomy, or at least partial autonomy, trumps other concerns. ICS was a direct threat to this autonomy, whereas placing science more effectively and immediately in the service of the policies of the state, even extreme ones, was not. The fact that science is an inherently elitist profession with regard both to talent and education makes the scientific community vulnerable to attacks from outsiders, especially in the context of populist revolutionary movements, but also more willing to accommodate itself to the state in return for the safeguarding of its elite status.

(2) "Old Regime" Science

France, at the end of the Old Regime, enjoyed an established and productive scientific community, complete with institutions, publications, and prize competitions. British science, like the British Empire, was a worthy rival, but hardly eclipsed the French. No other nation--Germany did not yet exist, and the United States was in its infancy--came close in the quality and quantity of scientists and scientific institutions.

Demonstrated mathematical ability was the usual prerequisite for success in French science, despite the fact that several individuals, after having thus gained entrance to the scientific community, then branched out into other fields. The exact sciences were more prestigious than the descriptive sciences like natural history, although these were also well established and embodied in the Botanical Garden.[4] Science, just like the greater society, was fundamentally elitist and aristocratic. Ability was required, but, with few exceptions, the education that was also necessary was only provided to the social elites. If a commoner managed enough education and demonstrated ability, he might succeed in science, but there was no perception that such talent latent in the lower classes needed to, or even should be fostered by the state.

The government valued science and mathematics, and their applications through engineering and medicine, for their value to the state, not as an end in itself. Engineering, both civil and military, was cultivated through schools with competitive examinations based on mathematics. Medicine and medical education was similarly fostered for maintaining the public health. Institutions allowed engineering, medicine, and science to be elite professions, including various societies and schools, and culminating in the Academy of Sciences.[5]

The Academy, like its counterpart in Britain, the Royal Society, was one of the first scientific institutions that appear modern. Scientists were elected on the basis of their scientific work--although professional rivalries and political influence resulted in some positions being given to individuals with lesser talents--and received both honor and a salary. The Academy's journals provided a forum for its members to publish their work. All of this was in the service of the French state, which meant in particular that the Academy was called upon to provide advice, to judge applications for royal privileges (analogous to having patent rights) and scientific works, and occasionally to investigate cases of possible charlatanism.

These responsibilities occasionally brought the Academy and its scientists directly into conflict with scientific outsiders and the larger population. The French state used the Academy to judge inventions and their inventors' desire for royal privileges.[6] It was sometimes a frustrating, if not humiliating experience when the inventor and his work were judged, and especially when it was turned down. The Academy was also called upon to assess the effectiveness of mesmerism, Franz Anton Mesmer's technique of using animal magnetism to heal people. When the Academy commission concluded on the eve of the Revolution in 1784 that there was nothing to this treatment, its “arrogant dismissal of what everyone found fascinating” collided with the fact that many people were convinced that they had been cured.[7]

Antoine Lavosier, along with being a prominent scientist, was also an investor in tax farming, whereby private individuals paid the state for the privilege of collecting taxes in a given jurisdiction for profit. When the corporation of tax farmers, acting on Lavosier's initiative, obtained the authority to erect a wall around Paris in order to thwart traffickers smuggling dutiable commodities into the city by way of many side streets, both Lavosier as an individual and science in general were resented.[8]

But perhaps the most foreboding conflict between the Academy and a pretender was between its scientists and Jean-Paul Marat, the former physician turned propagandist who subsequently played so important a role in the French Revolution. During the Old Regime Marat published his own scientific work, including experiments with optics and new theories of light, heat, and electricity that conflicted with those of Newton himself. When Marat did not receive the recognition he felt he deserved, he blamed the arrogant mandarins sitting in the Academy.[9] As Gillispie comments:

> ... scientists throughout history have considered themselves the benefactors in their work and influence of the whole people whose friend Marat now [during the Revolution] set up to be, and ... scientists probably have been right, materially at least. But it remains true that science has not always, or perhaps usually been perceived as benefaction by those subjected to the authorities whose powers it augments. Of course it is only coincidence that ... Marat ... should have traversed most of the misery of his own life vainly and unequally contending with and against science.[10]

Scientists who received the royal favor benefitted, others did not, but whereas individuals felt that they had been wronged, there was no perception that the relationship between science and the state should be different. In particular, as Gillispie notes in concluding his volume on science and polity during the Old Regime:

> What is it that statesmen have generally wanted of science? They have not wanted admonitions or collaboration, much less interference, in the business of government, which is the exercise of power over persons, nor in the political maneuverings to secure and retain control of governments. From science all the statesmen and politicians want are instrumentalities, powers but not power: weapons, techniques, information, communication, and so on. As for scientists, what have they wanted of governments?

> They expressly have not wished to be politicized. They have wanted support, in the obvious form of funds, but also in the shape of institutionalization and in the provision of authority for the legitimation of their community in its existence and in its activities, or in other words its professional status.[11]

Thus this bargain, instrumentalities for legitimation, already existed before the Revolution.

Although the financial structures of the Old Regime were breaking down, science and its integration into the French state and French society were stable and productive--no revolution appeared necessary or imminent. The range and quality of French science on the eve of the Revolution demonstrates the effectiveness of the educational system through which the great majority of the Academy of Science had passed. Very few French scientists of any note were self-taught, whereas almost all of the much smaller number of their English contemporaries were.[12]

The currents of reform in science that were visible did not appear to be leading towards the changes the Revolution would bring, rather instead can be traced clearly back to the Enlightenment and its emphasis on knowledge and reason. Indeed historians have argued that Condorcet, whose life and career ended during the Revolution, represents the end of this intellectual movement. Along with Condorcet in the social sciences, Vicq d'Azyr worked to reform medicine and Lavosier chemistry during the last years of the Old Regime.[13] These reforms were intended to make the state more efficient, and to improve the quality of peoples' lives, but not to challenge the political, social, or scientific status quo.

In 1787 Lavosier, here functioning as a political representative, not a scientist, accurately and clearly described the structural failings of the feudal system and how they interfered with agriculture and the rest of the economy. However, "It was not merely on economic grounds that Lavosier deplored this structure of prescriptive abuses. He was equally vehement on the moral damage they inflicted through the systematic humiliation of the productive classes in the name of law."[14] Lavosier proved to be prescient about these matters, but not about his own fate.

(3) Calls for an "Ideologically-Correct" Science

French science, and in particular the Academy of Sciences, came under pressure because of the momentous renunciation of aristocratic privilege on 4 August of 1789 by liberal nobles in the National Constituent Assembly and the subsequent elimination of feudal privileges and payments. Careers of all sorts should now be open to talent, not birth. But the Academy was a privileged body jealous of its prerogatives.[15]

> It was a corporation, a privileged corporation, one among the myriad boxes into which the Old Regime compartmentalized French society and kept the subjects of the King in thrall to the crown and separate from each other. Or so the revolutionary generation felt. That any vestige of corporatism was inadmissible was among the unquestioned givens of politics... No intermediate allegiances, no portioning of sovereignty, must intervene between the individual citizen and the state which, in Rousseau's formula, embodies the general will.[16]

Only late in 1789 did the Academy begin to question the conformity of its own regime with the revolutionary order of things. On the eighteenth of November the Duc de la Rochefoucald, a member and one of the liberal noblemen mentioned above, called on the Academy to purge itself of the taint of the past by framing a constitution that would eliminate every feature of its organization and procedures smacking of inequality or privilege.[17] This political initiative was not popular, and the Academy members, who ranged from scientists who would subsequently embrace Jacobinism to conservative, if not reactionary royalists, were not of one mind politically. They began to consider reforms, but did not hurry.[18] On 25 August 1792, just before France was declared a republic and approximately a year before the Terror, Antoine Fourcroy moved that the Academy expel those members who were know for lack of civic spirit[19] then and there. This unwelcome motion was postponed.[20]

The latent antagonism towards the Academy became very clear when the Convention opened in September 1792 with the tasks of governing France and drafting a new constitution for the republic. Condorcet, the permanent secretary of the Academy, was elected vice president of the Convention. He had become a republican, but as Gillispie notes, Condorcet was too principled to succeed in the Convention.[21] Condorcet also dominated the Convention's

Committee of Public Instruction, and used it to make a proposal for a reformed national educational system.

Condorcet would have preserved the Academy under another name, a National Society for Science and the Arts, and placed it on the very top of the national system of education. Science would have been the strong backbone of the curriculum, with everything under the oversight of scientists. The essential scientific functions of the Academy would have been sheltered within the apolitical educational framework.[22]

The Convention reacted with hostility to every suggestion of preserving institutionalized authority of any sort in science as in culture generally.[23] Strident voices objected that advanced education of any sort would produce an "aristocracy of savants" and "reproduce the academies under another name."[24] Indeed:

> ... this system subverts every principle of liberty and equality... it will have no other effect then to create two classes of men, those who think and reason, and those who believe and obey... you will reject, with justified indignation, this monstrous concept of a National Society, serving mainly to intrude into the State a National Administration, an autocratic government for science and the arts, a seminary, a literary priesthood... which would quickly become nothing but a nest of intrigue and corruption...[25]

and

> It is passing strange that the nation, after having shaken off the yoke of tyrants, after having rid itself of priestly domination, should under the guise of science and enlightenment be visited with the proposition of conferring special and permanent status at the expense of the public upon a certain class of citizens. And what citizens? Precisely those men with the greatest ability to dominate public opinion and to steer it. For self-named savants are held in a kind of superstitious awe like that surrounding kings and priests. I allude to our vaunted academies... [Suggesting that] the sciences are more harmful than advantageous to morality... It may be that we became so corrupt only because we had too much learning... In order to be happy, the French people need only enough science to be virtuous.[26]

This is the romantic ideology of the radical Enlightenment philosophe Jean-Jacques Rousseau, where virtue and emotion trump science and reason. The political class of the revolutionary years was deeply marked by Rousseau and the Rousseauist mentality that "loves nature and hates science." Any perception that the authority of science compounds abuses of authority accentuated those hostile attitudes and brought them out into the open.[27] Thus the condemnation of the Academy resonated strongly with the main Jacobin thrust of the Revolution as it led France into the Terror.

(4) Purge of Scientists and Transformation of Scientific Institutions

The practice of science under the Convention was dominated by three topics: reform of education and scientific institutions; a new metric system of weights and measures; and the war.[28] How these played out were determined by the course of the French Revolution, the Convention and the dictatorial Committee of Public Safety it created, and the Terror. Not surprisingly, the Terror, which saw such great loss of life through the guillotine and other radial policies like dechristianization, was also the period of the Revolution when scientists were purged and the transformation of institutions begun.

Resentment of the Academy of Science had long festered in the breasts of artisans, inventors, apothecaries, and laborers subject to its authority. The most paranoid voice and the most venomous pen were Marat's,[29] whose influence soared during the Revolution when he turned his hand to propaganda and politics. He launched his denunciations the Academy and its scientists in his newspaper, The Friend of the People.[30]

Marat took his revenge for the Academy rejecting his experiments and theories during the Old Regime in a forty-page pamphlet, The Modern Charlatan or Letters on Academic Charlatanism, published in September 1791, concurrently with the elections to the Legislative Assembly. He portrayed himself, not as the enemy of reason and knowledge, rather their defenders. "In a century said to be philosophic and amid a nation calling itself free, can it be thought a crime to unmask academic charlatanism, and to repudiate the epoch of barbarism that its ensconced adepts seek to revive?" Stipends were paid gratuitously to academicians and were part of the generalized scandal of pensions lavished on the favored few. Marat argued that such corporatism among the elite did not at all encourage scientific productivity, rather stifled creativeness.[31]

But Marat went beyond such arguments to muckraking and deceptive, if not false claims. He accused mathematicians like Laplace and Monge of being automatons--the opposite of what followers of Rousseau would want. Condorcet was essentially accused of being a second-hand pimp: Marat accused his patroness of benefitting financially from having been the mistress of a nobleman, and then Condorcet of helping her and getting a cut of the money she had "earned."

Marat was even harder on Lavosier:

> Since he has no ideas of his own, he takes over those of others, but since he almost never knows what to make of them, he abandons them just as easily and changes systems as he does shoes... If you ask me what he has done to be so extolled, I shall reply that he has procured himself an income of 100,000 livres, that he formed the project of turning Paris into a vast prison, and that he changed the name of acid to oxygen, of phlogiston to nitrogen [Marat had this wrong]... These are his claims to immortality. Proud of these great things, he now sleeps on his laurels while his parasites praise him to the sky...

After painting such harsh portraits of leading academicians, Marat asked his readers to "Judge from that the utility of academies and the virtue of their members... vile henchmen of despots, cowardly boosters of despotism." [32]

There was also a significant number of actual or would-be inventors who were advocating for new patent laws and wanted to be judged by their peers, not the haughty and excessively intelligent academicians, who would judge their cases at so high a level that the true merit would not be recognized: "The most enlightened body may be the most dreaded."

> How cruel and vexatious were the exaggerated pretensions of academic bodies! How revolting was that empire, tyrannical and destructive of industry, which the wealthy accorded to these usurious vampires, these despotic hornets always eager to devour the honey produced by the bees, who took advantage of their wealth or power, whether in order to seize hold of the hives also, or in order to reduce the artisans to fabrications of a degrading and ruinous sort and to deprive them even of the honor attaching to their work by usurping their inventions, by all sorts of discouragements that wearied and rebuffed their zeal, their courage, and their steadfastness, and finally by forcing most of

> them to abandon their ideas, or their specifically successful discoveries, whether because they wounded the self-esteem of the most privileged, or because they infringed on interests in pre-existing enterprises.[33]

Given the attacks by Marat and others close to the Jacobins, it is no surprise that the Academy was dissolved early in the Terror. When Condorcet and his allies tried to put a reform through that closed the other academies, but spared the Academy of Sciences, it was rejected. On 8 August 1793 the Convention decreed that: "All the academies and literary societies licensed or endorsed by the nation are abolished" and their facilities--botanical gardens, observatories, apparatus, libraries, museums, etc. would be placed under the oversight of unspecified governmental authorities. A speech by the artist David dealt the coup de grace. Though his examples of abuses came mainly from the Academy of Painting and Sculpture, David delivered a diatribe on "the absolute necessity of destroying en masse all academies, last refuge of all aristocracies."[34]

The law of 8 August contrasts sharply with the fate of the formerly Royal Botanical Garden.[35] Two months earlier the same Convention, already dominated by the Jacobin faction, converted the Botanical Garden and Natural History Cabinet into the Museum of Natural History.[36] The contrast with how the Academy reacted to the Revolution is equally stark. Early in the Revolution, the staff at the Botanical Garden produced the first democratic constitution for a fully modern scientific organization ever written. Its new purpose would be to research and teach the whole field of natural history, with particular attention to the improvement of agriculture, arts, and trades. All of its officers would have the title of professor and would enjoy equal rights and equal salaries. The director would be elected from their number for a term of one year, could be reelected once, but not again for at least two years.[37] The legislation for the Museum of Natural History passed the Convention at once, with no discussion among deputies whose minds were on other things.[38]

Gillispie interprets this in the following way:

> One would not wish to argue that intellectual and cultural factors were a sufficient cause either of the suppression of the Academy of Sciences, or of the creation of the Muséum, or indeed of any of the myriad other events that made the Revolution what it was. In all cases, real political, social, and economic interests were in play. But latent attitudes do

> help explain how the Convention, preoccupied with saving a Republic beset by war, rebellion, and treason, could have taken the decisions it did in the few moments its agenda allotted to the affairs of science. An assembly of educated, articulate laymen responded favorably to a political démarche on behalf of an already popular institution of natural history. Thereupon, they responded unfavorably to the effort mounted by leaders of the scientific establishment to defend the structure it had inherited against attacks by external critics and enemies, many of them working-class, whom the Academy had dominated, offended, or excluded.[39]

The five Academy members who had been most widely involved in public affairs at the start of the Revolution and had been visible as champions of the public welfare all perished: Bailly, who had served politically both in the Constituent Assembly and as mayor of Paris, was guillotined along with Lavosier. The liberal Noble La Rochefoucauld was assassinated by a mob. Vicq d'Azyr was driven to death, and Condorcet hounded to death.[40] The scientists who were not mobilized for the war were primarily preoccupied with their personal safety during the Terror. Laplace and others took the simple precaution of leaving Paris.[41]

Bailly, along with Lafayette, was unfairly blamed for the massacre of the Champ-de-Mars on 15 July 1791, when troops opened fire on the crowd. This was exacerbated by journalistic jabs reminding the public of his pompous bearing while mayor, blackening his image throughout the winter and spring of 1792. His trial was staged on 11 November. Bailly was arrested, tried, and found guilty in short order of conspiring with Louis Capet (the former Louis XVI), his widow, and others to disturb the peace, excite civil war and subvert liberty. The Revolutionary Tribunal further ordered the guillotine moved to the Champ-de-Mars for his execution.[42]

Although Lavosier was brilliant in many ways, his mind could not grasp revolutionary politics. “Lavosier's own temperament was such that he could never let go, nor accept that presentation of exact facts would not in the end prevail.”[43] Among officials of the Old Regime, it was common, and not improper, to multiply sources of income by occupying several positions at once. Lavosier made money from the General Tax Farm, drew a stipend as Gunpowder Administrator, was paid a salary by the Discount Bank, and received a pension from the Academy of Sciences as well as a fee for each meeting he attended. Unfortunately, “in the puritanical light of revolutionary public spirit,” the accumulation of offices was now considered

an "abuse." Lavosier, known to be a very wealthy man, then compounded his image problem by advertising his self-sacrifice, his devotion to public service, and his disinterestedness.[44]

Even in scientific circles his peers had more respect than sympathy for Lavosier, while he was distinctly unpopular among lesser scientists, the political class, and insofar as he was known at all, the general public. All the shareholders in the former federal Tax Farm within reach of the police, including Lavosier, were arrested. Both colleagues, and Lavosier himself, tried and failed to win him an exception, or at least a reprieve, because of his importance in technology. The tax farmers were summarily tried and executed. [45] With one possible exception, the scientists best placed to succor Lavosier neither said a word or lifted a finger. "Perhaps they agreed that participation in the General Farm was probably a capital offense. Perhaps they feared for themselves. Perhaps they simply averted their gaze finance being none of their concern. Or all of the above."[46]

Vicq d'Azyr had become physician to the queen in 1788, an honor that became a liability after the Revolution and a mortal danger after the royal family's aborted flight to Varrennes, when he refused to abandon his patient. He tried to compensate by demonstrating civic spirit. He was given numerous onerous jobs ranging from the trivial to the objectionable. When Robespierre staged the Festival of the Supreme Being on 8 June 1794, Vicq d'Azyr dared not stay away. He joined the crown marching through blazing heat to the Champ-de-Mars, where they listened and applauded. It was too much for him. He fell ill with congestion in the lungs accompanied by raging fever, and died delirious two weeks later.[47]

Condorcet could not join either faction in the Convention. He and Robespierre "distrusted each other politically and detested each other viscerally," which did not bode well when the latter became a dictator.[48] Condorcet helped draft one constitution that went nowhere in the Convention. When the Committee of Public Safety subsequently approved the radical constitution of the year III, Condorcet anonymously authored a broadside critique that led to the order for his arrest. He went into hiding, where he paradoxically wrote The Progress of the Human Mind, now his most famous work. He died while on the run, probably from a stroke, which spared him the guillotine.[49]

(5) Collaboration

The Terror and attacks on the scientific establishment in France brought great pressures to bear on scientists and their institutions. These did not react by resisting the

Committee of Public Safety, or rejecting its ideology, but rather by working ever closer with the state to help it achieve some of its most important goals. This collaboration both redeemed science and eventually silenced its critics.

With the exception of war work, organized scientific activity ceased during the Terror and its immediate aftermath.[50] In Cuvier's funeral oration of Berthollet, he justified scientists working for the war effort during the Revolution and under Napoleon with an argument that a scientist might well have made in the twentieth century as well: "Paradoxical though the assertion may appear, it would be easy to prove that the means of destruction furnished by science, in rendering combat more decisive, have made wars less frequent and more decisive."[51]

Lazare Carnot, the most prominent scientist, or scientifically trained engineer in the war, was simply the first military leader who "thoroughly believed in the Revolution that brought him to power." The war France was fighting had little in common with the static military operations for which he had been trained. It had to be fought, "not by noble officers animated by fading notions of chivalry in command of professional armies serving for pay, but by untrained, patriotic citizens in all ranks taking up arms to defend liberty and equality at home and impose those boons abroad."[52] Armies largely composed of raw recruits and conscripted peasants would have to overcome the training and skill of professional soldiers through their sheer mass and patriotic spirit.[53]

One of the most important ways scientists helped the revolutionary government was to use their expertise to find and seize material goods of value to France. Beginning early in the Revolution, the French government began applying the principle that property of the enemies of the people rightfully belongs to the nation. In 1790 the possessions of church, monarchy, and émigrés were expropriated. André Thouin, head gardener at the Botanical Garden, pointed out to authorities that the botanical wealth contained in the gardens of Versailles and other royal and noble estates was now being neglected (their owners had fled or were in hiding) and might be lost. He was given blanket authority to canvass the gardens and to transplant, before winter set in, whatever plants might be useful. It was important to salvage as many specimens as possible in order that provincial botanical gardens be enriched against the day when public education would begin.[54]

During the Terror, the Convention concentrated all oversight of the cultural patrimony, artistic, literary, and scientific, in the hands of a new Temporary Commission for the Arts.[55] The leading scientists were far too busy with war work, but lesser known specialists proved

perfectly capable of conducting the innumerable investigations and recommending appropriate dispositions of the manifold objects and resources they identified.[56] This policy was expanded to include the property of enemies of the people outside of France. The Committee of Public Safety subsequently ordered the creation of commissions of science and arts to accompany the armies in occupied countries. Their orders were: "... to betake themselves to Belgium and other countries occupied by the Armies of the North ... in order to collect all the monuments, all things of value, and all resources of learning that had any relevance to arts and sciences in order to enrich the Republic."[57]

Although many regions were plundered, the Netherlands offered an especially valuable treasure in the form of the Collection of the Stadtholder of Holland. French scientists received orders to proceed immediately to The Hague, to assess and conserve the Stadtholder's reportedly magnificent natural history collection, and to transport to Paris whatever might enrich the Museum of Natural History.[58]

They reported back that the Stadtholder's Natural History Collection was unique in the world. Because it had drawn from Dutch colonies, which were inaccessible to others, it contained specimens little known or totally unknown elsewhere. At least two-thirds of the collection would improve, augment, and complement the contents of the Museum and would make the French national collection the greatest in the world and the most useful for the progress of natural science. The first shipment consisted of one hundred forty-seven cases containing hundreds of choice specimens. The second of seventy-four containers included seventeen additional cases of natural history, ten full of scientific books. Living animals, including two elephants, followed.[59] As Gillispie notes: "No hint that anyone in Paris felt the slightest compunction about all this has come to light in the archives."[60] This expropriation had a direct effect on the advancement of French science. The natural historian Cuvier made a successful career at the Museum and greatly advanced knowledge in his field thanks in part to the collections taken from Holland.[61]

Napoleon Bonaparte followed this precedent in 1796-1797 when he named a commission of science and art headed by the mathematician Monge and scientist Berthollet to accompany the army of Italy. Napoleon enlarged it still more dramatically for his campaign to Egypt in 1798-1801.[62] "The tone of Monge's letters home mingles satisfaction with the rightness of exporting democratic revolution, the enthusiasm of a tourist enraptured on a first visit to Italy, and the enterprise of an art dealer with no scruples about a free hand in a good cause." Indeed Monge argued that French curatorial expertise was going to save the legacy of

antiquity and the Renaissance, which had been neglected in Italy, from the mold, decay, and insects that threatened them. The restoration and installation in the Louvre of these treasures would preserve them and make them available to all Europe.[63]

In response to the military threat, the Committee of Public Safety injected a revolutionary impetus into French society for industrial production in service of the war. Copper was produced by melting down church bells[64] and new processes sought for tanning hides quicker for shoe leather.[65] This new thrust provided opportunities for scientists to prove their worth. Scientists responded to the hostility expressed towards the Academy by inventors and artisans by working with them for the good of the war effort. The Bureau for the Consultation of Arts and Trades had already established in October of 1791.[66] Here academicians joined together with delegates from the crafts and trades as well as other non-academicians. Week after week, serving on subcommittees of two or three, they pored over specifications, drawings, and models and judged concrete mechanical devices. Despite the tension, the scientists and technicians serving on the Bureau appear to have developed a working solidarity among themselves. The Bureau operated throughout the Convention. Lavosier served on it until he was guillotined.[67]

The Committee of Public safety also created a weapons laboratory, what Gillispie argues "is not fanciful to define as the distant forerunner of Los Alamos," the Meudon Proving Grounds,[68] which remained an active site of military research and development into the Napoleonic period.[69] Scientists there worked on incendiary and explosive cannonballs, which were on the cutting edge of high-tech weaponry.[70] Other scientists tried to adapt aircraft to warfare, using tethered balloons for long-range observation.[71] These applications of science to warfare were still ahead of their time, and did not significantly influence the course of the war.

What France really needed was more high-quality gunpowder and muskets. Once again, Lavosier worked to serve the Revolution in this way. In the six months before resigning definitively from the Gunpowder Administration after the overthrow of the monarchy in August of 1792, Lavosier developed simplified procedures for the cold refining of saltpeter that made possible the revolutionary production of saltpeter and gunpowder and victory abroad.[72] From mid-May through mid-August he labored virtually full time on the problem of assaying crude saltpeter. This was the first time that a serious chemist had refined saltpeter with his own hands, instead of merely studying the principles and overseeing the refinery. Since his time was running out, He wrote up and published his incomplete experiments, including an exact

description of the apparatus he would have set up and the procedures he would have followed.[73]

Here, Gillispie argues, one needs to be precise about the role played by science. Gunpowder production was increased to meet the needs of the armies, but this was mainly due to the efforts of people already knowledgeable about the process, rather than consulting scientists, intervening politicians, or the participation of the general public. The influence of science was indirect. Because of the intervention of scientists, technicians became better educated, and conducted their work in a far more scientific fashion than they had done.[74]

Along with gunpowder, the French armies needed a reliable supply of muskets. During the Revolution the French experimented precociously with the development of constructing firearms from interchangeable parts. This was demonstrated in principle, but artillery officers were reluctant with regard to the social desirability of replacing skilled craftsmen with low-paid workers.[75] The Committee of Public Safety created another new institution, the Development Workshop,[76] to speed up the production of muskets. Once again, this was a technical success but a political failure. The artisans followed the new system only under duress and reverted to traditional methods for most of their output, which did increase in the late spring and summer of 1794.[77]

An important part of the revolutionary war effort was the mass mobilization of French society for the war. This included setting up armaments factories all across Paris.[78] In the late spring of 1794, at the height of the Terror, the capital of France was outwardly transformed into an open-air armory and a collective munitions factory, supplying the armies of the Republic.[79] These had been in place for a year before being closed down in November 1794; now, during Thermidor (the period following the Terror), this effort was considered impossible: the raw materials were often defective, the workers inexperienced, and the instructors incompetent. Much of the effort had gone into repair. Most important, the French armies had captured quantities of weapons from the enemy. But the goal of the Committee of Public Safety had not been just productivity. By distributing the forges massively in public places and along promenades adequate to accommodate them, they sought to inspire the people, make them feel confident in their resources, and to make "the populace itself the watchman over the impediments that this great effort of fabrication might encounter." [80]

Scientists were directly mobilized for the propagation of scientific knowledge useful for war production. In September 1793 the Committee of Public Safety ordered publications created and distributed within the several industries. In very short order a set of well-illustrated

technical manuals patriotically issued from the press.[81] The revolutionary manuals contained scientific knowledge of particular techniques, authored by important scientists. What brought them to the problems, however, was neither scientific curiosity nor a wish for recognition from their peers in a defunct Academy. It was the summons from the Committee. These publications were also not as effective as hoped: "Do not believe," wrote Roux-Fazillac to the governing committee in April 1794, "that it is possible for ironworkers to make steel with the sole help of the memoir you had distributed; it is too scientific and intelligible only by workers who already know how."[82]

The idea of using scientists to disseminate knowledge useful for workers and artisans was taken a step further with revolutionary courses. First of all there were crash programs of courses on saltpeter, gunpowder, and weaponry. This was expanded to benefit education in general. In October of 1794, during the months following the Terror, a proposal suggested creating: "in advance a large number of teachers capable of carrying into effect a plan... the purpose of which is regeneration of the human understanding in a Republic of twenty-five million men all of whom democracy makes equal. In these schools it will not be the sciences that are taught, but the art of teaching them. The disciples will not only be educated men; they will be men capable of educating."[83]

Young people were selected from the entire country and would receive intensive instruction given by masters in technical and other modern disciplines.[84] On 20 January 1795 some 1,400 aspirants overflowed the amphitheater of the Museum of Natural History, which had seats for 750, and spilled out into the garden. Like the munitions workers who had warmed the same benches, they had been selected by distant authorities throughout France in numbers proportional to the local population, in many cases on the recommendation of local patriotic societies.[85]

"Pedagogically the brave, or perhaps foolhardy, experiment could only be a spectacle, not a success." Relatively few of the auditors were adequately prepared even for elementary lectures. It accomplished more for the professors than the students. Leading scientists were called upon to the whole range of their subject in public, speaking without notes, while stenographers took down what they said. The lectures were subsequently edited for publication.[86] For the first time anywhere, science and higher learning were enlisted in the service of public education. For the first time, students were to be formed by new knowledge imparted firsthand by its makers and not old knowledge.

These revolutionary courses had far-ranging consequences. In the future scientists would typically be professors at the highest level and not just researchers. Reciprocally professors at institutions of higher learning would ideally be researchers and not just teachers, as they had been in the eighteenth century and earlier. Even at the highest level, the professor was expected to address himself to the whole range of his subject, and not merely to his specialty. Scientists were transformed into professors.

Gillispie also sees the interaction between scientists and the revolutionary governments as a collaboration, although he does not use this term:

> What happened amid the urgencies of revolution and war was an increase in the density and intensity of these exchanges. For science the difference in degree amounted to a difference in kind. From 1793 through 1795, scientists in the public eye did nothing else. In consequence, the importance of its success had long held in justifying the intellectual program of the Enlightenment was institutionalized. It was not in response to some démarche of scientists but through recognition of the magnitude of its presence in the events that shaped the future, that science displaced letters as the premier element of culture in the structure of the Institut de France.[87]

(6) Tighter Integration of Science and the State

Although scientists and the revolutionary governments of France entered into a collaboration for various reasons, the cooperation itself had long-term consequences for both. After the Terror the Convention abandoned the radical constitution it had never implemented and wrote a more conservative constitution that created the Directory to rule France. This constitution institutionalized modern science in France by means of the Institute of France,[88] modeled on the abortive educational reform proposed by Condorcet. In a real sense, this was the Academy of Science reborn. Thus it was the Thermidorian Convention and the Directory that conferred pride of place on science in French culture. This was then further entrenched under Napoleon, whose favor and patronage undoubtedly fortified morale among scientists and underwrote a great deal of scientific work.[89]

The French governments of the Convention, the Directory, and Napoleonic Consulate provided the scientific and technical community with the "very prototype of a modern set of institutions, administrative, advisory, honorific, research-oriented, educational, technological,

and journalistic." The Institute of France, Bureau of Longitudes,[90] the Observatory of Paris,[91] the National Museum of Natural History, the Polytechnic,[92] etc.--there was nothing comparable to this galaxy of facilities elsewhere in Europe.[93]

The Institute of France was modeled on the National Society Condorcet had placed atop his proposed educational reform. In contrast to the academies of the Old Regime, which existed by the grace and favor of government, royal or otherwise, the constitution of the year III (1795) guaranteed the Institute by civic right. Its structure demonstrated the "displacement of letters by the revolutionary dominance of science within French culture." The First Class included the physical and mathematical sciences, the Second the moral and political sciences (eventually suppressed under Napoleon), and the Third literature and the fine arts.[94]

The First Class consisted of the surviving members of the Academy together with new people named to fill the vacancies.[95] It utilized a system akin to modern peer review, and set prize contests that were very important for the development of science in the early nineteenth century.[96] Like the Academy of Sciences before it, the Institute of France was responsible for giving the government technological advice. Napoleon himself was a member, and was proud of it--which speaks volumes about the prestigious place of science in his regime. Bonaparte's esteem for the exact sciences and for his colleagues at the Institute, especially for its mathematical members, was well known.[97]

While Laplace retreated from Paris during the Terror, he wrote his soon to be famous book, Exposition on the System of the World.[98] He returned to help create and develop the new Bureau of Longitude (on the British model). This institution was charged with developing astronomy, improving hydrography, cartography, meteorology, and horology, conducting research on terrestrial magnetism, and perfecting the determination of longitudes for the benefit of the Navy and Merchant Marine.[99]

Perhaps the most famous and consequential collaboration between French science and the revolutionary and Napoleonic governments was the creation of the Metric System.[100] Old regime France had many different systems of weights and measures, which was universally condemned as inefficient and detrimental to the national economy. During the early years of the Revolution, the goal of a single system of weights and measures fit well into the passions of the time. France needed a clear break with the corruptions of the past. The revolutionary moment was to be seized. A fundamental reform yielding a standard based upon nature would be "true to the general cause of submerging all relics of feudal diversity in national uniformity."[101]

Just as the Terror in general was at times paranoid and irrational, so was its policy towards science. The Commission of Weights and Measures and its mission were considered important enough to go forward despite the demand of the war. But that did not stop the Committee from purging it in December of 1793 of valuable members at a time when scientific manpower was in short supply:

> considering how essential it is for the improvement of public spirit that those who are entrusted by the government neither delegate functions nor give missions except to men worthy of confidence through their republican virtues and their hatred of kings; after having consulted the members of the Committee of Public Instruction particularly concerned with weights and measures, decrees that from this day on Borda, Lavosier, Laplace, Coulomb, Brisson and Delambre shall cease to be members of the Commission of Weights and Measures, and shall immediately deliver to the remaining members the instruments, calculations, notes, memoirs, and in general everything in their hands related to the operation of measures, together with an inventory; And decrees, in addition, that the members remaining to the Commission of Weights and Measures inform the Committee of Public Safety as soon as possible which persons are indispensably needed to continue its work, and that it communicate at the same time its views on the means for giving all citizens the use of the new measures as quickly as possible, taking advantage of the revolutionary impetus.[102]

Work resumed on the metric system after the Terror and was completed under the Directory. It took much longer for the new system to establish itself among the common people. Indeed what succeeded was the incorporation of the metric system into the educational system.[103]

Equally impressive was Napoleon's Egyptian expedition,[104] carried out just before he came to power. It is striking how many scientists and experts from related fields he brought along. Its Commission of Science and Arts numbered at the outset some 151 persons, 84 of whom had technical qualifications while another 10 were medical men. Bonaparte himself specified which skills were to be represented and how many people he wanted of each sort.[105] Although the campaign was not a military or political success, it was for science. The results of the expedition, an enormous compilation of information on Egypt, were published in thousands of pages, including science, medicine, archaeology, and what might be considered social

science.[106] Perhaps the most famous result was the discovery of the Rosetta Stone in July of 1799.[107] As Gillispie notes, the Egyptian Expedition: "marks the beginning of the spread of European science and its appurtenances to African and Asian societies under the aegis of military conquest and political power."[108]

The legacy of the revolutionary schools became enshrined in the Polytechnic. The faculty consisted of leading scientists.[109] Unlike their counterparts at earlier schools, who were nominated by local authorities, Polytechnic candidates sixteen to twenty years old had to undergo a national competitive examination on mathematics.[110] Polytechnic students received basic training. The several service schools (military and civil) were upgraded and admitted only graduates of the Polytechnic--comparable to that of a modern American undergraduate education.[111]

In 1802, Napoleon ensured the success of the reform of the lower levels of schools, the lycées, by providing many generous scholarships, so that in the short run these schools would not lack for students. His object in the longer run was not to stimulate social mobility but to mobilize talent and attach it to the regime. For that purpose the pool of talent from boys from well-situated families was more than sufficient. Once the flow through the lycées was steady, the number of scholarships could be reduced.[112]

In 1804 Napoleon regimented the Polytechnic, giving it a pronounced military flavor.[113] A year later, students were charged fees. Instead of a school selecting its students on the basis of merit alone, it became a school selecting the most meritorious students whose parents could pay tuition.[114] This fit well with Napoleon's conception of the value of an education: "For people who are not well off, it is dangerous to give them too great a knowledge of mathematics."[115]

Napoleon himself said that he had felt that he had to choose between a military and scientific career,[116] which explains the favors, both honorific and material, that were shown to men of science under the Consulate and Empire. A few favored scientists became wealthy men.[117] With a few exceptions, scientists served the Napoleonic regime as ornaments rather than instruments of state.[118]

(7) Conclusion

French science from the end of the Old Regime to Napoleon does fit the ICS model. There are some striking similarities and significant differences with other examples.

i. Almost all of the ICS examples share with the French Revolution the criticism of the established scientific community as being elitist and unresponsive, if not hostile, to the new society and state.[119]

ii. The plunder of Holland and other countries occupied by French troops in the name of science is reminiscent of the plunder of Soviet plant breeding institutes by German scientists in the service of the National Socialist state.[120]

iii. The murderous purge of the Terror was similar to Stalin's Great Terror in that the purge was not directed towards scientists in particular groups, rather some scientists were included for other reasons. This contrasts with the specific purge of Jewish scientists under Hitler and the targeting of intellectuals, including scientists, during Mao's Cultural Revolution.[121]

iv. French scientists were able to redeem themselves and their community through service to the state, which is very similar to the case with scientists working under National Socialism, but differs from the waves of purge and redemption experienced by Chinese scientists under Mao.[122]

v. Scientists have perhaps never been as honored or rewarded as under Napoleon. ICS in the Soviet Union, National Socialist Germany, Communist China, and perhaps even during McCarthyism in the United States all had a strong anti-intellectual current.

vi. Almost all ICS examples resulted in a tighter integration of science with the state. This is perhaps the main lesson from ICS.

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[1] Michael Gordin, Walter Grunden, Mark Walker, and Zuoyue Wang "'Ideologically Correct' Science," in Mark Walker (ed.), Science and Ideology: A Comparative History (London: Routledge, 2003), 35-65.

[2] Definition from the Oxford Dictionary of English, 2nd Ed. Revised, at http://www.oxfordreference.com/views/BOOK_SEARCH.html?book=t140&subject=s7, accessed 22 January 2010.

[3] Charles C. Gillispie, Science and Polity in France at the End of the Old Regime (Princeton: Princeton University Press, 1980); Charles C. Gillispie, Science and Polity in France: The Revolutionary and Napoleonic Years (Princeton: Princeton University Press, 2004). We referred to the older literature in our earlier article, this article will focus on Gillispie's work.

[4]Jardin des Plantes.

[5] Gillispie, Old Regime, pp. 81-99.

[6] Gillispie, Old Regime, pp. 96, 99.

[7] Gillispie, Old Regime, pp. 261-289, the quotation is from Gillispie, Revolutionary, p.11.

[8] Gillispie, Revolutionary, p. 11.

[9] Gillispie, Old Regime, pp. 290-330.

[10] Gillispie, Old Regime, p. 330.

[11] Gillispie, Old Regime, p. 549.

[12] Gillispie, Revolutionary, p. 135.

[13] Gillispie, Old Regime, p. 198.

[14] Gillispie, Old Regime, p. 387.

[15] Gillispie, Revolutionary, p. 10.

[16] Gillispie, Revolutionary, pp. 166-167.

[17] Gillispie, Revolutionary, pp. 186-187.

[18] Gillispie, Revolutionary, p. 188.

[19] Incivisme.

[20] Gillispie, Revolutionary, p. 210.

[21] Gillispie, Revolutionary, p. 147.

[22] Gillispie, Revolutionary, p. 189-190.

[23] Gillispie, Revolutionary, p. 158.

[24] Gillispie, Revolutionary, p. 163.

[25] Gillispie, Revolutionary, p. 154.

[26] Gillispie, Revolutionary, p. 153-154.

[27] Gillispie, Revolutionary, p. 166.

[28] Gillispie, Revolutionary, p. 141.

[29] Gillispie, Revolutionary, p. 190.

[30] L'Amie du people; Gillispie, Revolutionary, p. 95.

[31] Les charlatans modernes, ou lettrés sur le charlatanisme académique; Gillispie, Revolutionary, p. 191.

[32] Gillispie, Revolutionary, p. 193.

[33] Gillispie, Revolutionary, p. 200.

[34] Gillispie, Revolutionary, p. 165.

[35] Jardin des Plantes.

[36] Cabinet d'Histoire Naturelle, Museum d'Histoire Naturelle.

[37] Gillispie, Revolutionary, p. 165.

[38] Gillispie, Revolutionary, p. 183.

[39] Gillispie, Revolutionary, p. 167.

[40] Gillispie, Revolutionary, p. 10.

[41] Gillispie, Revolutionary, p. 311.

[42] Gillispie, Revolutionary, pp. 315-316.

[43] Gillispie, Revolutionary, p. 319.

[44] Gillispie, Revolutionary, p. 94.

[45] Gillispie, Revolutionary, pp. 318, 322.

[46] Gillispie, Revolutionary, p. 324.

[47] Gillispie, Revolutionary, p. 317.

[48] Gillispie, Revolutionary, pp. 147, 139.

[49] Gillispie, Revolutionary, pp. 329-332.

[50] Gillispie, Revolutionary, p. 285.

[51] Gillispie, Revolutionary, p. 339.

[52] Gillispie, Revolutionary, p. 384.

[53] Gillispie, Revolutionary, p. 385.

[54] Gillispie, Revolutionary, pp. 289-290.

[55] Commission Temporaire des Arts.

[56] Gillispie, Revolutionary, p. 290.

[57] Gillispie, Revolutionary, pp. 434-436, quotation on p. 436.

[58] Gillispie, Revolutionary, p. 439.

[59] Gillispie, Revolutionary, pp. 441-442.

[60] Gillispie, Revolutionary, pp. 442-443.

[61] Gillispie, Revolutionary, p. 451.

[62] Gillispie, Revolutionary, pp. 444, 553.

[63] Gillispie, Revolutionary, p. 554.

[64] Gillispie, Revolutionary, pp. 392.

[65] Gillispie, Revolutionary, pp. 394.

[66] Bureau de Consultation des Arts et Métiers.

[67] Gillispie, Revolutionary, p. 207.

[68] Les Épreuves de Meudon.

[69] Gillispie, Revolutionary, p. 370.

[70] Gillispie, Revolutionary, p. 358.

[71] Gillispie, Revolutionary, p. 371.

[72] Gillispie, Revolutionary, p. 212.

[73] Gillispie, Revolutionary, pp. 406-410.

[74] Gillispie, Revolutionary, pp. 416, 420-421.

[75] Gillispie, Revolutionary, pp. 424-425; also see Ken Alder, Engineering the Revolution: Arms and Enlightenment in France, 1763-1815 (Princeton: Princeton University Press, 1997), and Charles C. Gillispie and Ken Alder, "Engineering the Revolution," Technology and Culture, 1998, 39/4, pp. 733-754.

[76] Atelier de Perfectionnement.

[77] Gillispie, Revolutionary, pp. 425-426.

[78] Manufactures de Paris.

[79] Gillispie, Revolutionary, p. 382.

[80] Gillispie, Revolutionary, p. 427.

[81] Gillispie, Revolutionary, p. 389.

[82] Gillispie, Revolutionary, p. 427.

[83] Gillispie, Revolutionary, p. 495.

[84] Gillispie, Revolutionary, p. 397.

[85] Gillispie, Revolutionary, p. 496.

[86] Gillispie, Revolutionary, pp. 499, 502.

[87] Gillispie, Revolutionary, p. 444; for the Institute of France, see below.

[88] Institut de France

[89] Gillispie, Revolutionary, p. 651.

[90] Bureau des Longitudes.

[91] Observatoire de Paris.

[92] École Polytechnique.

[93] Gillispie, Revolutionary, p. 446.

[94] Gillispie, Revolutionary, p. 447.

[95] Gillispie, Revolutionary, p. 448.

[96] Gillispie, Revolutionary, p. 450.

[97] Gillispie, Revolutionary, p. 611.

[98] Exposition du Syst me du Monde.

[99] Gillispie, Revolutionary, p. 455.

[100] Gillispie, Revolutionary, pp. 223-285, 458-494; also see Ken Alder, The Measure of All Things: The Seven-Year Odyssey and Hidden Error That Transformed the World (New York: Free Press, 2003).

[101] Gillispie, Revolutionary, p. 226.

[102] Gillispie, Revolutionary, pp. 276-277.

[103] Gillispie, Revolutionary, p. 494.

[104] Gillispie, Revolutionary, p. 557.

[105] Gillispie, Revolutionary, p. 561.

[106] Gillispie, Revolutionary, p. 597.

[107] Gillispie, Revolutionary, p. 576.

[108] Gillispie, Revolutionary, p. 600.

[109] Gillispie, Revolutionary, p. 523.

[110] Gillispie, Revolutionary, p. 524.

[111] Gillispie, Revolutionary, p. 528.

[112] Gillispie, Revolutionary, p. 620.

[113] Gillispie, Revolutionary, p. 538.

[114] Gillispie, Revolutionary, p. 539.

[115] Gillispie, Revolutionary, p. 539.

[116] Gillispie, Revolutionary, p. 611.

[117] Gillispie, Revolutionary, p. 612.

[118] Gillispie, Revolutionary, p. 612.

[119] Gordin, Grunden, Walker, and Wang "'Ideologically Correct' Science."

[120] For example, see Susanne Heim, Plant Breeding and Agrarian Research in Kaiser-Wilhelm-Institutes 1933-1945 (Boston: Springer 2008).

[121] See Alexei Kojevnikov, Stalin's Great Science: The Times and Adventures of Soviet Physicists (London: Imperial College Press, 2004); Stefan L. Wolff, Die Ausgrenzung und Vertreibung der Physiker im Nationalsozialismus – welche Rolle spielte die Deutsche Physikalische Gesellschaft? in Dieter Hoffmann and Mark Walker (eds.), Physiker zwischen Autonomie und Anpassung - Die DPG im Dritte Reich (Weinheim: VCH, 2006), 91-138; Zuoyue Wang, "Physics in China in the Context of the Cold War, 1949-1976," in Helmuth Trischler and Mark Walker (eds.), Physics and Politics: Research and Research Support in Twentieth Century Germany in Comparative Perspective (Stuttgart: Franz Steiner Verlag, 2010-forthcoming); also see Richard Beyler, Alexei Kojevnikov, and Jessica Wang, "Purges in Comparative Perspective: Rules for Exclusion and Inclusion in the Scientific Community under Political Pressure,"in Carola Sachse and Mark Walker (eds.), Politics and Science in Wartime: Comparative International Perspectives on the Kaiser Wilhelm Institutes, Osiris 20 (Chicago: U. of Chicago Press, 2005), 23-48.

[122] See Susanne Heim, Carola Sachse, and Mark Walker (eds.), The Kaiser Wilhelm Society under National Socialism (Cambridge: Cambridge U. Press, 2009) and Hoffmann and Walker, Physiker; Wang, "Physics".