The Avenging Sword:
An Analysis of Technology in Nazi Germany

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Contents

To what extent did the government of Germany influence the development of military technology immediately preceding and during World War II and how did this affect the outcome of the war?

The rapid advancement of science and its subsequent application to military technology distinguished World War II from previous large-scale military engagements. Inventions such as radar, aircraft carriers, modern cryptography, and atomic weapons revolutionized the conduct of warfare. Therefore, to fully understand the causes of the war's outcomes, it is necessary to diagnose the progress of technology in each of the major world powers of the war and, more specifically, the effect of the differing governmental systems of those nations on technological advancement. Germany in particular lagged in the development and application of emerging technologies as the war progressed, contributing to its defeat. The policies of the German Third Reich promoted the conversion of German science to applied military technology during the militarization of Germany and the first two years of World War II. However, scientific progress in Germany slowed as the war advanced, and as a result, Germany's military technology suffered. This was due to Nazi ethnic prejudice, political interference in German Universities, a vast array of competing research agencies, a lack of natural resources and manpower, and an underestimation of the duration of the war.

The Militarization of German Science

Germany was the preeminent academic center of early twentieth century science, entering World War II with a large scientific community. The highly disproportionate number of Nobel prizes won by German scientists, the number of citations in prominent physics journals, and the number of papers written in nuclear physics in Germany highlight the momentum of German Science in the early twentieth century against the following decline (Appendix A). Modern

physics, the product of such famous scientists as Albert Einstein, Max Planck, Werner Heisenberg, and Erwin Schröedinger arose predominantly in Germany. During the Weimar era there was a rapid influx of Jews to university teaching positions due to the limited number of career options open to them and the easy path to social advancement academics offered.[1] The Nazi racial prejudice towards Jews created tensions that would later wreak havoc on scientific progress in Nazi Germany.

The National Socialist movement both depended on and supported technological advancement. Alfred Rosenberg, one of the founders of Nazi ideology and author of The Myth of the Twentieth Century, entwined the fates of National Socialism and science by claiming technology "is based on an everlasting German drive which would disappear together with the downfall of technology."[2] Furthermore, Hitler's strategy for fighting *Blitzkrieg,* or "Lightning War," was entirely based upon a massive implementation of military technology. With that in mind, Hitler supported the German academia, although, displaying contempt, he later clarified his position in a private interview in 1931 as merely utilizing German scientists as a means to an end.

> 'Do you not believe that, in the event of a successful revolution along my Party's lines, the brains would not come over to us in droves? Do you believe that the German bourgeoisie [scornfully]–the flower of the intelligentsia–would refuse to follow us and place their brains at our disposal? The German bourgeoisie would, as usual, accept the fait accompli.'[3]

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[1] Josephson, Paul R. Totalitarian Science and Technology. Atlantic Highlands N.J.: Humanities Press, 1996, 56.

[2] Renneberg, Monika and Walker, Mark. Science, Technology, and National Socialism. New York: Cambridge University Press, 1994, 32.

[3] Rose, Paul Lawrence. Heisenberg and the Nazi Atomic Bomb Project: A study in German Culture. Berkeley California: University of California Press, 1998, 236.

Furthermore, in a 1933 article in *Science* entitled "The Scientific Situation in Germany," Dr. Willhelm Frick, Minister of the Interior, was cited as speaking to an assembly of the Kaiser Wilhelm society justifying the association of science with National Socialism.

> 'With all respect for the freedom of science, let us postulate that service to science must be service to the nation and that scientific achievements are worthless when they cannot be utilized for the culture of the people.'[4]

The popularity of National Socialism was due in part to a political approach that combined a promise of technological advancement and a grass-roots public appeal. *Lebensraum* or "Living Space" was a concept based upon German expansion into eastern European lands primarily in the Ukraine. Richard Walter Darré's infamous "Blood and Soil" doctrine reinforced this position and attracted farmers and other members of the lower class who were decimated after the Depression of the 1930s. The economic situation in Germany had been severely impaired by the hefty war reparation payments Germany was required to procure after the loss of World War I, providing an opportunity for the rise of a radical, expansionist government. The marriage of territorial and technological expansion is best demonstrated in German *Orstforschung,* or "Research on the Eastern Lands," which combined racist population policy and scientific planning through the designation of *Hauptdorfs*, lower-class townships of 20,000 people to be built in the lands captured during World War II.[5]

German scientists and engineers were individually willing to aid in the development of military technology. In the wake of the Depression of the 1930s, scientists and engineers found solace in the promise of National Socialism to promote their professional careers through a vast military buildup. This is clearly shown in the immense popularity of Nazi organizations of

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[4] Physics and National Socialism: An Anthology of Primary Sources. Ed. Klaus Hentschel. Trans. Ann Hentschel. Science Networks Historical Studies 18. Boston: Birkhouser Verlag,1996, 60.

[5] Josephson 36-37

scientists and engineers, most notably the Reich Society for Technological and Scientific Work, the National Socialist German Workers Party, and the University Lecturers' League. The latter two were particularly popular with younger university faculty who used party membership as a method of advancing their careers.[6] With the redirection of German scientific thought to military technology, scientists and engineers often sidestepped into making their research useful to the military in order to open up a floodgate for funding. For example, the aim of German rocket research was originally limited to peaceful space exploration, but the concept was retrofitted for military production in order to gain funding.[7] Conversely, there was a superficial sense of professionalism in German science and engineering that dictated a strict separation of science and politics. Using this as an excuse, large numbers of German scientists and engineers were wholeheartedly adopted by the Allied powers after the war's end and immediately employed without strict screening policies.[8] Operations Paperclip and Overcast were two of the United States' attempts to import German scientists and engineers at the close of the war. Stalin went so far as to criticize German technology to incense captured German engineers to work more diligently.[9]

Because of a need to maximize resources, research programs in Germany were reevaluated based upon their immediate benefit to military technology. Sciences that were not directly relevant to Nazi doctrine or military technology were challenged. The newly modernized German physics witnessed a *Deutsche Physik,* or "Aryan Physics," movement that focused on experimental rather than theoretical science. Johannes Stark and Phillip Lenard, who attempted to gain power in academic circles by gaining favor with the Nazi party, led the

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[6] Physics and National Socialism xxxix-xlvi
[7] Renneberg 52-54
[8] Renneberg 46-47
[9] Renneberg 39

movement. They combined German nationalism with science, simultaneously condemning modern physics as tainted by Jewish research. Stark in particular aimed at obtaining the support of other physicists for his own political goals, but most German physicists at the time felt that science should not be influenced by politics.[10] The obvious exception to this rule is Einstein, who frequently dabbled in international affairs and became a political figure first in Germany and later in the United States. By focusing on experimental science and practical applications to technology, the *Deutsche Physik* movement promoted the rapid militarization of German science.

The concentration of power in Nazi Germany allowed roadblocks to scientific research to be overcome. The foremost example is the consolidation of scientific research and development under the Reich Education Ministry (REM). The REM paralleled the Office of Scientific Research and Development (OSRD) in the United States. Both organizations promoted the militarization of science in their respective countries. The power hierarchy in Nazi Germany added an element of irrationality to scientific and technological development because of unpredictable personal conflicts and friendships that influenced political decisions. Albert Speer, the famous Nazi architect and later the Minister of Armaments and War Production, gained power by being personally supported by Hitler. Scientists were oftentimes appointed to university positions because of their party affiliations, and, for this reason, Max Planck urged the wholesale adoption of Nazi ideology in the sciences, so as to prevent unqualified scientists from gaining undue academic offices.[11]

[10] Josephson 60-61
[11] Josephson 64-65

The Decline of Technology Under National Socialism

The most obvious cause of the decline of Nazi technology is the emigration of scientists and engineers because of ethnic prejudice. The 1933 "Law for the Restoration of the Professional Civil Service" created a stream of émigrés that would continue throughout the Third Reich by proclaiming, "civil servants who are not of Aryan descent are to be placed in retirement; in the case of honorary officials, they are to be dismissed from office." [12] The purging of Jews, homosexuals, and other minorities in university teaching positions resulted in the emigration of between 15% and 17% of all university faculty by the end of World War II.[13] The majority of this discrimination was not coordinated on a national level but was instead a result of the pressure of Nazi racist propaganda. Emigration was especially heavy in physics and mathematics and even more specifically in theoretical physics, which was directly targeted by the *Deutsche Physik* movement. The number of math majors in Germany universities dropped by 95% from 1932 to 1939, and the number of physics majors dropped by 75%.[14] The total number of students enrolled in German universities decreased drastically during the Third Reich, even before World War II had begun (Appendix B). Nineteen Nobel laureates in the sciences left Germany from 1933 to 1945.[15] This emigration had a twofold effect: it not only decreased the size of the academic community in Germany, it increased that of the Allied powers as well. Forty-eight percent of all emigrated scientists and engineers ultimately ended up in the United States, and many of those contributed to the Manhattan Project and other military research programs in the United States during World War II.[16]

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[12] Physics and National Socialism 22
[13] Physics and National Socialism lvi
[14] Physics and National Socialism l
[15] Josephson 57
[16] Physics and National Socialism lix-lxi

The reorganization of German universities restricted freedoms and subsequently inhibited innovation. A vast amount of research was subjugated to industry during World War II as part of the formation of the German military-industrial complex. The Nazi Party gave the German Peenemünde research center a monopoly on rocketry research by moving both design and production in-house to maintain top security. With the intervention of the Gestapo, businesses involved in rocket production were forcibly shut down, and talk of rocket design was banned from the press.[17] These and other security measures taken by the German government severely limited the flow of information within the sciences. Although security was vital to all nations during the war, the United States government assumed a fundamentally different role by maintaining the freedoms of institutes of higher learning. Vannevar Bush insisted that universities maintain their independent status, and, as a result, no OSRD laboratories were built during the war as all research was contracted out to universities.[18] He affirmed this position in a federal report in 1945.

> Support of basic research in the public and private colleges, universities and research institutions must leave the internal control of policy, personnel, and the method and scope of the research to the institutions themselves. This is of the utmost importance.[19]

Other restrictions on the German academia are illustrated by the 1937 decree by Hitler that "acceptance of a Nobel Prize is herewith forbidden to all Germans for all future times" after the awarding of the Nobel Peace Prize to Carl von Ossietzky, who was then confined in a German concentration camp.[20]

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[17] Renneberg 56-57

[18] Mann, Alfred K. For Better or for Worse: The Marriage of Science and Government in the United States. New York: Columbia University Press, 2000, 8.

[19] Averch, Harvey A. A Strategic Analysis of Science & Technology Policy. Baltimore and London: Johns Hopkins University Press, 1985, 11.

[20] Physics and National Socialism 141-143

The *Deutsche Physik* movement would have continued unabated causing Germany to become scientifically isolated but for two reasons. Johannes Stark became too influential over scientific research and created enemies in the Reich Education Ministry, most notably in its president Bernhard Rust, which severely diminished Stark's political influence. Also, Werner Heisenberg successfully repelled attacks by Stark and Lenard, who claimed him to be a "White Jew," by gaining the personal support of Heinrich Himmler, the Reichsführer of the SS. Himmler further admonished the claim that theoretical physics was not Aryan by drawing a clear distinction between academic work and ethnicity.[21] This led to the ultimate collapse of the *Deutsche Physik* movement in Nazi Germany and a subsequent re-adoption of theoretical science. However, by this point the *Deutsche Physik* movement had already caused irreparable damage to the German scientific community.

In contrast to physics and mathematics, biological and chemical studies skyrocketed during the Nazi regime due to an increase in funding because they were directly relevant to both Nazi ideology and technology respectively.[22] The eugenics movement in Nazi Germany was a scientific justification of the racist policies of the government and contributed to the prominence of biology during the war. Walter Schoenicher, the director of the Agency for the Preservation of the Monuments of Nature, suggested that all Nazi youth be educated in ethnic science.[23] However, the impact of biology on German military technology during World War II was very minimal due to a ban on biological weapons research imposed by Hitler himself. The only use of offensive biological warfare by Germany during World War II was the pollution of a swamp in

[21] Josephson 63
[22] Renneberg 9
[23] Josephson 35

northwestern Bohemia.[24] The short-lived "Aryan Chemistry" movement failed to produce a significant shift in German chemistry, resulting in the continued progress of German chemistry research as evidenced by the 330% increase in students majoring in chemistry from 1933 to 1939.[25] However, the major chemical advents in military technology had already occurred during World War I, most prominent among them mustard gas. Therefore, the sciences least hampered under Nazi Germany were also the sciences that contributed least to military technology during the war.

The internal divisions within the German hierarchy prevented cooperation between research divisions, which in turn prevented long-term projects from being successful. The "Behemoth" model of Germany, first proposed by Franz Neumann, contends that far from being an authoritarian state, Nazi Germany consisted of a cartel of competing power blocs. The impact of this internal competition on scientific research was extensive. There were research agencies associated with each branch of the military. There were divisions within each branch as well. Aeronautical research programs included the Air Warfare Academy, the German Glider Research Institute, the Air-to-Ground Communications Institute, and the Research Institute Graf Zeppelin. Even the Postal Ministry had its own research center.[26] Willy Messerschmitt had developed the Me 262, a turbofan powered fighter, by 1942, but his personal enemies delayed production, and the first planes did not roll off assembly lines until 1944, too late to be effective and a clear example of the lack of coordination in military research.[27] In1942, Hitler decreed the

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[24] Christopher, George W., LTC USAF, et al. Biological Warfare: A Historical Perspective. University of California at Los Angeles. 29 Aug. 2001 <http://www.lsic.ucla.edu/classes/mimg/summer1_01/micro12/Website/JAMAarticles/history.html>.

[25] Physics and National Socialism l

[26] Physics and National Socialism xxxii

[27] Renneberg 40

formation of a Reich Research Council to be headed by Reich Marshall Göring to consolidate technological research and development. The council was designed to combat the stratification of German research, but had little impact because of its late introduction. Moreover, Göring, wishing to preserve his own aeronautical research institutes, failed to coordinate scientific research and undermined the goal of the council.[28]

As World War II progressed, Germany faced a shortage in natural resources and manpower that hindered technological development. The German war model of *Blitzkrieg* depended on rapid victory over foreign lands and the subsequent assimilation of conquered resources. As an island nation, Japan faced a similar shortage of resources. As the European war slowed during and after the Battle of Stalingrad, World War II developed into a war of attrition, which the Allies, with vast amounts of production power, were more prepared to face.[29] The myriad of aircraft designed toward the end of the war demonstrates the shortage of resources in Nazi Germany. They included fighter-gliders to conserve fuel, rocket aircraft, suicide aircraft with no landing gear, and the *Volksjäger* or "People's Fighter" which was partially constructed of wood and was designated to be flown by the *Hitlerjüngs* or "Hitler Youth" (Appendix C). Albert Speer, Minister of Armaments and War Production, in *Deutsche Technik* in January 1943 appealed directly to engineers to conserve resources.

> 'I call upon the men of German technology to ensure that in the coming year the front has weapons, ammunition, and equipment needed. The task falls upon you to enhance the military might of our people. Your work in the coming year should be guided by the necessity to conserve manpower, material, energy, and transport.'[30]

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[28] Physics and National Socialism xxxiii

[29] Walker, Mark. Nazi Science: Myth, Truth, and the German Atomic Bomb. New York: Plenum Press, 1995, 194.

[30] Renneberg 38

The shortage in resources also affected the scale of research in Germany. Werner Heisenberg later admitted that at the time he was aware of the measures needed to develop an atomic bomb, but he abstained from directly suggesting such a project due to the massive resources it would consume.[31]

German leadership underestimated the duration of World War II, causing long-term scientific programs, which were deemed outside the time span of the war, to be disregarded. The initial victories of *Blitzkrieg* warfare caused overconfidence in the German population that was reinforced by Nazi racist propaganda. The German people were led to believe that the war would be over in a matter of months with only few casualties.[32] Consequently, the general attitude of scientists and engineers emphasized short-term projects. They felt that long-term "wonder weapons" would not be completed by the war's end, and they also feared punishment if they could not deliver on their promises.[33] Atomic bomb research invites a direct comparison of the German and American estimation of the war's duration. Taking a defensive and conservative posture, the United States estimated the war would last on the order of five years, thus pushing Vannevar Bush, the head of the OSRD to vehemently suggest that atomic research was a crucial step to winning the war. His German counterpart, Erich Schumann, the head of the research division of the Army Ordinance department concluded that nuclear fission weapons were impractical for the immediate war at hand, but he allowed the *Uranverein* or "Uranium Project" to continue with minimal funding under the leadership of Werner Heisenberg.[34] The recordings at Farm Hall after the war have shown that German scientists had a working knowledge of nuclear fission comparable to that of the Allies in 1942. Reading newspapers with only vague

[31] Walker 226-227
[32] Walker 193
[33] Walker 196
[34] Walker 195-196

descriptions of the atomic bombs dropped on Hiroshima and Nagasaki, they were able to independently deduce their composition and size, demonstrating that they might have been able to construct a similar bomb had political decisions not preempted such development. Erich Schumann wholeheartedly supported rocketry research instead, and the research center at Peenemünde preceded and was comparable in size to the American Manhattan Project at Los Alamos.[35] The German defeat at Stalingrad caused a nationwide panic in Germany that created a new push for weapons of mass destruction, but the Allies had already gained an unsurpassable lead.

Finally, cooperation on the international level was stunted within the Axis powers, while Great Britain and the United States cooperated effectively. Sir Henry Tizard of Great Britain provided the United States with detailed plans of British inventions, most notably the short-wave magnetron that led to the development of radar at the Radiation Laboratory at MIT.[36] Japan had an independent atomic bomb project that was close to fruition by the end of the war. Because of the resource shortages in Japan, the Japanese requested a supply of uranium from Germany without clarifying its future purpose. Germany initially refused and only later reluctantly agreed, demonstrating the racial tensions between Germany and Japan.[37]

The degree of responsibility of German scientists and engineers for Nazi war crimes remains one of the most important unresolved issues of World War II. German scientists and engineers developed technologies designed specifically for euthanasia and mass genocide. In addition the aforementioned suicide aircraft differed from the Japanese *kamikaze* planes by being built solely for suicidal purposes. Science under Nazi Germany has traditionally been viewed as

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[35] Renneberg 60

[36] Teitelman, Robert. Profits of Science: the American Marriage of Business and Technology. New York: BasicBooks, 1994, 28-29.

[37] Wilcox, Robert K. Japan's Secret War. New York: Marlowe & Company, 1995, 102-104.

a period of discontinuity and German scientists as victims of the Nazi regime, preventing the investigation of the moral implications of Nazi technology. Recently the trend has been reversing, but much research in this direction remains to be conducted.

As shown, the progress of technology in Nazi Germany reveals a distinct decline that directly contributed to the defeat of Germany. Much like the war itself, the initial advancement of technology under Nazi Germany could not be sustained. Of course, the war's outcome had multiple causes, all of which are connected by interdependencies and impossible to entirely isolate, but the mired technological progress of Germany assuredly contributed to its defeat.

Appendix A

The following data tables were taken from the document "American Physics outdoes German Physics" written by Carl Ramsauer in January 1942. Physics and National Socialism, 282-284.

Year of Publication	Germany	USA
1897	64%	3%
1912	54%	7%
1933	36%	33%

Figure 1: Percentages of citations in 5 major physics journals. Countries not shown are England, France, and Russia.

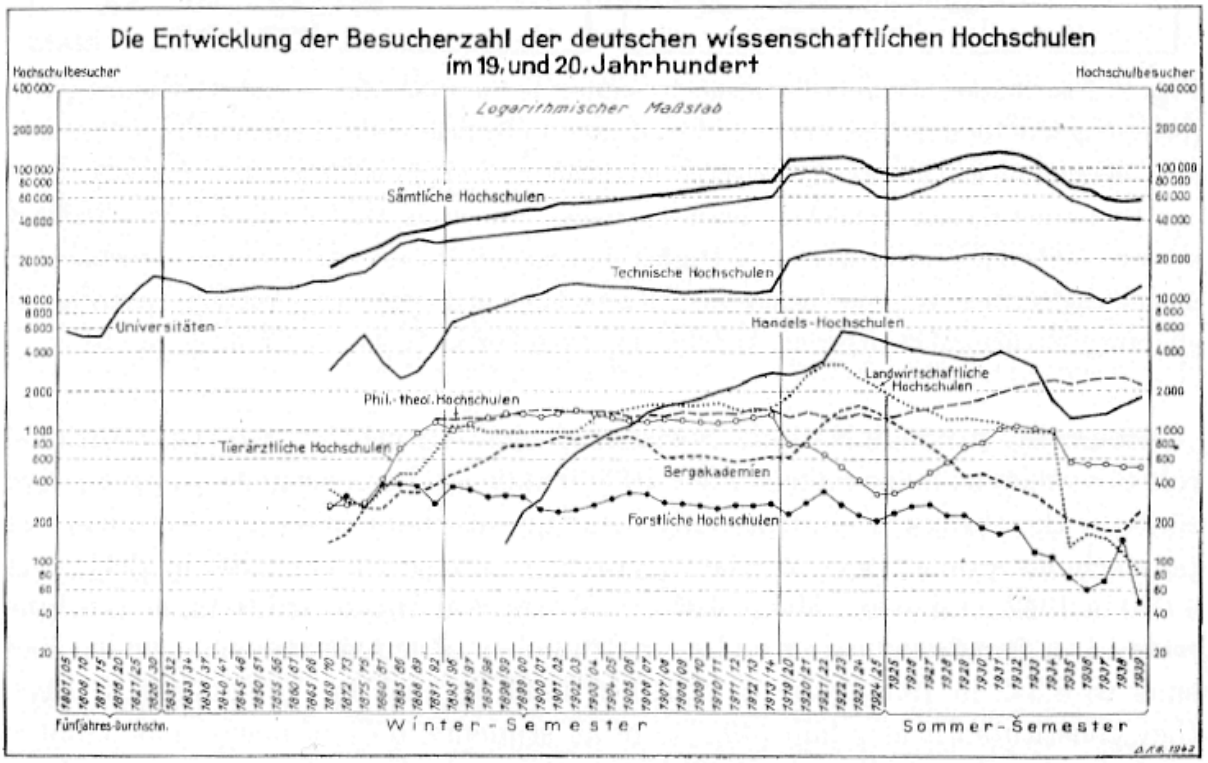
Number of Prizes	1890-1920	1921-1935
Total	33 (100%)	9 (100%)
To Germany	12 (36%)	1 (11%)
To USA	2 (6%)	2.5 (27.5%)

Figure 2: Number of Nobel Prize recipients by country.

	1927	1931	1935	1939
Germany	47	77	129	166
USA and England	35	77	329	471

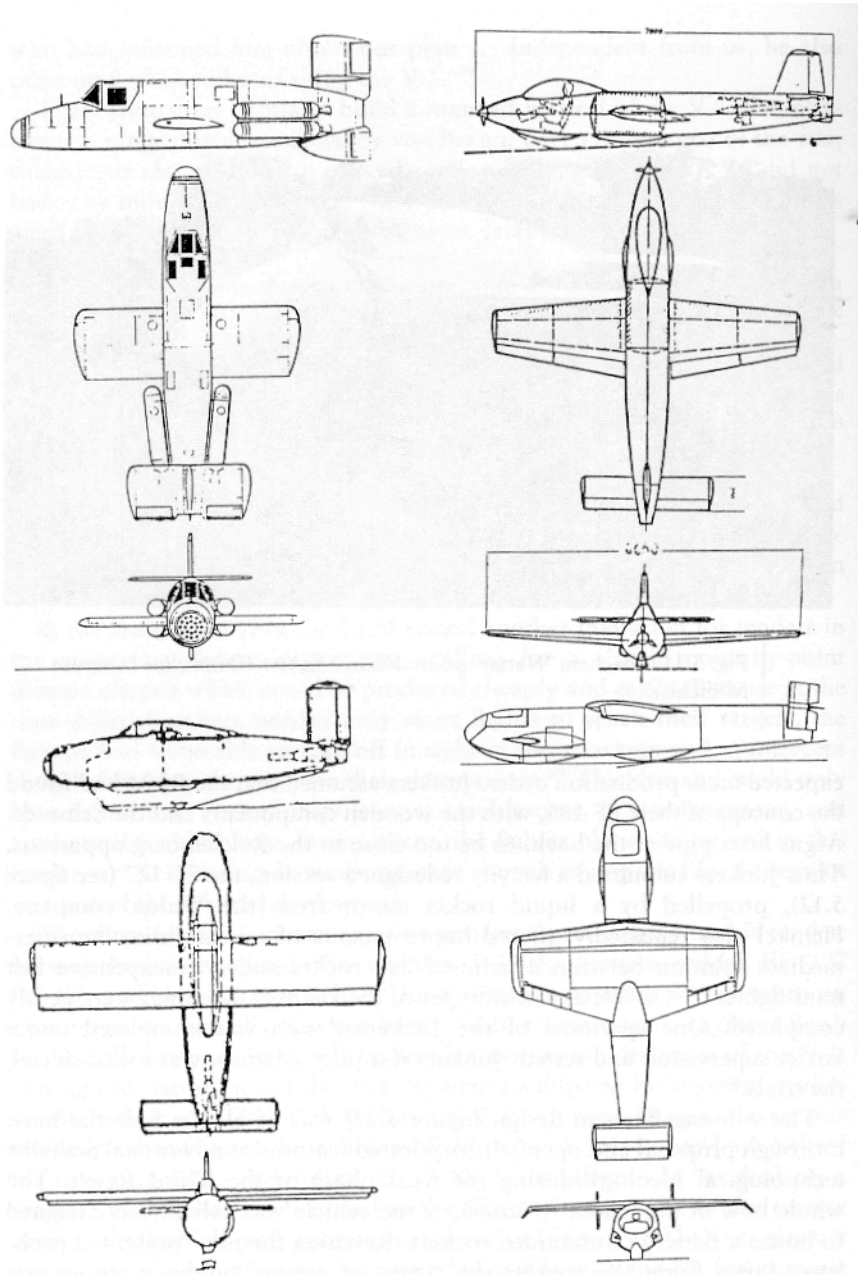
Figure 3: Number of papers written on nuclear physics by country.

Appendix B



"The development of attendance at German universities in the 19th and 20th Centuries. Captions from top: All, universities, polytechnics, business colleges, agricultural colleges, liberal arts colleges, veterinarian colleges, mining academies, forestry colleges, five-year average." Note the logarithmic scale. Physics and National Socialism, li.

Appendix C



Proposals for the *Jägernotprogramm* or "Emergency Fighter Program."[38] Note the lack of landing gear. Renneberg, 118.

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