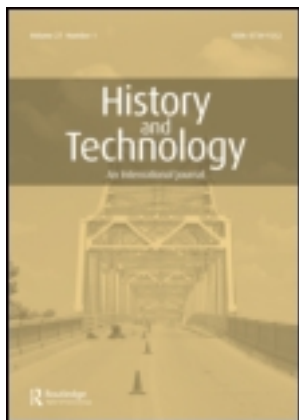


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## The Nazi aerospace exodus: towards a global, transnational history

Michael J. Neufeld\*

The exodus of Third Reich scientific and engineering personnel after World War II has traditionally been understood through its impact on the Cold War missile and space race. This article assesses the state of scholarship on this topic globally, particularly in aerospace professions, in the process drawing some conclusions on the total numbers, skill composition and Nazi backgrounds of the Germans, the stages of movement, and the technological impact of their movement. Such an assessment not only demonstrates the geographical weaknesses in existing knowledge, notably in the scholarship on Britain, France and much of the Third World, but it also points us towards a global, transnational history of the phenomenon, as cross-border flows of people, information, and technology grew beyond the bounds of the victorious powers' national programs for exploiting German knowledge.

**Keywords:** Nazi; aerospace; specialists; Paperclip; Osoaviakhim; Germany

At the end of World War II in Europe, the Allied powers rushed to grab defeated Germany's weapons, technical facilities, industry, and personnel in a campaign that remains unique in the history of modern warfare. At the end of no other recent war has the perception been so strong that the opponent was in the possession of technologies equal or superior to that of the victorious powers. The widespread belief in Nazi Germany's scientific and technological superiority was exaggerated, but there was no doubt that the Third Reich had developed guided missiles, aircraft, and other technologies that were ahead of Allied capabilities even if they had made no effective difference to the course of the war. Allied efforts became not just a matter of evaluating the enemy's weapons and taking war booty and reparations – these were age-old – but rather of exploiting and often exporting technical facilities, equipment, and personnel.<sup>1</sup> This concerted exploitation derived from two intertwined beliefs at war's end: (1) that these technologies would be decisive in future warfare, and (2) that along with nuclear energy, they were prime symbols of a nation state's technological and scientific prowess and, thus, of its power in international relations.

The Cold War only intensified these views. German personnel and their technologies became even more valuable assets as states mobilized research and development in the new context. The USA, USSR, UK, and France, as the four occupying powers of Germany and Austria, initially controlled the movement of personnel and technology, but German specialists soon found their way to other Allied countries and even Third World nations such as Brazil, Argentina, Egypt, and India, becoming part of a complex pattern of superpower relations and postcolonial nation-building. In the first two postwar

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decades, the movement and circulation of German engineering and science experts and teams became a transnational phenomenon in which aerospace personnel were central, because of the centrality of aerospace technologies to Cold War military power, but also because of Nazi Germany's visible and important advances in guided missiles, jet aircraft, and high-speed aerodynamics.

In popular and academic historiography, this historical process has been understood primarily – and in the case of much popular history, almost exclusively – through the transfer of V-2 rocket technology to the USA and USSR. In the wake of the superpower ballistic-missile and space races, Wernher von Braun's team of ex-Germans in the USA captured almost all of the attention because of the role they played in the US Army and the National Aeronautics and Space Administration (NASA) in early space missions and the Apollo program. To many in the West, this group of engineers, scientists, and technicians were Project Paperclip, the post-war American program to import German technical expertise – although in fact they constituted only about 20% of those brought to the USA.<sup>2</sup> Late in the Cold War, revelations about the Nazi records of von Braun and his associates, as well as other Paperclip specialists, inspired a new muckraking literature by investigative journalists which changed the tone, but modified this emphasis only slightly.<sup>3</sup> The space race also motivated early attempts to write the story of German rocketeers in the USSR and much later, those who went to France,<sup>4</sup> but in general, the wholesale transfer of German aviation and missile assets after 1945 was treated as part of the Cold War race between the Soviet and American rocket programs, with Britain and France reduced to afterthoughts.

The collapse of the Soviet Union and the end of the Cold War opened up Soviet records to scrutiny, making feasible a new scholarship about their ballistic missile and space programs, but also about Germans and German technology in the USSR post-1945 generally. Much of it has been written by German scholars.<sup>5</sup> Extending the scope of this work, another German scholar has examined German weapons experts in Brazil and Argentina.<sup>6</sup> This latter study is a noteworthy exception to the almost exclusive focus on the USA, the USSR, and (very modestly) Western Europe. The Soviet and South American cases also bring to light that the majority of ex-German personnel in those countries, and almost everywhere else, were in aeronautics. Aviation specialists were often dispersed in smaller groups with much more heterogeneous professional backgrounds and projects, however, making their contributions more obscure and less easy to reduce to a master narrative than was the case with the rocket engineers.

My aim is to assess the state of scholarship on the exodus of German technical personnel after World War II, particularly in aerospace professions, in the process drawing some conclusions on the total numbers, skill composition and Nazi backgrounds of the Germans, the stages of movement, and the technological impact of their movement. My survey of the secondary literature includes countries often neglected – Australia, Canada, Spain, Egypt, and India, as well as Argentina and Brazil – all of which received ex-German personnel and knowledge, and sometimes artifacts in the form of aircraft, rockets, engines, and components. Looking at the global picture allows a more complex and less polarized view of the impact of the exodus of Third Reich aerospace personnel on aerospace technology and weapons development, and also points us toward a transnational view of the phenomenon.<sup>7</sup> That is, the exodus is not simply a product of competing national programs emerging out of World War II, it also developed in the late 1940s and 1950s into movements of knowledge and personnel across national boundaries and into the Third World, and also back to the two Germanies, which sometimes posed challenges to the hegemonic systems of the two superpowers. This assessment bears com-

parison with other scholarly research on the transnational movement and circulation of experts, knowledge, and technologies in areas such as nuclear energy, agriculture, and public health in the first decades of the Cold War.

I should add that I am using the terms ‘Nazi’ and ‘aerospace’ loosely, as roughly only half of the people I am discussing were actually members of the Nazi party and/or its organizations, and spaceflight had nothing to do with their activity in the Third Reich. Aerospace was a term only coined after Sputnik by the US Air Force to try to lay claim to space as part of its natural domain, but has become useful shorthand to cover a sphere of engineering activity broader than just aviation. In the case of German exodus, it includes missile and rocket engineers, many of whom came out of fields other than aeronautical engineering, and who formed distinct teams separate from the aircraft development and aerodynamics groups that numerically were the largest component of the German scientists, engineers, and technicians in most countries. It is also worth noting that the term German is itself used loosely, as it encompassed for the victorious powers all specialists from the former *Grossdeutsche Reich*, i.e. including many Austrians and a few ethnic Germans from Eastern Europe. Finally, I should note that I am using the term ‘specialists’ here, which is what the Soviets called their Germans, as the usual American terminology, ‘scientists’ is quite misleading (the corresponding German term, *Wissenschaftler*, is less narrow). Of these specialists, only a minority of the Germans came out of the natural sciences. The majority were engineers or technicians; some were skilled industrial workers or even secretaries, especially in the countries that took whole industrial teams like the USSR and France.

Let me begin with a brief overview of the origins of the exodus of German technical personnel after World War II. For the four occupying powers of Germany and Austria, the export of personnel to their home countries began ad hoc, as an adjunct to their technical evaluation of Third Reich weapons and industrial facilities. Highly valued German technical experts and teams were moved to collection points or camps inside their respective occupied zones or sent directly to the home country. For example, Dr Herbert Wagner, an industrial missile expert of great interest to the US Navy for the war against Japan, landed in the USA with two assistants on 19 May 1945 – less than two weeks after the German surrender. Because of concerns over providing an orderly process and legal cover for the importation of further specialists to help in the Pacific War, the US Joint Chiefs of Staff created a secret Operation Overcast in July for the short-term exploitation of 350 experts. When hostilities ended shortly thereafter, however, the program continued, because the US armed services wanted the benefit of German knowledge.

In the USSR, even before Josef Stalin’s acceleration of the Soviet atomic bomb project in the wake of the Hiroshima attack on 6 August, the Soviets began moving about 100 German nuclear physicists and chemists, voluntarily or involuntarily, to the Soviet Union. But the Soviets only forcibly moved most of their German specialists from other fields to the USSR (at least 1600 of the 2200 sent involuntarily) much later, on 22 October 1946. It was a lightning, one-day, secret-police and military operation called Osoaviakhim that gutted the elaborate infrastructure of design bureaus that had been built up in the Soviet zone (the later German Democratic Republic). These bureaus combined German groups with Soviet experts into joint teams that were reconstituted in the USSR. Months before Osoaviakhim, in February 1946, the USA had extended its program under a new cover name, ‘Paperclip’, and opened the prospect of permanent immigration. In December, partly as a public-relations response to the Soviet action, the US government declassified the presence of Germans in the USA, emphasizing their voluntary participation.<sup>8</sup>

The British and French governments similarly moved in 1945/46 to regularize their importation of Germans. In Britain, the military chiefs created a Deputy Chiefs of Staff committee for specialists desired by the UK armed services (the Program becoming known as the DCOS Scheme), and Sir Charles Darwin (grandson of the famous biologist) headed a panel for reviewing civil experts (the Darwin Panel Scheme). Britain also allocated experts to Commonwealth countries, or tried to.<sup>9</sup> In France, the economics minister issued a circular in March 1946 to try to regulate the terms of exploitation.<sup>10</sup>

While the four occupying powers officially controlled the movement of all German and Austrian specialists until the mid 1950s, illegal emigration soon began, notably with the smuggling of about a 100 to Argentina in 1947/48 (more on this below). Global movements of ex-Nazi specialists continued into the 1950s and 1960s, when they began to move among the principal countries, but also to new locations, notably Brazil, Spain, Egypt, and India.

Table 1 summarizes the numbers involved in this phenomenon, and its aerospace component, based on secondary literature in English, German, and French.<sup>11</sup> It is immediately obvious that while we have at least reasonably established numbers for the total number of specialists in the USA, USSR, Argentina, and Brazil (thanks to the scholarship mentioned), and in Canada and Australia (thanks to investigations of possible war criminals), we do not have a good grasp on the number in Britain and France, on which scholarship has been weak. For Spain, Egypt, and India there is even less information. There are no doubt several more countries who took small numbers – South Africa and the Netherlands have been mentioned. In every case I am discussing formal, national programs for importing German and Austrian technical expertise. In the postwar emigration wave out of Germany, half a million people went to the USA alone by 1960, and thousands more to Canada and elsewhere, so there were undoubtedly qualified people who emigrated by their own efforts, but it is very difficult to trace them.<sup>12</sup>

Establishing the number of aviation and missile specialists is even more problematic, especially for those located outside the USSR and South America. Even the numbers in the USA are not known with certainty. Despite the extensive literature on the US projects Overcast and Paperclip, no one has ever been able to establish the total number of specialists who came to the USA or their occupational breakdown, although we have sound numbers for the early years. In part that is because the full complement of over 1600 Foreign Scientist Case Files at the National Archives was only declassified recently. (The US Defense Department created a file on every individual who either came over, was invited to, or was investigated as a possible target. A significant percentage never came.) In 2009, I and an intern surveyed the first 234 files in this record group, of which 128 or 54.7% came to the USA under Overcast, Paperclip, and their related programs: Project 63, National Interest, and DEFSIP (Defense Scientists Immigration Program). Based on that sample, the total US number must approach 900 up to the end of December 1957, and two-thirds can be classified as aerospace.<sup>13</sup> Viewed against this data, Linda Hunt's assertion that 1352 specialists came through 1959 is problematic, but her research does seem to substantiate that these programs continued into the 1960s.<sup>14</sup>

Of the other nations in the table, the lack of really solid numbers for France and Britain is especially noteworthy. Despite the literature sparked by the revelations about the Paperclip specialists in the 1980s, followed by the collapse of the Soviet Bloc and the opening of Eastern European archives, the French and British cases remain under-researched, with the sole exception of the French rocket and missile program, which was recently more comprehensively examined in a book by Olivier Huwart.<sup>15</sup> Regarding the aerospace component of the total specialists, however, we can say that the two countries

Table 1. German specialists in foreign countries after World War II.

Country	Total German specialists	Percentage Aerospace	Total aerospace specialists
USA	700+ (to 1953) (Ciesla and Trischler) <i>ca</i> 900 (see below, in text) 1352 to 1959 (Hunt)	<i>ca</i> 67%	<i>ca</i> 500 (1952) <i>ca</i> 600 by 1957 127 von Braun group (1946)
USSR	2900–3000 in 1948, including POWs and concentration-camp prisoners (Mick)	50–55%	<i>ca</i> 1600 1342 max Min. Aircraft Ind. 8/47 302 rocket sector 10/46 (Mick)
France	800 (11/1946) (Ludmann-Obier) > 1000 (L'Express 1999)	50–70%?	500+? 150+ SNECMA/BMW (Scranton) 90 LRBA. <i>ca</i> 20 Chatillon, 96 St. Louis, 25 GERIA (Villain) St Louis: 32 (end 1945), 77 (end 1946), <i>ca</i> 100 (1955) (Baumann)
UK	<i>ca</i> 500 (Mick)  807–1052 (Glatt)	much lower than US/ USSR	< 100?  27+ at RAE 1947 (Glatt)
Argentina	108 (Stanley)	<i>ca</i> 65%	69+ 45 Tank; 20+ Henrici (Hs 293 missile); 4 Horten
Brazil	27 (Stanley)	<i>ca</i> 80%	22, of which 20 are Focke's helicopter group
Australia	150 (Jones)	7% 'defence science' (Jones)	< 10? military aviation  with civil aviation < 20?
Canada	41 (Margolian)	small	< 5? (Margolian only explicitly mentions one, a Peenemünder who stayed only one year)
Spain	<100?		Messerschmitt group only: 10 (1953)+ M. part-time 18 (end 1955) (Ebert et al.); max. <i>ca</i> 25
Egypt	<100?	80%?	< 80? Messerschmitt group from Spain 1960 2 rocket groups (early and late 50s), 20 in early group (Horeis/Engel)

(Continued)

Table 1. (Continued)

Country	Total German specialists	Percentage Aerospace	Total aerospace specialists
India	<50?		20+? 18 in Tank's team (Indian AF-connected website) from Argentina Hanna Reitsch active—alone?
<i>Total</i>	<i>6000–7000 (ca 400 double-counted?)</i>		<i>ca 3000 (ca 200 double-counted)</i>

diverged considerably. The French pattern appears to have been much like the American, Soviet, and South American, namely half to three-quarters were aviation and missile specialists, whereas the British government concentrated on civilian industrial scientists and engineers. The UK decided not to invest much in guided missiles immediately and was not interested in hiring aircraft or engine design teams because domestic talent was deemed more than adequate, with the result that the aerospace percentage appears to be much lower. However, little has been published except Carl Glatt's economic history dissertation, which is primarily on British reparations policy, and Christoph Mick's brief investigation of the British case in the comparative section of his book on the USSR – and Glatt and Mick disagree on the total number by a factor of two. Glatt mostly discusses the larger British civil program, with its tendency to recruit non-aerospace industrial specialists (the only data I have to draw on).<sup>16</sup> The two Commonwealth countries for which I have any numbers, Canada and Australia, follow the British pattern of emphasis on civilian industrial specialists, even more so, in fact, than Britain.<sup>17</sup>

I should mention one more methodological issue regarding the table: the duplication of names caused by the movement of personnel in the 1950s from one country to another. In the early 1950s there were significant number of departures from France to Brazil, the USA, Egypt, and elsewhere, followed by the departure of Kurt Tank (before 1945, the chief designer of Focke-Wulf, a leading German aircraft manufacturer) and part of his team from Perón's Argentina to Nehru's India in the mid 1950s, and the movement of Willi Messerschmitt's team, established in Franco's Spain in 1951/52, to Nasser's Egypt in 1960. (Messerschmitt was a famous aircraft designer and industrialist in the Third Reich, but never participated in Allied specialist schemes, as I will explain below.) Many of those in Britain were also on short-term contracts and some of them ended up in the USA as well, as did a few individuals formerly in Argentina and Australia. As best as I can determine, the international movement of ex-Third Reich aerospace personnel outside Germany and Austria (as opposed to returnees to those countries, who numbered in the thousands) seems only to amount to a couple of hundred people in total. But these moves indicate the extent to which what had started as the national exploitation programs of the four main occupiers of Central Europe had evolved in the 1950s into a transnational phenomenon intertwined with the Cold War and with the efforts of a few non-aligned nations to develop their own indigenous jet fighter and missile programs – sometimes to the discomfort of the USA.

Chronologically, the exodus of Nazi aerospace personnel falls into at least three overlapping stages. Beginning just after the end of the war and continuing into the early 1950s, the USA, the USSR, the UK, and France exported the majority of the aviation and missile specialists (*ca 2700 out of a total of 5000+*) for their national programs. The

Western powers relied mainly on voluntary recruitment, whereas the Soviets forcibly moved most of theirs. The Osoaviakhim action in October 1946 notably stripped the rocket design bureaus around Nordhausen and Berlin, and two aircraft bureaus constituted primarily of personnel from the former Junkers and Siebel firms. In those latter cases, the Soviets took most of the factory structure, with the result that the majority were not engineers at all, but foremen, skilled workers and administrative staff.<sup>18</sup> By contrast, the American strategy tilted towards the highly qualified. Even in the singular case of Werner von Braun's V-2 rocket group, the only large team the US took, von Braun got just a quarter of the people he wanted to bring, primarily the top engineers, although there were a handful of foreman-level craftsmen in the mix.<sup>19</sup>

The second phase, starting about 1947, saw the movement of small numbers of specialists into other Allied countries, such as the allocation of some to the Commonwealth via British military and civilian schemes. The unique case was the Argentina of dictator Juan Perón, who had opportunistically declared war on Germany in March 1945, but was well known for providing safe haven to Nazis, leading to a contentious relationship with the USA. Using the same networks that smuggled ex-SS officers and war criminals out of Europe, Argentinean officials, in 1947–48, were able to illegally import about a 100 Germans, *ca* 70 of them in aerospace occupations, in violation of the movement controls imposed by the Allies. Most notable was Tank's team of about 45, most of which came from Focke-Wulf, tasked with creating a supersonic jet fighter based on his late-war Ta 183 design. Tank had earlier negotiated with the British and, surprisingly enough, with the Soviets even after Osoaviakhim.<sup>20</sup>

The third phase began about 1951/52, and was alluded to previously: the further transnational migration of teams and individuals, such as the Brazilian recruitment from France, in cooperation with other Western powers, of a team of 20 helicopter designers under Henrich Focke (one of the namesakes of the Focke-Wulf firm and Tank's colleague), a story also told in Stanley's work. Francisco Franco's fascist Spain established its own jet trainer and fighter project at the same time, led by Willi Messerschmitt, who was present, however, only part-time. The nascent West German republic supported this project as a way to help rebuild its aviation industry, so it falls on the borderline of the post-Nazi specialist phenomenon – was this the Spanish equivalent of Paperclip, or a routine international export deal? The same might be said of its second life as an Egyptian fighter project after 1960.<sup>21</sup> Even before this effort, Gamal Abdel Nasser's Egyptian dictatorship had recruited German rocket and missile specialists, many of them formerly in France, in the early and late 1950s, as part of its arms race with Israel. The rocketeers left or were pressured to withdraw by West Germany in the early 1960s after Israel launched an overt diplomatic offensive and a covert assassination campaign, presumably by Mossad, which resulted in one specialist narrowly escaping a hit squad on a visit to Germany and another's secretary being mutilated by a mail bomb!<sup>22</sup>

The third phase also saw the Soviets return to the new German Democratic Republic (GDR) by 1958 all their Germans and Austrians, most of whom arrived in the early 1950s, as the secrecy-obsessed Soviet state could not see accepting them as permanent immigrants. The East Germans created an aircraft design bureau in Dresden to retain the Junkers-dominated group after their return. They were tasked with converting a bomber design for the Soviets into an airliner, which proved to be a disaster and was cancelled in early 1961.<sup>23</sup> Roughly a quarter of the specialists in all fields migrated to West Germany through Berlin, which was still open until the Wall was hastily erected on 13 August 1961.<sup>24</sup> Only a few, evidence suggests, ended up in the USA, Britain, or France, as ex-Soviet bloc specialists were viewed as security risks,<sup>25</sup> but many of this cohort



were debriefed and then readily found jobs in the rising economies of West Germany and Austria. One prominent aero-engine designer, the Austrian Ferdinand Brandner, who started a line of Soviet turboprop engines that would power their intercontinental bombers, later went to Egypt. He was to design a turbojet power plant for the Tank and Messerschmitt supersonic fighter projects that ended up moving to India and Egypt, respectively.<sup>26</sup>

In contrast to the Soviet pattern of getting rid of all their Germans, and the French and British pattern of not retaining most, the USA in the third phase extended and even revived its recruitment program after 1953, almost entirely out of West Germany and Austria, with a handful from other countries. This expansion was driven by a continuing desire to deny potential technical talent to the Soviet bloc, and perhaps also by shortages of specialized US manpower in the aerospace and other defense industries as a result of the Cold War arms race, although the latter assertion is hard to prove without further research. Paperclip continued after the original projects of the other three major powers had ceased, and even after West Germany had regained its sovereignty in 1955, creating a diplomatic problem.<sup>27</sup>

The presence of specialists in Perón's Argentina, Franco's Spain, and Nasser's Egypt, certainly raises the question as to whether those countries recruited from among the most ideologically motivated Nazis. The three dictators harbored unrepentant true believers and major war criminals. Yet there is little evidence that political convictions had anything to do with the destinations of technical specialists, although systematic data about their Nazi affiliations is thin. Ruth Stanley found that 44 out of 108 specialists in Argentina (including non-aerospace people) or 41% had been party members and nine of those members had been honored with higher Nazi awards and titles or had long records of political commitment. In Brazil, it was eight out of 27 (30%), with two having higher awards or signs of commitment.<sup>28</sup> By comparison, out of 90 members of the von Braun team, I found that 42 had been party members (47%), two had been in the Schutzstaffel (SS, one of whom was von Braun) and 21 had been in the SA (Sturmabteilung, the Brownshirts), most of them also party members.<sup>29</sup> In my larger sample of Foreign Scientist Case Files, of the 128 specialists who immigrated under Paperclip programs up to 1957, 56 or 43.75% had been members of the party, SS or SA. Forty of them came in the first three years of the program, 1945–47, whereas the 1950s arrivals often had been too young to be members.<sup>30</sup> Based on the existing literature, inadequate as it is, it appears that the USA likely had the biggest Nazi problem, as several of the von Braun team were involved with V-2 production using concentration-camp labor, and the USA also got the cream of the aerospace medicine experts, some of whom certainly knew about the experiments on concentration-camp prisoners at Dachau and perhaps used the data.<sup>31</sup> Of course, no one ever held to account aircraft designers like Messerschmitt and Tank, whose firms all exploited slave labor. Cynicism, amoral *raison d'état*, or national self-interest was the norm in every country that took Germans.

As to the technological impact of the transnational movement of ex-Third Reich aerospace specialists, it was clearly very considerable, but by no means universally successful. It would take an extended treatment to discuss all the individual technologies and national programs. Therefore, I will focus briefly on: (1) the large-scale differences between the missile and aviation sectors, and (2) the relative success and failure of various national schemes for integrating or at least exploiting the specialists.

In the immediate aftermath of World War II only the four main victorious powers could potentially afford a big rocket and missile program based on German technology and personnel, but the British government very quickly decided that it did not have the

trained manpower and industrial capacity to support missile and supersonic aircraft development simultaneously. When the British did get back into the long-range-missile field in the 1950s, the handful of German rocket engineers still in the UK played an unimportant role as there were so few of them. The French were forced by the reality of limited resources to cut back the development program of their German group at Vernon to sounding rockets and an experimental anti-aircraft missile, though these specialists laid a foundation for later nuclear missile and space programs.<sup>32</sup> As the story of US and Soviet early Cold War rocket development is, in comparison, well known, I will not retell it here, other than to note that the fate of their German groups mirrored the divergent approaches of the two nations to the specialists: immigration and integration vs knowledge extraction and expulsion. Two other nations, Argentina and Egypt, attempted to use Germans to develop small tactical missiles, primarily to complement their aircraft projects – but all their rocket projects led to nothing because of the lack of an indigenous industrial and engineering base.<sup>33</sup>

In contrast to the geographically more limited footprint of the missileers, aviation specialists were the dominant group in the aerospace sector in all countries, and the dominant group among all specialists in most countries, as a modern air force or aircraft industry after World War II meant coming up to speed with German advances in jet and rocket aircraft. The western Allies, at least, did not have that much to learn from German piston aircraft, radar and avionics, but the massive, and ultimately wasteful Nazi investment in transonic and supersonic aerodynamics, high-speed aircraft design, and rocket propulsion stunned technical evaluators both in the East and West, and German jet engine designs would prove useful, especially for the French, who were farther behind. The German lead in aerodynamics was especially noteworthy. The four major powers set out to absorb Third Reich personnel, knowledge (in the form of massive document caches that were seized, copied and sometimes translated) and facilities – all four moved wind-tunnels, or at least their major components and test sections, to their home countries, plus large numbers of aircraft and missiles. Even Britain, which was not very interested in hiring German aviation specialists, brought at least 27 Germans, primarily aerodynamicists, to the Royal Aircraft Establishment in Farnborough, to help run the transplanted high-speed wind tunnels of the former *Luftfahrtforschungsanstalt Hermann Göring* in Braunschweig-Volkenröde.<sup>34</sup> Smaller nations had neither the opportunity nor the financial capacity to import or copy large aerodynamics facilities, and had to settle for the importation of knowledge via documents and a handful of personnel, which was to prove a major handicap in ambitious programs to build supersonic fighters in Argentina, Spain, Egypt, and India.

The latter cases raise the question of the relative effectiveness of the various programs for employing German specialists. Three out of those four programs were failures even when they succeeded in producing prototypes that flew. Stanley's examination of Kurt Tank's team in Argentina is especially telling here. Tank had direct access to President Perón, but nothing could compensate for the fact that when he built his Pulqui II swept-wing jet fighter, there was no industrial base in Argentina to deliver adequate components, so the prototype had to be hand-made. While the aircraft had an impressive performance, producing a short-lived propaganda coup for Perón, it proved dangerous to fly because Tank did not have the benefit of a wind-tunnel to refine its aerodynamics. Creating a jet-engine in Argentina was impossible, so Tank had to redesign the fuselage for a British one. In the end only a few prototype Pulquis could be built before the country ran out of money, which occurred even before Perón was overthrown in 1955.<sup>35</sup> Tank went to India, where he did develop the HF 24 Marut jet fighter – a partial success in that the aircraft had excellent flying characteristics, but was underpowered with the only

engines available, an older British design. The alternate powerplant, which Brandner was developing in Egypt for both the Egyptian and Indian supersonic fighters, was tested in flight but never proved reliable.<sup>36</sup> Jet engines were the Achilles heel of advanced aircraft projects outside the leading powers, as they were complex, expensive and difficult to develop, and much easier to subject to export controls than airframe design expertise.

Messerschmitt's project in Spain created a workable jet trainer, the Ha 200, but Franco's government, finding further development too expensive, sold the project to Nasser's Egypt, which license-produced more Ha 200's, but never built more than a couple of the follow-on Ha 300 supersonic fighters in the late 1960s. As Egypt came to align itself with the Soviet Union, relatively cheap MiGs became available (the same was true in India) – in parallel to the Western bloc, where American and French aircraft came to dominate the combat-aircraft export trade. Even in a nation such as Canada, with a much sounder technological base, found it too expensive to continue to develop its supersonic Avro Arrow and its Iroquois engine, as Julius Lukasiewicz has outlined in a valuable article.<sup>37</sup> After the Diefenbaker government killed the Arrow in 1959, Canada resigned itself to only buying or license-producing American advanced military aircraft.

As the cases of Argentina, Spain and Egypt show – and also Brazil, where Focke's helicopter projects were a complete flop – importing German specialists was by no means a guarantee of success if the technical/industrial and/or political/bureaucratic contexts were inappropriate. The experience of the three largest importing countries, the USSR, France, and the USA, was much more successful in general, but that did not rule out some noteworthy failures.

Thanks to the work of Mick in particular, we have an especially clear view of the overall successes and failures of Soviet policy in employing the Germans. As a gross generalization, one can say that the initial transfer of Third Reich knowledge, both in the eastern occupation zone and in the USSR, was a success, but afterwards the value of most of the German teams quickly diminished as a result of the Stalinist policy of isolation and secrecy, compounded by linguistic difficulties, differences in engineering cultures, rivalry and resentment from indigenous engineers and scientists, and the inefficiencies and disincentives of the planned economy. In the rocket sector, Stalin ordered that Soviet teams begin by copying the V-2 (as he did also for the American B-29 bomber and Fat Man plutonium bomb). The Germans played a central role in that process, including the further development of the missile and its rocket engine, but after 1948 they were increasingly frozen out and set to work on theoretical designs that were never used. German specialists also played a critical role in the development of the first generation of Soviet anti-aircraft missile systems – so much so that some team members were rewarded by being held in the USSR until 1958. In the aeropropulsion sector, Brandner's team developed the Jumo 222 turboprop into a powerful and important line of engines for Soviet intercontinental bombers and transports. The two large aircraft design bureaus that were predominantly German were much less successful. They developed several improvements on the exotic-looking Junker Ju 287 forward-swept-wing bomber, but none of them were ever adopted by the Soviet Air Force. For several years they tried to bring to flight the Siebel Si 246 rocket plane to test supersonic aerodynamics, much like the Bell X-1 in the USA, but there were multiple delays in making a workable engine. It only ever flew as a glider. In airframe technology and aerodynamics, it appears that much of the value to the Soviets was derived from initial seizure and testing of German aircraft, the translation of German technical literature, and the initial collaboration with German engineers. Not much was accomplished, however, after the first year or so in the Soviet Union.<sup>38</sup>

The inadequacy of the literature on France makes such a thorough analysis impossible to replicate. The French had success with the Vernon rocket group, initially numbering about ninety Germans; their efforts led to a line of rocket engine and vehicle development that in 1965 made France the third nation to launch its own satellite.<sup>39</sup> They also benefited from the work of specialists from the BMW aeropropulsion team, headed by Hermann Oestrich, which went to the state-owned aero-engine firm SNECMA and started the very successful ATAR line of jet engines based on the BMW 003. In contrast, another engine team went to Turboméca and failed. At least one designer, though, helped the company start a successful line of very small gas turbine engines, as Philip Scranton outlines in his valuable work comparing French and American jet-engine development after 1945.<sup>40</sup> Based on existing literature, it is impossible to say how much German specialists influenced French aircraft design.

In the USA, the spectacular success of the von Braun rocket group with the US Army and NASA has always overshadowed the contribution of the other 80%-plus of specialists who came under Paperclip or its related programs. Nearly half came under the auspices of the Air Force, more than for any other service or civilian agency,<sup>41</sup> but they came as individuals and were integrated into USAF laboratories or moved into industry, where they often made outstanding contributions, but produced nothing that is easily identifiable as a product of a German-led team, as was the case with the Army. However, Hans-Ulrich Meier's history of German swept-wing research argues convincingly that Third Reich aerodynamics research led directly to the redesign of the F-86 fighter and B-47 bomber wing platforms, notwithstanding some preliminary, but not fully accepted, American work on the swept wing before the end of World War II. In a rare (for America) case of direct copying, the experimental variable-sweep Bell X-5 aircraft, developed in the late 1940s, looked exactly like the Messerschmitt P.1011.<sup>42</sup> The role of individual Germans in all those cases is not clear, but the presence at Wright Field in Dayton, Ohio, of such figures as jet engine co-inventor Dr Hans von Ohain, cannot have been without impact. German aerospace medicine experts under Dr Hubertus Strughold, notwithstanding their dubious associations, greatly bolstered the discipline in the USA.<sup>43</sup> Individual Germans failed and returned home, or faded into obscurity, but I cannot name a single important technical failure in the aviation and missile sector produced by the American policy of skimming off the elite and integrating them permanently into the US military establishment and aerospace industry.

Finally, I should briefly address the role of German artifacts. The existence of large numbers of Third Reich aircraft and missiles in museums attests to the role of technical evaluation in the intelligence and technology-transfer activities of the Allies. The current geographical distribution of these aircraft and missiles is to a great extent the product of that evaluation effort – most are in the USA, Western Europe, Canada, and other Commonwealth countries, and also the former Soviet Union. What is now in German museums is largely a product of return of captured German artifacts from Western countries, although wreck recovery has become a factor. As for the less-developed nations that started jet fighter projects, the German teams brought nothing with them but their knowledge and some reports and written sources, hence no Third Reich aircraft and missiles are found in their museums that date to the early period, although examples of the types that the Germans developed there likely survive.<sup>44</sup>

The real question for this survey is what role did these captured aircraft and missiles play in the technology transfer process, and to what extent did they have anything to do with the German teams who went to the same countries? The V-2 is almost the unique case, in that over seventy were launched by the USA for military and scientific purposes

and the von Braun team had a critical role in training American military personnel and contractors to work with the missile.<sup>45</sup> In the Soviet Union, the Gröttrup team was crucial to the testing of a much smaller number of German-built V-2s, and a larger number of its Soviet copy, the R-1. The US copied the V-1 cruise missile and produced it in large numbers, but apparently with very little or no input from Germans who came later through Paperclip. The role of aircraft testing, and of engines, is much harder to evaluate. There is a large enthusiast literature on Nazi airplanes that sometimes discusses their afterlife in Allied countries, but no real scholarly evaluation of the big picture of how these technologies facilitated (or not) the technology transfer process, and even less on the role of German specialists. In the USA at least, the latter role appears to be minor, but that is only a guess. In the Soviet Union, the Germans did seem to have some connection to some aircraft flown for evaluation, and in a few cases German test pilots flew them.<sup>46</sup>

One noteworthy area of the German technology transfer from which there are very few museum artifacts, unfortunately, is in the area of high-speed aerodynamics and wind tunnels. We have one very good memoir, Peter Wegener's *The Peenemünde Wind Tunnels*, in which he describes the transfer of the key test sections and instrumentation first to Kochel in the Bavarian Alps in 1943, then to the Naval Ordnance Laboratory in White Oak, Maryland, in 1945/46. Nine Germans, including Wegener, went with them to the USA.<sup>47</sup> An original Peenemünde test section that had been modified into a vacuum chamber remains in White Oak, as a display object in a hypersonic tunnel facility that the Air Force took over from the Navy.<sup>48</sup> In addition, the Deutsche Museum in Munich exhibits one test section from the Braunschweig A7 supersonic tunnel that had spent years in Britain.<sup>49</sup> I think it should be a matter of priority to technology museums to try to salvage some physical evidence from the critical and highly influential process of seizing and integrating Third Reich aerodynamics knowledge, facilities, and personnel.

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In conclusion, let me briefly address how far we have come towards a global, transnational history of this topic, and how far we have to go to adequately achieve that goal. If transnational is defined as cross-border movements of people, knowledge or artifacts carried out by nation states and non-governmental actors outside the formal system of international relations between states, a significant fraction of the German specialist phenomenon is transnational, and it is certainly global in scope. Aerospace and other weapons and industrial technologies are very expensive undertakings requiring the investment of nation states, so state action was almost always involved on at least one side of any specialist movements and formal national programs dominated the early years after World War II. Knowledge – for example transonic and supersonic aerodynamics – flowed across borders with fewer restrictions, despite attempts to classify it. Within a decade what the Germans had discovered simply became the state of the field. Individuals also increasingly took the initiative to move transnationally in the 1950s when they no longer were satisfied with the situations they were in. Tank went hunting for a new sponsor, while much less prominent individuals simply inquired with overseas firms or with the US government under the Paperclip program. Over time, transnational flows of knowledge and people from Third Reich programs initiated by non-state actors grew in importance.

From a global history standpoint, the German specialist phenomenon obviously played itself out in the context of the Cold War. The movement of personnel, knowledge and artifacts of course had the greatest effect on the competition of the two blocs. Despite the West's overall greater success and efficiency in employing ex-Germans, I would have

to conclude that the massive transfer of weapons knowledge had the net effect of helping the Soviet Union more than the West because it had farther to come in 1945 in terms of technical prowess in some areas, notably aircraft, missiles, radar, electronics, and nuclear weapons. In ballistic missiles in particular, the Soviets effectively exploited the heritage of German technology, resulting in the surprises of 1957: the first successful intercontinental ballistic missile (ICBM) test and Sputniks 1 and 2. In reality, despite these Soviet propaganda successes, the USA always led in deployed nuclear forces, but the USSR reached relative parity in the 1960s a little sooner because of specialist phenomenon. Another country that gained was France, which used German technology and people as a foundation for its *force de frappe* and space program, symbols of its return to credibility as at least a quasi-independent military and civil power in the Western alliance.

The effect of German people and technology were not confined to the two blocs, as we have seen. The attempts of developing and non-aligned nations to develop prestige weapons outside the system of the two superpowers were almost always complete failures, although even the failed projects might have modestly helped to increase the technical competence of the local armed forces and industry. In the central case of jet fighter aircraft, the end result was that virtually every nation ended up purchasing or license-producing US, Soviet, French, and (decreasingly) British types, but the independent projects created considerable heartburn in the USA and allied governments as examples of undesired weapons proliferation. In the Soviet bloc, even with official USSR support, the East German attempt to create an airliner created suspicion and discomfort in the Soviet Union, which helped to sabotage the project.

Where might research go from here? Just from an empirical standpoint, this study has demonstrated that there are large gaps even in our basic knowledge of the specialists and the technology transfer they facilitated. We know far too little about British and French policies and experiences in the aerospace area, French rocketry aside. Egypt, India, and Spain have been barely covered at all. There are other nations that were involved in this phenomenon but for which information is incomplete or is available only as generalities, e.g. the Netherlands. Even in the case of the USA, a thorough analysis of the full Paperclip program through the 1960s is lacking. Nor do we know much about the technical analysis and usefulness of German hardware beyond the well-studied rocket cases. Another interesting study would be how US foreign policy tried to cope with flows of people, knowledge and technical artifacts to other countries, notably to nations on the margins of, or outside the American alliance system, with the objective of fortifying the US Cold War position vs the Soviet Union, as well as its hegemony in its own bloc. John Krige's illuminating study of the US role in the reconstruction of science in Western Europe to further its hegemonic position is suggestive of the complexities.<sup>50</sup> Further comparative studies of multiple nations or of the German specialist phenomenon with other multinational movements of scientists and engineers, combined with a more rigorous attention to the theory of transnationalism and globalization, would broaden our understanding of the Cold War and the new geopolitical frameworks that emerged with the collapse of colonialism. Clearly, there is much more that could be done.

## Notes

1. Two overviews reflect the flourishing of scholarship on the Soviet and American programs in the 1990s: Judt and Ciesla, *Technology Transfer*; Neufeld, 'Overcast, Paperclip' (from a book originally published in German in 2001). In Neufeld, *The Rocket and the Reich*, it was argued that the V-2 ballistic missile program was so expensive it was actually detrimental to the

- German war effort; the net effect of technological superiority was to place a heavy burden on the war economy for minimal military results. Krige, 'Building the Arsenal,' notes that the USA took similar interest in only one Japanese area of scientific/technological research, biological warfare, but to my knowledge no Japanese researchers came to the USA for any length of time.
2. McGovern, *Crossbow and Overcast*; Bar-Zohar, *The Hunt for German Scientists* (originally published in French in 1965); Lasby, *Project Paperclip*; Ordway and Sharpe, *Rocket Team*. Lasby was the only one who attempted a general history of Paperclip. After 40 years it remains the best survey, despite being very out-of-date owing to the declassification of records in the 1980s.
  3. Hunt, 'U.S. Coverup;' Hunt, *Secret Agenda*; Bower, *The Paperclip Conspiracy*; Simpson, *Blowback*. A scholarly treatment of Paperclip in the context of the Western occupation zones of Germany came out at the same time: Gimbel, *Science, Technology and Reparations*. I have not cited the extensive journal literature here as it would take up too much space. However, for a demolition of Hunt and Bower's core thesis that Paperclip imported individuals with significant Nazi records illegally and against presidential orders, see Gimbel, 'German Scientists.'
  4. Ordway and Sharpe, *Rocket Team*, 318–43; Villain, 'France' 119–61; Teyssier and Hautefeuille, 'Recherche scientifique;' Huwart, *Du V2 à Veronique*.
  5. Siddiqi, *Challenge to Apollo*; Siddiqi, 'Germans in Russia;' Siddiqi, *The Red Rocket's Glare*; Uhl, *Stalins V-2*; Albrecht, Heinemann-Grüder and Wellman, *Die Spezialisten*; Mick, *Forschen für Stalin*; Sobolew, *Deutsche Spuren* (originally published in Russian). On the general level, the fundamental work is that of Mick, which builds on and confirms through basic archival research the earlier conclusions of Albrecht, Heinemann-Grüder and Wellman.
  6. Stanley, *Rüstungsmodernisierung*.
  7. The word 'transnational' has become faddish in the history discipline, so much so that it has become difficult to distinguish it from 'international.' A useful survey is Van der Vleuten's, 'Toward a Transnational History.'
  8. Hunt, *Secret Agenda*, 6–7; Lasby, *Project Paperclip*, 76–187; Mick, *Forschen für Stalin*, 15–17, 28–33, 42–65, 80–5.
  9. The literature on post-1945 German experts in Britain is extremely thin. Glatt, 'Reparations,' examines primarily civil personnel as part of the larger question of reparations. See esp. 244–8, and chap. 9, and for the origins of the Darwin Panel, 882–4. Mick, *Forschen für Stalin*, also discusses the British programs briefly in comparison with the Soviet, notably 66–8, 72–4, 76–9. Historians of British Cold War armaments and aerospace industries have taken little interest in Germans in the UK: Edgerton, *Warfare State*; Twigge, *The Early Development*; Bud and Gummett, *Cold War, Hot Science*. One article in the latter contains virtually the only references to the influence of Germans in the UK: Nahum, 'The Royal Aircraft Establishment,' 29–55, esp. 36–8 and 50–1.
  10. The only general articles on France that I have found are Ludmann-Obier, 'Un aspect de la chasse,;' and the popular piece by Nouzille with Huwart, 'Comment la France,' 122–(?) (copy incomplete). One unique French institution, which eventually became a bi-national German–French one, is the Institut Saint-Louis. A group of Luftwaffe ballisticians evacuated from Berlin to southwest Germany were moved to Saint Louis, near the meeting point of France, Germany and Switzerland outside the city of Basel. The Germans lived on the German side of the border and were bused to France. Their research shifted towards army ground warfare over time. Baumann, 'Die Gründung,' 237–55, also published in French in a slightly different version, Baumann, "'Was die wissenschaftlichen Ergebnisse'".
  11. The sources of this table come from most of the works cited above. I will only mention here the names called out explicitly in the table: Ciesla and Trischler, 'Legitimation Through Use;' Hunt, *Secret Agenda*, 176; Mick, *Forschen für Stalin*; Ludmann-Obier, 'un aspect'; Nouzille with Huwart, 'Comment la France'; Villain, 'France and the Peenemünde;' Scranton, 'Le management du projet' (provided as an English draft); Baumann, 'Die Gründung'; Glatt, 'Reparations'; Stanley, *Rüstungsmodernisierung*; Jones, 'The Employment of German Scientists;' Margolian, *Unauthorized Entry*; Ebert, Kaiser, and Peters, *Willy Messerschmitt* (originally published in German); Horeis, *Rolf Engel*; <http://www.bharat-rakshak.com/IAF/History/Aircraft/Marut1.html> (accessed 7 September 2010).
  12. Citing a book by Thomas Stamm, Mick does note that between 1949 and 1966, about '1800 deutsche Wissenschaftler und 4200 Techniker' emigrated to the USA, presumably including

- those coming under Paperclip and successor programs: Mick, *Forschen für Stalin*, 316. I would assume that the former category includes the Diploma and Doctor Engineers (Dipl. Ing. and Dr. Ing.), and that the less educated practical engineers (Ing. often a two-year certificate) are under the latter category with skilled technicians.
13. These records are in National Archives College Park, Record Group 330 (Joint Chiefs of Staff), Joint Intelligence Objectives Agency (hereinafter JIOA), Foreign Scientist Case Files (hereinafter FSCF). I did the first nine, and Kristina Maimer, an intern with me in summer 2009, carried out the tedious job of classifying 225 files. In order to ensure a fully random sample, we analyzed every file beginning in Box 1 (name file Aakula) all the way to Demant in box 29. Of the 128 who immigrated under these programs, 87 could be classified as aerospace specialists, or 68%, based on their previous occupation or their destination agency or company in the USA. In fact the percentage is almost certainly a bit higher, as some went to Army or Navy units that are not obviously aerospace in core function (such as the Signal Corps Engineering Laboratories in Fort Monmouth, NJ), but may well have been involved in aviation or missile applications.
  14. Hunt, *Secret Agenda*, 176, based on JIOA administrative records, which as usual she poorly footnotes, making the original documents very difficult to trace. On pp. 199–200 she claims from JIOA records that 109 came in 1958, and 158 in 1959–60 under Paperclip/DEFSIP alone, not counting Project 63 and National Interest cases. In our survey we found no arrivals later than December 1957, other than one case in 1963 which appears to have been outside of the systematic program. Hunt asserts that many dossiers were destroyed or removed by the FBI in the wake of the 1964 discovery that the former Director of the JIOA was a Soviet spy (p. 200), so it may be that the value of my sample is limited to pre-1958 arrivals. Hunt carried out the pioneering work on the long afterlife of Paperclip, which she tells notably in chaps 11 and 12, but a reexamination of the program in the 1950s and 1960s is long overdue.
  15. Huwart, *Du V2 à Veronique*.
  16. Glatt, 'Reparations,' 244–8, and chap. 9; Mick, *Forschen für Stalin*, 66–8, 72–4, 76–9. Bower's *Paperclip Conspiracy* discusses Britain extensively, but primarily its wartime and post-war technical evaluation of German technology and relations with the Americans. The book is useless as a history of British policy, is riddled with errors and sensationalism, and is driven by an uncritical belief in German technical superiority. Its primary virtue in the 1980s was digging up scandals long buried in classification, as is true of Hunt's work (and he profited from her pioneering Freedom of Information Act actions in the USA).
  17. See Jones, 'The Employment of German Scientists,' and Margolian, *Unauthorized Entry*, cited above. Glatt, 'Reparations,' 894, mentions British Darwin Panel allocations of Germans to Australia of 44, India 24, 'Canada about six and Pakistan probably only two.' Whether they all actually arrived in those countries is unclear. See also Koerner, 'Technology Transfer.'
  18. Mick, *Forschen für Stalin*, chaps 2 and 3; Albrecht, Heinemann-Grüder and Wellman, *Die Spezialisten*; Uhl, *Stalins V-2*, chaps 3 and 4; Siddiqi, 'Germans in Russia,' Neufeld, 'Overcast, Paperclip, Osoaviakhim.'
  19. Neufeld, *Von Braun*, 209–11, 216–17.
  20. Stanley, *Rüstungsmodernisierung*, 139–48, 166–79; Mick, *Forschen für Stalin*, 79.
  21. There is little on this Messerschmitt group other than an uncritical overview in a biography plus passing mention in other works. See Ebert, Kaiser, and Peters, *Willy Messerschmitt*, 320–59; Lehmann, *Die Bundesrepublik*, 133–7; Nordeen and Nicolle, *Phoenix*, 178–9.
  22. Nordeen and Nicolle, *Phoenix*, 177–80; Bar-Zohar, *The Hunt*, chap. 13 ('Nasser employs some Germans'); Heinz Horeis, *Rolf Engel*, 84–90.
  23. Ciesla, 'Die Transferfalle; Mick, *Forschen für Stalin*, 302–10.
  24. Estimate by Ciesla given in Mick, *Forschen für Stalin*, 302. For a wider view of the importance of the returned specialists in all fields to the GDR economy, see Augustine, *Red Prometheus*.
  25. I did find one case in my sample of Foreign Scientist Case Files of someone who had been in the German rocket group in the USSR and ended up in the USA: National Archives College Park, RG 330, JIOA, FSCF, Box 26, file COERMANN, Rolf. He apparently was able to evince a convincing anti-Communist record.
  26. Mick, *Forschen für Stalin*, 80, 175–6, 178, 206, 212; Ebert, Kaiser, and Peters, *Willy Messerschmitt*, 353–7.
  27. Hunt, *Secret Agenda*, 182–3, 194, 200–1.



28. Stanley, *Rüstungsmodernisierung*, 123–6.
29. Based on ‘Basic Personnel Record’ forms filled out at Fort Strong in Boston harbor after arrival, dates 19 November 1945 to 15 February 1946, in National Archives College Park, RG165, E.179, Box 703, file ‘Boston.’ I only took notes on members of the von Braun group, but there are also some from Army Air Forces Germans heading to Wright Field in Dayton, Ohio, in the folder. See Neufeld, *Von Braun*, 216–7, for a discussion of aspects of this data.
30. National Archives College Park, RG 330, JIOA, FSCF, Boxes 1–29. A larger number of specialists had been in the DAF (German Labor Front) and the NSV (National Socialist People’s Welfare), but I am not counting these cases, as these were the type of organizations that were difficult to avoid in a totalitarian society. Membership in the party of course does not necessarily mean true belief, as the majority certainly joined out of opportunism, but it is the most useful marker, after the SS and SA, of Nazi commitment.
31. If the USA perhaps ended up getting disproportionately more specialists with dubious records than anyone else, it was likely a side-effect of skimming off the best technical group overall. The highly qualified aerospace specialists were predominantly young men between the ages of 22 and 45 from educated, middle and upper-middle-class backgrounds (*Bildungsbürgertum*), a demographic group inclined to National Socialism. As one of the requirements of ascent in industry and government under Hitler was often membership in the party or other Nazi organizations, opportunism was an even more important factor. For scholarly assessments of the war crimes connected to von Braun group and the aerospace doctors, see Neufeld, *The Rocket and the Reich*, and Neufeld, ‘Wernher von Braun;’ Mackowski, *Testing the Limits*. Unfortunately, the latter, useful book is marred by a naïve acceptance of Strughold’s rationalizations of his behavior in Nazi Germany, making it the mirror-image opposite of the scandal-mongering approach of Bower’s *Paperclip Conspiracy* and Hunt’s *Secret Agenda*, where the crimes connected to the von Braun group and the aerospace doctors are prominently featured.
32. Twigge, *Early Development*, 186–7; Glatt, ‘Reparations,’ 247–8, 961; Huwart, *Du V2 à Veronique*, 121–33.
33. Stanley, *Rüstungsmodernisierung*, 194–205; Nordeen and Nicolle, *Phoenix*, 178–9; Horeis, *Rolf Engel*, 84–90.
34. Nahum, ‘The Royal Aircraft Establishment,’ 36–8, 50–1; Glatt, ‘Reparations,’ 244–6, 299; Bower, *Paperclip Conspiracy*, 164–8.
35. Stanley, *Rüstungsmodernisierung*, 166–79; Wagner, *Kurt Tank*, 250–7.
36. Wagner, *Kurt Tank*, 258–65; <http://www.bharat-rakshak.com/IAF/History/Aircraft/Marut1.html>, and <http://www.bharat-rakshak.com/IAF/Aircraft/Polly-Marut.html> (accessed 7 September 2010).
37. Lukasiewicz, ‘Canada’s Encounter.’
38. Mick, *Forschen für Stalin*, esp. 137–48, and 179–209 for analysis of the problems. See also Sobolew, *Deutsche Spuren*, 128–47.
39. See sources above, note 3.
40. Scranton, ‘Le management du projet;’ Scranton, ‘L’introduction des moteurs;’ and Scranton, ‘Managing Uncertainty.’ Hermione Giffard advises me that the British and Americans (who largely started by copying British designs) had less interest in German jet engine work because their own designs were already advanced. She recently completed a doctoral dissertation: Giffard, ‘The Development.’
41. From my sample of 128 specialists who immigrated 56 or 58 (two are marked Army but appear more likely that they are Air Force) were sponsored by the USAAF/USAF, or about 45% (see above note 8). Ciesla, ‘German High Velocity,’ earlier calculated about 40% Air Force up to the early 1950s.
42. Meier, *German Development*, esp. chap. 8 by Ciesla and Krag, ‘Transfer of German High-Speed.’ Meier’s book originally appeared in German in 2006. Hallion, ‘Lippisch, Gluhareff and Jones,’ discusses early US research.
43. Mackowski, *Testing the Limits*; Bower, *Paperclip Conspiracy*, chap. XI; Hunt, *Secret Agenda*, chap. 5. Another luminary was pioneering swept-wing theorist Adolf Busemann, who uniquely ended up at NACA’s Langley Laboratory in Hampton, Virginia: National Archives College Park, RG 330, JIOA, FSCF, Box 24, file BUSEMANN, Adolf.
44. The National Air and Space Museum does own a Messerschmitt-designed Ha 200, a gift of the Egyptian air force.
45. DeVorkin, *Science with a Vengeance*.

46. Sobolew, *Deutsche Spuren*, 201, 208, 222–4.
47. Wegener, *Peenemünde Wind Tunnels*, chaps 7–10.
48. There were attempts to return the test section to Germany in the late 1990s, which the Air Force finally denied. Initiatives by myself and John Anderson to collect it for the National Air and Space Museum were also rebuffed. In fall 2011 we inspected the test section again, where it is now in a case in a display area outside Tunnel 9 (because of facility access restrictions, it is not straightforward to view it). In view of its current good preservation and past history, we have refrained from further attempts at this time to ask the Air Force for its transfer to the Smithsonian.
49. Hans Holzer/DM e-mails to Michael Neufeld, 9–10 January 2012.
50. Krige, *American Hegemony*. I owe to John Krige further stimulus to thought regarding transnational movements of scientists and engineers thanks to two articles he provided me: Krige, ‘Building the Arsenal,’ (cited above, note 1) and Krige, ‘American Science in the Global Cold War’ (draft).

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