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Jet Propulsion Technology in Switzerland

Introduction without Production in the Emerging Cold War, 1945–1949

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This article explores the introduction of jet propulsion technology to Switzerland through arms transfers during the emerging Cold War. In 1947, the Swiss Air Force bought a series of finished Vampire aircraft from Great Britain. This led to the introduction of jet propulsion technology to Switzerland. For the following series, the Federal Military Department intended to build the engine and the airframe inside the country's borders. This intention was not realised, and only the less technologically demanding airframes were produced in Switzerland. In a first step I will focus on the reasons for Switzerland to buy jet powered fighter aircraft in the first place, and in a second step I will answer the question why the Swiss were unable to move one step further and actually produce jet engines under licence from Great Britain.

In the light of the differences between states' abilities to produce weapons, arms transfers are the logical result of the quest to acquire modern means of warfare. As states often prefer producing weapons to acquiring them, the arms transfer system is not only a trade in goods, but also a vehicle for the transmission and diffusion of military technology. According to Keith Krause, there are four types of military technology: technology I refers to the skills needed to operate the weapons; technology II is the scientific and engineering skills to reproduce technology I; technology III involves an autonomous improvement of the imported weapon system; at technology IV a society is able to produce new forms of technology. If one applies these technology types to arms transfers, technology I equates to material transfer (the simple diffusion of machines and material), technology II to design transfer (transmission of blueprints, formulas, books, et cetera) and technology III to capacity transfer (the transfer of basic scientific knowledge and technical expertise).

The factors determining the step from one technological level to another – such as domestic demand, local investment capital or investment in research and development – are the same in military and civilian production. However, political will is necessary for successful diffusion on a military level, mainly because of the nature of the military market. The shift to technology II requires significant

capital and labour resources, while the transfer of technology I needs little or no local capital and labour expertise. In conjunction with these domestic factors, the arms transfer system can contribute strongly to the choice between material and design transfer. If there is a technological gap and the producing state is willing to export his products for profits, the receiving state is more likely – because of the lower cost – to choose material transfer. However, if the arms transfer system becomes controlled, and the state possessing the technology is unlikely to export the weapons, the recipient state may be willing to go for design transfer, despite the heavy investments needed.[1] Meanwhile, the arms transfer system has also to allow the transfer of technology.

During the late 1940s, monitoring of East-West trade and military technology transfers was not yet firmly established. The economic containment of the Soviet Union and its satellites came about rather slowly as a reaction to the Cold War. In December 1947, the Truman administration decided to implement an embargo on East-West trade.[2] However, the British and the other allied European powers were reluctant to curtail or suspend their trade with the Soviet Union. Consequently, the Coordinating Committee of the Consultative Group, which was to oversee day-to-day operations, was only established in Paris in January 1950.[3] Only after enormous pressure from the United States did Switzerland agree to comply with the trade restrictions through a Gentlemen's agreement on 23 July 1951.[4] It was by setting up the Coordinating Committee that the free flow of technology was seriously reduced.[5]

If the arms transfer system allowed technology transfers, the international situation not only hindered a state's ability to acquire military technology, but also encouraged another state to sell its technology. After the war, Switzerland encountered the hostility of the two emerging superpowers – the United States and the Soviet Union. Not only did they consider the Swiss to be war profiteers, but they were also hostile to neutrality.[6] The only major ally supporting Switzerland after the war was Great Britain, which was willing to help the Swiss in finding an agreement with the Americans in 1946 over Nazi assets and gold. This support, however, was only forthcoming because the Swiss had granted Britain an important credit with advantageous conditions.[7] After the war, the United Kingdom was in a dire financial situation and needed hard currency, if possible from another country than the United States, which would expect major concessions in imperial economic policy.[8] Besides common economic interests, after the war the Swiss and the British both opposed political European integration and had a "special relationship" in the military field.[9] The likelihood of receiving modern technology from the British was thus higher than from the United States. Moreover, the important technology gap between Britain and Switzerland favoured arms transfers.

The Technology Gap

After the war, the Swiss attributed their unscathed survival mainly to their armed neutrality. The Federal Council was convinced that the only way to remain neutral was to meet any violation of neutrality with armed resistance. Better military preparedness meant a lower risk that neutrality would be violated.[10] Fearing the Soviets, the plateau with the bulk of the population and industry was included in the defence perimeter. This further increased Switzerland's need for air and tank defence.[11] Despite the conflict between defenders of a "mobile" and a "static" defence, and additional budget constraints, the need for modern equipment was considered important. Consequently, the Swiss started to rearm in 1945.[12] Ideally, this had to be achieved through a self-reliant armament policy to avoid dependence on other countries.[13] Especially in the field of aviation, this was difficult to achieve. In many countries – such as Britain, the United States, Germany and France – the invention of aircraft during the "Belle Epoque" was met by enthusiasm and led to the establishment of an aircraft industry. Yet, in Switzerland, the establishment of an aircraft industry failed, because there was not sufficient support by the Federal authorities to compensate for the absence of other factors, mainly because of the country's small size.[14] During World War I, the Federal Construction Workshop Thun started to produce a limited amount of aircraft for the Swiss Air Force. In the interwar period, aircraft were mainly produced under licence and technological developments were not competitive. Once World War II had started and the procurement of aircraft from abroad became ever more difficult, the Federal Aircraft Factory Emmen – primarily responsible for building improved versions of the French Moran-Saulnier 406 aircraft – was founded. In the private sector, in 1926, the Dornier aircraft factory (later Flug- und Fahrzeugwerke Altenrhein) was established, as their owner fled the armament restrictions imposed by the Versailles Treaty on Germany. During the war, on Emil Bührle's initiative, the Pilatus aircraft factory was created to supply the Swiss Air Force with indigenous aircraft.[15] In 1939, all companies involved in the production of aircraft founded the Swiss Association of the Aircraft Industry to defend their interests vis-à-vis the Federal authorities.[16]

During the war, the Federal Aircraft Factory, Pilatus and the Flug- und Fahrzeugwerke Altenrhein worked together in the production and development of aircraft. Despite important efforts, the only prototype ready to enter into production after the war was the piston-engined D-3802, an improved version of the obsolete MS-406.[17] Even though the 1930s had seen leading scientists such as Professor Eichelberg, a gas turbine specialist, and Professor Ackeret, who tackled the problems of the axial flow compressor, there had been no work on jet engines in wartime.[18] Moreover, the war had not brought about any major aircraft

company capable of major research and development, and the coordination of military aircraft production remained in the Military Technical Service's domain. After the war, the number of people working in the aircraft industry further decreased, and in 1947, the Federal Aircraft Factory employed between 400 and 500 people, while the Flug- und Fahrzeugwerke Altenrhein employed 100 and Pilatus around 150 in the production of aircraft.[19] Compared to the British aircraft industry, which in 1950 still employed 179,000 people, these are small numbers.[20] Aware of the technological delay and lack of capacity, on 25 April 1945, the Military Technical Service called upon the Swiss machine industry to submit proposals for the development of jet engines, with the intention to develop a Swiss jet aircraft in line with the ideal of a self-reliant armament policy.[21] Switzerland's desire for its own jet aircraft was not an isolated phenomenon after the Second World War, as not only neutral Sweden, but also countries such as Spain, Argentina, India and the United Arab Republic started to work on their own jet aircraft.[22] The Military Technical Service's call for proposals encountered, however, only a very limited success. By June 1946, Brown Boveri, although it had started its own research, was unwilling to develop an engine. Because of the economic boom, its gas turbine section was over-employed, and jet technology was seen as an insecure investment. Escher-Wyss for its part had also begun with preliminary research. Yet the company refused to develop an entire engine, for it considered it an unrealistic venture, and argued that its present orders did not leave sufficient capacity for such an enormous project. Finally, only Sulzer agreed to sign a contract with the Military Technical Service for the development of a jet engine.[23]

Soon thereafter, however, the Federal Aircraft Factory – which was responsible for the development of a Swiss jet aircraft – was not satisfied with Sulzer's suggestions, and started working on a modified Mamba engine from the British company Armstrong Siddeley Motors. From 1950, work on the "Swiss Mamba" was prioritised, only to be abandoned later, and in 1954, Sulzer stopped the research on its D-45 engine – which it had continued at its own expense.[24] If this predicted the later failure of the development of an "indigenous" jet aircraft, it definitely put an end to Switzerland's attempt to develop its own jet engines.

In Great Britain, the case was completely different. The overall public investment in the armament industry before and during the war was enormous, amounting to £1 billion between 1936 and 1945.[25] In 1940, Churchill created the Ministry of Aircraft Production to coordinate the aircraft industry, which at its peak in the war employed even more people than the coal industry.[26] Frank Whittle had made the first proposal for a jet engine in 1929. In 1938, his company Power Jets received a contract from the Air Ministry, and in 1939, it was finally decided to build an airframe for the engine. This aircraft, later called Meteor, made its

first flight on 15 May 1943. Meanwhile, the Ministry of Aircraft Production had identified the jet as a potentially vital technology and the ministry wanted other firms involved in the development work. Consequently, in July 1944, the Meteor entered service and Rolls-Royce and de Havilland were producing jet engines in quantity. With the destruction of the German aircraft industry – the other leading nation in jet technology – Britain was the leading nation in the production of jet powered military aircraft.[27]

After the war, Britain needed a massive influx of revenue from increased exports. The military aircraft and jet engines offered the new Labour Government an irresistible revenue source. The Air Ministry, by reducing its export controls, offered foreign buyers the opportunity to acquire jet aircraft. Moreover, the Attlee Government was also ready to sell know-how, because the Open List included not only finished aircraft and engines, but also manufacturing licences for jet production. This created an inherent conflict over aviation in the "special relationship" between Britain and the United States at the onset of the Cold War. While London considered it vital to sell to survive, Washington was afraid of technological dissemination.[28] Moreover, considering Switzerland a war profiteer in 1945, the United States refused "as a matter of policy" to export surplus P-51 aircraft to Switzerland.[29] Even though with the mounting East-West tensions the Americans finally agreed to deliver them in 1947,[30] still in 1948 the Swiss received no priority in the delivery of modern military equipment.[31]

Vampire I

After the purchase of three British Spitfire aircraft towards the end of the war,[32] and the visit of a British aircraft industry representative to Switzerland, Berne made known that it would greatly appreciate an invitation to send a technical mission to the United Kingdom.[33] The Ministry of Aircraft Production was very interested in this visit and insisted that even the sale of a licence would be financially appealing, because it would create a long dependency of Switzerland on the United Kingdom for accessories, instruments, armaments, et cetera, especially in the light of the probability of American competition.[34] With the agreement of the other interested departments (Foreign Office, Board of Trade, Department of Overseas Trade and Treasury), the Ministry of Aircraft Production obtained the backing of John Wilmot, Minister of Supply, to invite a Swiss mission and to present them aircraft and engines to choose from and thus obtain a valuable export business.[35]

The Commission for Military Aircraft Procurement – Defence Minister Karl Kobelt's advisory body – agreed that there was a need for more fighter aircraft.

The National Defence Commission, although sceptical of the Swiss Air Force's efficiency, agreed with this conclusion.[36] The aim of the mission to Britain was to get an overview of the engines and aircraft available in order to buy small amounts of them to learn more about jet propulsion. Buying finished aircraft was never considered, because the aircraft had to be developed or produced under licence in Switzerland.[37] On their return, the mission's members suggested sending another delegation to Britain to choose a small number of the most appropriate aircraft for testing purposes among those they had seen. Despite opposition from its scientists and the representative from the Swiss Association of the Aircraft Industry, who feared for the fate of autonomous aircraft development, the Commission for Military Aircraft Procurement agreed.[38] In spring 1946, a new Swiss mission went to Britain and tested piston- and jet-engined aircraft. All the members of the mission considered de Havilland's Vampire appropriate for Swiss conditions, and requested the purchase of a limited number for test purposes.[39] However, in the meeting of the Commission for Military Aircraft Procurement of 14 May, the Head of the Military Technical Service, René von Wattenwyl, defended the future production of the piston-engined Swiss aircraft D-3802 against an eventual purchase of British aircraft.

While he criticised that the Vampire was not appropriate for Switzerland's topography, he argued that the manufacture under licence would not only take longer than the production of the D-3802, but would also come at a higher cost and at the expense of the Swiss aircraft industry. On the contrary, the Head of the Swiss Air Force, Friedrich Rihner, stressed that piston-engined aircraft were a relic of the past and that only jet aircraft guaranteed the future safety of the country. He suggested – taking into account finance and time – that with the money foreseen for the D-3802, approximately 100 Vampires could be bought. This solution not only made an early delivery of state-of-the-art aircraft to the troops possible, but was also cheaper than the production of Vampires under licence and the manufacture of the D-3802. Confronted with this deadlock, a further meeting of the commission was necessary to come to a compromise.[40] In the meeting of 5 June, the issue was whether Vampires were to be bought instead of the production of the D-3802. Eventually, the Head of the Military Technical Service had to abandon the D-3802, because the Head of the Swiss Air Force was able to mobilise the support of the commission's president, Alfred Büchi. Yet, von Wattenwyl only gave in after having received the promise that a second series of Vampires was to be manufactured under licence and would thus help maintain the Swiss aircraft industry.[41] With this agreement reached, the Defence Minister informed the National Defence Commission on 25 June that he had decided to scrap the D-3802, and to buy three Vampires for testing purposes, leading eventually to a purchase of a Vampire series.[42] On 27 and 29 July 1946,

the first Vampires were flown to Switzerland, and introduced jet technology in a "material transfer".[43] After lengthy tests and political wrangling, the Swiss Government ratified a contract for 75 Vampires for 64.45 million Swiss francs in October 1947.[44]

Vampire II

In a meeting of the Commission for Military Aircraft Procurement at the beginning of 1948, Rihner argued that the manufacture under licence of 100 further Vampires should begin as soon as possible, so that delivery to the troops could start in 1953. In agreement with him, von Wattenwyl suggested informing the Swiss aircraft industry about this decision, to demonstrate that the Federal Military Department was giving attention to their destiny.[45] In February 1948, the Military Commission of the National Council was informed that the production of Vampires under licence was the next step in Switzerland's procurement policy and its members agreed. At the same time they were sceptical about taking the next step, namely to develop an indigenous jet fighter.[46] Two weeks later, the same commission was informed about how the manufacture under licence was supposed to happen, underlining that this procedure was essential, because Switzerland could not eternally count on Britain's willingness to deliver finished aircraft. Astonishingly, only the airframes and not the engines were to be produced in Switzerland. The reasons given were that the establishment of a production plant for only 100 engines would be too costly and time-consuming; the bottleneck in Britain's production capacity for airframes appeared to be more important than that of engines; the manufacture of airframes was considered sufficient to keep the Swiss aircraft industry alive; and finally, the purchase of engines in Britain would bring about commercial advantages. On these grounds the Commission agreed.[47] In the light of the communist coup in Czechoslovakia, however, Rihner enquired about the feasibility of the production of engines under licence, arguing that this would make Switzerland independent from British supplies. To justify his case, he pointed to the example of Sweden, which had already started to produce British jet engines under licence, while continuing to buy airframes.[48] In response, the Head of the Military Technical Service argued not only that the production of jet engines would delay the delivery by ten months, but also that no Swiss company could make an offer for it.[49] The Director of the Military Airfields, Walter Burkhard, argued that the machine industry had more interesting orders, Switzerland lacked the engineers with the necessary experience, and even if feasible, it would further delay the delivery. Finally, he underlined that a comparison with Sweden was not appropriate, because this country had an important aero-engine factory.[50]

After having received these arguments, the Head of the Swiss Air Force did not make any further enquiries.

In a meeting on 7 May between the Chief of the General Staff, the Military Technical Service, and the Swiss Air Force, the findings were paradoxical. While they agreed that a modern indigenous aircraft would not be ready for years to come and the procurement of aircraft abroad was dependent on the international situation, they opted only for a partial licence.[51] On 16 June 1948, Kobelt made the request to the Federal Council that another series of Vampires was to be purchased, with the airframe produced in Switzerland under licence, and the engine to be bought abroad. He argued that an earlier delivery of aircraft to the troops would become possible through a licence, because de Havilland was overloaded with orders. Yet, he did not justify the choice for a partial licence.[52]

If in a crisis period airframes might not be delivered, why did the Federal Military Department believe in a greater chance of getting the more complex jet engines? Federal Councillor Ernst Nobs, Head of the Federal Finance Department, detected this problem. He criticised that the argument for independence became null and void through a partial licence, underlining that the only remaining reason for this was to speed up delivery dates. Favouring the purchase of finished aircraft, he complained about the higher cost resulting from the manufacture of airframes in Switzerland.[53]

Even though von Wattenwyl first reacted by suggesting to also buy the engine licence,[54] he continued to defend the partial licence. Writing to de Montmollin, he argued that independence was not immediately achievable, and a step-by-step approach was necessary. The licence manufacture of the airframes together with the shorter delivery times for engines would help in speeding up the production of Swiss Air Force equipment.[55] Informed by his Chief of the General Staff,[56] the Defence Minister followed this reasoning in his reply to the Finance Minister.[57] Kobelt nevertheless gave the order to enquire about an engine licence,[58] and authorised the Military Technical Service to start preliminary negotiations with de Havilland for buying the licences in question.[59] Finally, at the Federal Council's meeting on 19 October, the Defence Minister submitted three variants for the acquisition of a further series of Vampires to his colleagues: 1. Manufacture of the whole aircraft under licence; 2. Production of airframes under licence and purchase of the engines; 3. Purchase of the entire aircraft. They finally opted for the second, which had been favoured by the Federal Military Department in the first place.[60] It is unclear how exactly this decision came about. Yet, there certainly were strong military and economic reasons. From a military perspective, although there was a strong desire for independence, the setting-up of a production plant for jet engines would have further delayed the delivery of aircraft. With the bottleneck mainly in the production of airframes, the partial licence could

reduce the timeframe. On economic grounds, the production of jet engines for a Vampire series of 100 was considered too expensive, but with a partial licence the Swiss aircraft industry would also be satisfied. Finally, the purchase of engines in Britain would positively influence the Anglo-Swiss balance of payments, and thus entail economic benefits for Switzerland. Probably, the British Air Attaché in Berne was right by stating that solution number two was smart, because "[one] is impracticable because of time involved and [three] does not give support to native aircraft industry".[61]
Finally, after political wrangling, the purchase of another 100 Vampires on this basis was accepted by the Swiss National Council on 23 March 1949, and by the State Council the following day.[62]

Conclusion

From the beginning, the British had been willing – mainly for financial reasons – to sell the Swiss licences for the manufacture of jet engines. This was appealing for the Swiss authorities, which favoured a self-reliant armament policy. Yet, in the summer of 1946, the Federal Military Department determined the course for the purchase of finished Vampire jet aircraft from Britain. This option was chosen because it was less expensive than both the production of the indigenous D-3802 aircraft and the manufacture of the Vampire under licence. Moreover, the purchase of jet aeroplanes from Britain allowed the use of earlier equipment of the Swiss Air Force along with modern aircraft. However, this could only happen because the Military Technical Service was promised – for the sake of the Swiss aeronautical industry – that a second series of jet aircraft would be produced under licence in Switzerland. Nonetheless, this first Vampire deal introduced jet technology to Switzerland through a material transfer from Britain.
Despite the intention to produce a second Vampire series under licence with the aim of achieving a self-reliant armament policy, the Federal Military Department finally opted for a partial licence, with the manufacture of the airframe in Switzerland and the import of finished jet engines from Britain. The reasons were the costs and time needed to set up a production plant for only 100 engines; the existence of a bottleneck in the British production of airframes but not engines; the commercial advantages of purchasing finished engines; that this arrangement was seen as sufficient to keep alive the Swiss aircraft industry; the reduced time it would take to deliver aircraft to the troops; that Switzerland did not possess an aero-engine industry comparable to that of Sweden; and that the major Swiss machine industry companies were reluctant to include the development of jet technology in their business strategy. Consequently, the step-by-step approach

won out, despite the fact that it endangered Switzerland's potential supply in times of crisis or war, as the country remained dependent on the delivery of jet engines from Britain. The second Vampire series was a partial design transfer with respect to the whole aircraft, but only a material transfer with regard to the jet engine. In sum, despite Britain's willingness to sell its jet technology in the form of licences and an arms transfer system allowing for important technology transfers, the Federal authorities lacked the political will to make up for the absence of domestic factors – such as the cooperation of the machine industry – facilitating the production of jet engines under licence in Switzerland.

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Zusammenfassung

Strahltriebwerkstechnologie in der Schweiz. Einführung ohne Produktion zu Beginn des Kalten Krieges

Die Technologie des Strahlantriebs wurde zu Beginn des Kalten Krieges in der Schweiz eingeführt. 1947 entschied der Bundesrat, eine Serie fertiger Vampire-Flugzeuge in Grossbritannien zu kaufen. Dies führte zum materiellen Transfer der Düsen-Technologie. Zwei Jahre später kauften die Schweizer eine weitere Vampire-Serie. Während die Flugzeugzellen dieses Mal unter Lizenz in der Schweiz gebaut werden sollten, bezog man die Düsentriebwerke als Fertigprodukt. Der Artikel geht der Frage nach, weshalb ein Transfer der Düsentechnologie in dem erwähnten Waffengeschäft nicht inbegriffen war. Die Frage vermag zu faszinieren, denn man verfolgte in Bern eine Rüstungspolitik der Selbstversorgung, während Grossbritannien durchaus bereit gewesen wäre, die Technologie gegen harte Devisen zu verkaufen. Der Artikel argumentiert, dass die Schweizer vor allem aus finanziellen Gründen und wegen dem wahrgenommenen Zeitdruck keinen politischen Willen aufbrachten, eine Fabrikationslizenz für die Düsentechnologie zu erwerben.