The mutual development

The State, big industry and cooperation on Swedish electric power technology

COOPERATIVE ARRANGEMENTS have been a prominent feature of Swedish industrialization. The ”cooperative spirit” in the labor market, in the form of joint centralized negotiations between employers and the trade unions, is well known. This book explores a less known cooperative arrangement in the Swedish technology market: the joint development of new technologies by the State and big industry. This arrangement has taken the form of long-term, intimate collaboration between large state customers and large manufacturing companies – a type of industrial relationship for which the term ”development pair” (*utvecklingspar*) has been coined. A development pair is ”a close, long-term collaboration between a industrial company and a state customer on several development projects on new technologies”.

The subject of this book is the formation of a development pair around electric power technologies between the State power utility the Royal Board of Waterfalls (*Kungliga Vattenfallsstyrelsen*, later known only as *Vattenfall*) and the Swedish electrotechnical company ”The General Swedish Electrical Inc.” (*Allmänna Svenska Elektriska Aktiebolaget*, known by its acronym *Asea*) that today has merged as Asea Brown Boveri (ABB). The book describes the collaboration and the central processes in its formation up to the 1960s.

Background

The book’s introductory chapter gives an overview of its methodology and conceptual framework and discusses previous research connected to mutual development between the Swedish state and industry. It opens with the public ”discovery,” from the 1960s onwards, of various long-term Swedish development cooperations. The second part of the chapter defines what is meant by a ”development pair” to describe particular long-term Swedish cooperations, and discusses key concepts such as ”technology” (*teknik)*, ”cooperation” (*samarbete*) ”State” (*stat*) and ”development” (*utveckling*). This is followed by an overview of previous research on mutual development between Asea and Vattenfall, Ericsson and the Telecommunications Administration (*Televerket*), the Saab company and the Defence Material Administration (FMV), and Asea and the State Railways (SJ). There follows a discussion of social science research on innovation as collective development, the forms of industrial networks and user-producer relations, and the involvement of the state in domestic industrial development, such as ”organized capitalism” and ”developmental states”. From these perspectives emerges a focus on such factors as stability and social resources (trust) in long-term and advanced technological development collaborations and an emphasis on the role of autonomy and social embeddedness in state developers. Analytically, the development pair belongs to the ”meso” level linking macro and micro levels. Two more analytically developed meso levels are the sociotechnical systems perspective and the development block approach. These approaches have very similar key concepts and this study uses ideas from both. A micro-level approach is developed under the label ”sociotechnical engineering”. This perspective recognises the fact that engineers in their development work are, in addition to technological construction, also engaged in social and cultural construction activities. Technological constructions include traditional engineering activities such as designing tools and machines, systematic development activities such as technological testing and using and developing technological theories and performing simulations. Social construction work includes creating and using alliances and relations to actors that can influence the development project as well as participating in, constructing or using social institutions such as system goals, reverse salients and critical problems. The cultural or ideological construction work of engineers connects their development projects to larger cultural values and ideals. This is done through various representational activities and technological displays such as demonstrations and public presentations. The chapter goes on to discuss the scope and source material of the study, which explores various aspects of the development collaborations between Asea and Vattenfall in the period 1906-61. Its coverage ends in 1961 since the relationship went into a new phase

from the end of the 1950s. The development work influencing the various projects can be divided into public and private spheres. The public sphere includes discussions concerning critical problems at engineering associations and technical conferences, and is analysed mainly through presentations published in engineering journals. The private sphere concerns activities inside Vattenfall's and Asea's offices and laboratories and is described through material from Vattenfall's and Asea's corporate archives. The chapter ends with a critical discussion of the purpose of the study: to understand the interwoven dynamics of collaboration on micro and meso levels which led to the formation of a development pair around electric power technology between Asea and Vattenfall.

Chapter 2, ”The forming of an electric power technology development culture”, explores the culture of electric power engineering in Sweden. Drawing on perspectives from cultural studies, it is divided into four elements. The core of the culture is its ”material culture” – electric power technology, machines and knowledge. This is explored by following the emergence of new electrical power technologies in Sweden from the 1880s until 1910s as well as their producers and users in the form of new international and Swedish electrical manufacturing companies and Swedish power utilities. Central among these were Asea, founded in 1890, and Vattenfall's predecessor the Royal Canal and Hydro Board of Trollhättan (*Kungliga Trollhätte Kanal- och Vattenverk*), founded in 1906 and transformed into Vattenfall in 1909. The non-material, knowledge part of the technology is described through a discussion of the ideal competence and education of Swedish electrical engineers. The second part of the culture comprises the social institutions and networks which mediated the reproduction of values, commodities and activities in the interest of the culture. By following the career of one of Vattenfall's engineers (Edy Velander) a picture is given of the social composition of the electric power culture, its professional networks and formative institutions such as the School of Electrical Engineering of the Royal Institute of Technology (*Kungliga Tekniska Högskolan*) in Stockholm, the Swedish Association of Electrical Engineers (*Svenska Elektroingenjörs-föreningen*) and its Technical Journal (*Teknisk Tidskrift*). The third cultural element is the set of norms and values cherished by its members. Among these, Swedish nationalism had a bearing on electric power development since the exploitation of Swedish hydro power was seen as a central means of uniting and strengthening the nation. The success of national champions such as Asea was seen as important to national autonomy and pride. The exploitation of Swedish hydro power came to be constructed as a national project and the development of electric power technology became nationalized. The fourth and last part of the culture comprises its institutionalized activity patterns, which are described through Vattenfall's and Asea's development strategies for system building and industrial entrepreneurship in electric power up to the First World War. Asea chose an aggressive marketing strategy which sought technological parity with the international giants; Vattenfall followed an expansive build-out strategy in which it maximized its efforts to exploit the State's hydro power and compete with other Swedish power utilities. These four elements can be considered the sociotechnical heritage influencing the development pair. They provided the necessary, but not sufficient, cultural conditions for the formation of a development collaboration. What was also needed was opportunity and a willingness to engage. This came with the joint projects.

The formation of a development pair

The second part of the study opens with Chapter 3, ”State Instruments for National Development, 1906–16.” The chapter focuses on the development collaborations of Asea and Vattenfall on circuit breakers. The first part of the chapter describes Vattenfall's and Asea's affairs and joint development activities connected to the build-out in 1906-10 of the first state hydro power plant in Trollhättan, the ”Swedish Niagara”. The two engineers in charge of this project became inspired through an American study-tour (*fig.* 3.3). In their procurement of turbines and electrical equipment for the Trollhättan plant the new state board favored Swedish companies and one of these ”national affairs” led to the first joint development project. Asea was lagging internationally in transmission technology and recruited a Swedish-American engineer from General Electric and managed to secure the order for the circuit breakers. While the breakers were being manufactured, Vattenfall found out that they would probably not be good enough and in 1910 initiated an experimental collaboration that improved the construction of those breakers that Asea subsequently delivered to Trollhättan. The second part of the chapter describes further attempts in 1912-16 by Vattenfall's engineers at the Trollhättan power plant and at Asea to initiate more extensive and systematic experimental collaboration concerning circuit breakers. Because of a power struggle inside Vattenfall, however, these attempts faltered during the First World War. These projects were characterized by close personal networks between engineers of Asea and Vattenfall and nationalistic solidarity among engineers to cooperate for the good of the nation and national industry.

In Chapter 4, ”Strategic Links between System Building and Entrepreneurship, 1915-26,” the emerging development pair enters its first large scale project connected to an expansion of Vattenfall’s and Asea’s separate development strategies. This cooperation concerned the construction of transformers for large power transmission. Asea strengthened its competence in transmission technology by buying its foremost domestic competitor and erecting its first industrial laboratory and its own steel mill. Vattenfall had undertaken a more offensive strategy and began acquiring waterfalls in the north of Sweden. In 1919 Vattenfall drew up a national trunk line plan to interconnect all of Sweden’s State power plants. This conflicted with the electrification plans of the State Railways (SJ) but it was decided that SJ had to coordinate their electrification with Vattenfall. In 1920 Vattenfall decided to order transformers of 130 kilovolt for the first trunk line between Vattenfall’s power plants in Trollhättan and Västerås. This project was the first in Europe to use such a high transmission voltage which made it of strategic importance, especially to Asea. Even though Asea’s transformers had not previously been up to international standard, Vattenfall decided to buy three transformers from Asea and one from its more experienced competitor General Electric. Together Asea and Vattenfall carried out model tests on the construction of the insulation of the transformers. After delivery, two of Asea’s transformers broke down leading to a crisis between Vattenfall and Asea. The crisis was overcome when Asea managed to repair and re-construct the transformers. Vattenfall never went public with this incident and also deferred from penalty payments. In the mid-1920s when SJ went ahead with its large-scale railway electrification, Vattenfall once again ordered transformers from Asea, which now had become a major transformer export firm.

Chapter 5 ”A breakpoint for the scientific development, 1925–35,” describes how science became increasingly connected to the development of electric power technology and how the development pair’s activities contributed to that connection. The chapter opens with two examples of how ”scientific engineers” at Asea and Vattenfall became interested in systematic investigations into the improvement of operational reliability of long-distance transmissions. A mutual problem connected to operational reliability arose in 1925 when the circuit breakers that Asea had delivered to Vattenfall’s Western trunk line malfunctioned and exploded. Vattenfall and Asea performed experiments in Vattenfall’s power plants and Asea’s work-shops in 1925–30 which resulted in a safer breaker. As science and research gained increasing importance in electrical engineering, Vattenfall and Asea set up laboratories for research and development. Asea’s two new laboratories connected with a broader effort by the company to improve its capacity for more systematic development. This included their first large-scale development project 1928-32 to develop a commercial mercury-arc rectifier for tramways, trains and industrial uses. Asea also set up two development laboratories for breakers and rectifiers. The chapter then returns to the experimental breaker cooperation in 1931-33 in which Asea tested out a new radical breaker construction, the contraction chamber. The development of breakers and rectifiers was used as an argument for improving theoretical and laboratory resources for the education of Swedish electrical engineers and was a prelude to the larger breakthrough of technological research in the postwar period.

Chapter 6 ”The mutual record years, 1940–57,” describes the zenith of the development pair. The joint projects concerned two radical new transmission technologies on a completely different scale and scope than hitherto. These projects concerned a reverse salient in Vattenfall’s system building – the long distance between the large State hydro power resources in the upper north and the consumption centers in the south – and involved developing technologies for Swedish superpower transmissions. The chapter begins with a recapitulation of the ”second battle of the currents” and the various projects and prototypes for European superpower transmissions which caused significant problems for the dominant alternating current (ac) transmission technology. As a possible solution, engineers started to discuss high voltage direct current (hvdc) transmission. The critical problem for hvdc-transmission was to develop a high converter between hvdc and ac. Several international prototypes were developed in the interwar period. In 1933 two competing Swedish prototypes were presented, one of which was developed by Asea. In the early 1940s Asea turned to Vattenfall to find a practical project on which to test their prototype. In 1942 Asea and Vattenfall began collaborating and performed practical and theoretical investigations of the feasibility of hvdc or ac higher than 220 kilovolt. In 1943 they signed a cooperation agreement and erected a joint experimental transmission plant in Trollhättan. Through this the previous informal collaboration became institutionalized. By 1946, when Vattenfall made its critical technological choice, the hvdc development had not progressed enough. Vattenfall chose to develop an ac transmission of 380 kilovolt together with Asea. The development pair was at the same time strengthened when a high-ranking Vattenfall engineer became Asea's new CEO in 1948. He also began forming a new development pair around electric trains with Asea's other large state customer SJ. Meanwhile the joint 380 kilovolt project progressed and in 1952 the first power line became operational. The development pair also continued with the hvdc development and in 1956 Vattenfall inaugurated the world's first commercial hvdc transmission, to the island of Gotland. This was a small project but thanks to its success and Vattenfall's enthusiastic support, Asea in 1957 obtained their first export order for a hvdc link across the English Channel.

The case-studies end with Chapter 7, ”The relationship's social drama, 1954–1961,” which focuses on a failed development collaboration which led to a severe crisis in the relationship. While working on the joint projects described in the previous chapter, the development pair had cooperated since 1954 on the development of heavy water nuclear power reactors. But a third collaborator, the semi-public, scientist-led development company Atomic Energy Inc (*AB Atomenergi*) demanded principal responsibility for reactor construction. This led to a conflict with Asea, who were largely supported by Vattenfall. However, in 1956, the government decided to place Atomic Energy in charge of the construction of Swedish reactors. In private, Vattenfall and Asea continued their collaboration until Vattenfall decided to approach Atomic Energy, mainly for budgetary reasons. In 1957 the President of Vattenfall left for another company and was replaced by a former government administrator. This, and the fact that Vattenfall ordered a transformer from a foreign manufacturer in 1959, led to a public dispute between the Presidents of Asea and Vattenfall. In private, however, they worked hard to repair the relationship between the two concerns. But it took a long time before the development relation was strengthened. The chapter ends with a discussion drawing on Victor Turner's social drama scheme to describe the crises and its conclusion in the late 1960s.

Conclusions

The book ends with Chapter 8, ”The mutual development,” which discusses the dynamics of the collaboration from micro and meso perspectives. From a micro perspective it explores the sociotechnical logics of technological development. It concludes that technologics were neither linear nor predictable, and that traditional design manufacturing competence was critical throughout the period. Despite the increasing scientification of development activities with laboratories and the increasing prevalence of technological theories, detailed scientific knowledge was often lacking and traditional testing activities had to fill the gap. The importance of sociologics is shown in the way that many of the conflicts – managerial and technical – experienced during development were mediated through personal social channels characterized by trust and friendship. Regarding ideologics, the legitimating values of national solidarity and ”science” were prominent, as was the technocratic strategy of electrical engineers to de-politicize power struggles as issues of ”rationality.” Concerning the more long-term relational dynamics the book concludes that the development pair was not the result of any master plan. After a first exploration phase, where problems and possibilities were encountered, the relation in the mid-1920s entered a formation phase. In this period the major collaboration arrangements in the form of jointly financed experiments were worked out. In this period Asea also discovered the developmental dynamics of the relationship more clearly than before. The mature phase lasted from the 1940s until the late 1950s. Now the formal collaboration was institutionalized through contracts and joint facilities. This was followed by a stagnation phase in the 1960s and a re-institutionalization in the late 1960s. With respect to the relational dynamics it can be concluded that Vattenfall was dominant with a ”tough love” toward Asea and its technologies. The chapter also concludes that this seems to have been a cooperation characteristic, if not wholly unique, to Sweden and that it played a significant role in the Swedish model. The final section discusses the often-posed question as to whether the joint development has been good or bad. This must depend on the perspective chosen. What is beyond doubt regardless of opinion, however, is that the practice of mutual development has been of great significance for twentieth century Swedish society.