Learning and Returning

Return Migration of Swedish Engineers
from the United States, 1880–1940

Per-Olof Grönberg, *Learning and Returning: Return Migration of Swedish Engineers from the United States, 1880-1940*

ABSTRACT
This thesis examines aspects of international migration and return migration among Swedish engineers – particularly to and from the United States between 1880 and 1940. The social, geographical, and educational backgrounds of these engineers and their role in diffusing technological knowledge in Sweden in addition to being a possible source of technical development during the country's second industrial breakthrough is of particular interest.

Swedish engineers were a geographically mobile group. The labour market and contemporary mass emigration to North America contributed. However, the ideal of an emigrating engineer was, in a Weberian sense, a "target migrant" who planned to return after a well-defined interval. More than two-thirds of the emigrating engineers later returned to Sweden. International industrial competition was important in the Swedish development nationalism and so was American examples and returning Swedish-Americans. American experience, but also German, was a valuable symbolic capital in what can be identified as an engineering field in line with Bourdieu. The engineers were informed about technical development in the leading industrial countries and this spurred an interest to work with technology that was largely unknown in Sweden at the time. The engineers emigrated to learn the technology and the contemporary spirit in Sweden increased the power and influence of engineers with this experience.

Return rates among engineers differed according to their social, geographical and educational background. Generally speaking, engineers from a high social origin, a high level of education, and born in the larger cities were most prone to return. The social and symbolic capital of these engineers made them attach greater importance to the opportunities on the engineering field. Foreign experience raised engineers with low social origins and levels of education. However those with a higher background and more education classes, who also had foreign experience were the ones who were most likely to reach the level of management.

Four representative companies are studied to examine the role of returning engineers. These are: *ASEA* (electrical), *Sandvikens Järnverks AB* (steel and iron), *Bolidens Gruv AB* (mining) and *Bolinders Mekaniska Verkstads AB* (engineering industry). The share of returning engineers who filled responsible positions was highest at ASEA. It was somewhat lower at Sandviken. At the other two companies, there were returning engineers in the top management but the source material does not allow for the same kind of systematic study as at the two former. Even if there also was purely technical influence brought about by the returning engineers, the knowledge gained from American companies consisted mainly of how to rationally organise workshops and rolling mills etc. in a more or less Taylorist spirit. Often, these practices were combined with welfarism that largely also came from the United States. However, it would be an exaggeration to call all these practices American as engineers with experience in Germany also contributed ideas regarding organisation. The technical influence on Sweden was thus a mix in which the United States was most important. In the electrical industry, engineers who had worked in Germany challenged those who returned from the United States while those with experience in Britain contributed to Swedish engineering companies. Engineers who had worked in Norway played a considerable role in the mining industry. It was in the field of steel and iron production Swedish-American engineers were most evident.

The returning engineers filled a large number of key positions in the leading companies in the four industrial branches studied here. The fact that there were several engineers with similar experience acting after a specific pattern ensured they held considerable influence. Returning engineers were most evident in the electrical and engineering industries and least conspicuous in mining although even there a fourth of all managing directors and chief engineers had foreign experience. This pattern clearly points to the returning engineers as being a source of technical development in Sweden during the second industrial breakthrough. As such, they could possibly be considered an historical example of what today is often referred to as 'brain-gain'.

Key words: emigration, return migration, engineers, technology transfer, Sweden, United States, industrialisation, electrical industry, steel and iron industry, mining, engineering industry.

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Cover illustration: From the left, J. Sigfrid Edström, Harald Håkansson and Emil Lundqvist in Pittsburgh, PA, United States, 1895. Source: Karl Axel Bratt, *J. Sigfrid Edström. En levnadsteckning. Förra delen* (Stockholm, 1950), 41.

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Per-Olof Grönberg

1. INTRODUCTION

The American historian Mark Wyman described the return migration from North America as a part of the large-scale Americanisation of Europe, a process that has continued to the present-day.[1] The era of mass emigration influenced the whole of Europe but there were national as well as regional differences. Sweden was one of the countries that lost the highest share of the population to North America from the mid-nineteenth century to around 1930.[2] Emigration created a public network between Swedes on both sides of the Atlantic that was probably one of the most significant in Europe.[3] Some of the emigrants returned to Sweden. The general return rate from North America to Sweden was about 18% between 1875–1930.[4]

In light of this, it is easy to agree with Erik Åsard, Rolf Lundén and the author and former Member of Parliament, Hans Lindblad, who together viewed it as strange that Sweden lagged behind other European countries when it came to research about American influences.[5] One chronicle once wrote that "next to Sweden, the United States is the most Americanized country in the world".[6] It is difficult to ascertain the credibility in that statement. However, Swedish researchers have generally agreed on the importance of American influences for Swedish development, with the Swedish emphasis on the public sector as the main exception.[7]

Two occupational groups were emphasised by Lindblad as the most important ones when it came to the exchange of ideas between the United States and Sweden; a country whose large-scale industrialisation occurred comparatively late. The groups were pastors and engineers.[8] It must have been attractive for Swedish engineers to go to the United States and Germany – another country that was a "model" in Sweden in the decades around 1900, and return with knowledge and experiences from their industry. These engineers were, to quote Swedish popular singer Lasse Dahlqvist's song from the 1930s, "very, very, welcome hem" [home]. Hypothetically, the spirit facilitated both the career moves and the possibilities to implement their ideas for engineers with experiences from abroad. The returning engineers were possibly also a source of technical change during the large-scale Swedish industrialisation.

1.1. Purposes, questions and points of departure

The emigration and return of engineers, careers, technical diffusion and the returning engineers as a possible source of technical change are the subjects of this thesis. The overall purpose is to cast light on the transatlantic influences on Swedish industry and technology. The emigration and return with regard to North America will be compared with other countries, primarily Germany. The period from the 1880s to the 1930s was an era when industrialisation and democratisation began. Beginning in the 1890s Gross National Product increased in many countries. However, in no other country was the acceleration and speed of growth as high as in Sweden.[9] It is reasonable to say that this period set the ground for what was to become the modern Swedish welfare state.

This study deals with several aspects of international migration and the return migration of Swedish engineers. The questions addressed in the study are:

(1) What was the strength of emigration and return migration among Swedish engineers from the 1880s to 1930s and what were the reasons behind these geographical moves?

(2) What was the importance of foreign experience for the occupational careers of engineers in Sweden during these decades?

(3) Did the engineers who returned contribute to the diffusion of technology and/or other ideas to Sweden and – if so – what were their contributions?

(4). To what extent did these engineers fill leading positions at major Swedish electrotechnical companies, engineering workshops, steel and iron works and mining companies and what conclusions can be drawn about their importance for Swedish industry from the 1880s to the 1930s?

This thesis does not claim that an engineer who returned to one of the companies in the case studies was necessarily the first person to bring this practical knowledge to Sweden. While the engineers were abroad they learned similar things. Their learning was, however, brought back individually. This study takes the points of departure from some previous empirical findings. They will be discussed more fully in the part about previous research, but deserve a short mention now.

It has been noted that Swedish engineers went abroad and then returned to Sweden. Some studies have also revealed and discussed statistics about the emigration of engineers.[10] This study seeks to apply a broader perspective, by focusing on a long time period, different criterion such as education as well as social and geographical background and different industrial branches. To a larger extent it also focuses on return migration. A quantitative perspective has only been adopted in Lars O. Olsson's studies of the naval architects. Migration and geographical movements have been described as the most important channels for technical information and diffusion.[11] The quantitative perspective is, therefore, important.

Foreign experiences have been discussed in previous studies – in many cases indirectly – as important for the occupational careers of returning engineers, primarily at the individual level.[12] A powerful position was a prerequisite for an engineer to become a "real carrier of technology" – something that will be discussed in the theoretical framework. To what extent these engineers were able to reach powerful positions compared with engineers who never emigrated is, therefore, an important aspect of the analysis. This study seeks to examine the pattern on a wider scale.

There have been some previous studies of the diffusion of technology and ideas from abroad and particularly from the United States.[13] The main focus of this study is the implementation of these practises on a wider scale in industrialising Sweden. In the four case studies, quantitative and qualitative analysis are combined, and the chapters will show how the practises were implemented in some selected Swedish companies. In the chapter about the returned engineers as managing directors and chief engineers in larger companies within the same branches, the focus is shifted to Swedish industry in general.

1.2 The organisation of this study

Few studies of return migration and technology transfer have used a combination of quantitative and qualitative methods.[14] The quantitative study is based on 5.994 engineers who graduated between 1880 and 1919 of whom 1.660 were returnees. Their careers in Sweden after they returned have been followed. This has also been done for a group of 1.013 non-emigrants for comparative purposes. In the case studies of the companies, suggestions regarding organisation and technical changes from the returned engineers are discussed with reference to the engineers' time abroad. Olsson made a somewhat similar study about the dispersion of returned engineers to major Swedish shipyards. He showed that all managing directors at four major shipyards had foreign experience and that this "new" generation differed from the elderly in this way as well as in other respects.[15] Both in the case studies and in the study of the dispersion of returned engineers to leading positions at major Swedish companies, the quantitative perspective is used to discuss the returning engineers as a possible source of technical change.

The remainder of this chapter focuses on previous research on the impact of return migration, the theoretical framework of the study and definitions, limitations, sources and methods. Chapter two provides the critically important context about the nature of Swedish society and industry from the 1880s to 1930s, the so-called "development nationalism", engineers in Sweden and the United States during this period as well as Swedish emigration. Chapter three gives a history of emigration and return migration of Swedish engineers based on different criterion and examines their occupational careers in comparative perspective. Chapter four to seven are case studies of engineers in four Swedish companies who returned from abroad. Each part also fills the function of revealing previous research on respective companies. Chapter four is a systematic survey of Sweden's largest electro-technical company, *ASEA*, and the engineers in charge at different departments. It reveals quantitatively how many of the leading engineers had foreign experiences, their possible sources and influences, and their actions at ASEA. In chapter five, the same technique is used for *Sandvikens Järnverks AB* which was one of the country's major iron works.

Chapter six and seven are also case studies, but somewhat different in character. Chapter six deals with *Bolidens Gruv AB,* a mining company established in the 1920s in the area around Skellefteå in northern Sweden. The subject of chapter seven is *Bolinders Mekaniska Verkstads AB* in Stockholm, one of the "elderly" diversified engineering workshops in Sweden and its shift from British to American methods of production in the decades around 1900. The differences between chapters four and five and chapters six and seven will be discussed later, but it is worth mentioning here that chapters six and seven are not as systematic as chapters four and five.

In chapter eight the diffusion of returning engineers to key positions in major Swedish electro-technical companies, steel and iron works, engineering workshops as well as mining companies is revealed. In this context, the complex expressions of "brain-drain" and "brain-gain" are discussed. Chapter nine offers a concluding discussion of the thesis.

1.3. Previous research on return migration

Demographic aspects

In 1960, the British historian Frank Thistlethwaite claimed that historians had been too occupied with the effects of transatlantic migration on the receiving country. He urged historians to concentrate on the sending countries.[16] Studies of return migration have usually focused on the demographic characteristics of the migrants. In Sweden, Lars-Göran Tedebrand studied return migration in his dissertation about the population exchange between the Swedish County of Västernorrland and North America. Bo Kronborg, Thomas Nilsson and Hans Norman also wrote shortly, there after, about return migration in their studies of Halmstad and the district of Bergslagen. These studies were done within the project *Sverige och Amerika efter 1860* (Sweden and America after 1860) at Uppsala University in the 1960s and 1970s.[17]

Many studies of return migration took their point of departure from "The Laws of Migration" written in 1885 by the British statistician, E. G. Ravenstein. One of these laws was that a great migration stream from one area to another always generated a return-migration stream to the area of departure.[18] Conclusions regarding the demographic aspects of return migration from North America to Europe have identified clear patterns. The return streams were male dominated, and this also characterised streams back to southern European countries after World War II. Return migration was primarily a movement of working-aged people (15–45) and most returnees were unmarried even if the proportion married was higher among them than among the emigrants. Unskilled workers dominated the return streams. High numbers of women working as maids or servants were also among the return migrants. Generally, social mobility was unusual during the time in North America maybe because the stay was often less than five years. It was common that a person made several journeys back and forth on a seasonal basis – a sort of geographically extended journeyman migration. Return migrants often went back to their native parish or region.[19]

Influences from return migration

Other than examinations of demographic features, the phenomenon of return migration in the era of the great migration over the Atlantic had been little emphasised before Wyman wrote *Round-Trip to America* in 1993.[20] Conclusions about the influence of this process on European society have differed. Some scholars have emphasised the negative. Europe suffered a loss of people and those who came back were not able to contribute to any large degree. Older studies of Ireland by Arnold Schrier and by Francesco P. Cerase of Italy reached these conclusions and found that the returnees played a largely conservative role.[21] In Italy, authorities had hopes that remittances and innovations brought home by returnees would help to modernise the southern part of the country. Instead they had only a marginal effect and Dino Cinel attributed this to the traditional and conservative values that characterised the region.[22] Similar conclusions regarding Poland were reached by Adam Walaszek.[23] Examples of return migration after World War II that have been of little importance primarily concerned southern Europe and northern Africa.[24] Earlier studies by Semmingsen and Hovde in Norway as well as by Virtanen in Finland have pointed out that the influence was only local and primarily in rural areas.[25] In the 1970s and 1980s many governments and organisations as the ILO (International Labour Organisation) hoped that return migration would be a source of development for less-developed countries. These beliefs were based on the "human capital" approach from neoclassical economics; a temporary stay in a more developed country meant increased competence and know-how. A return could be a source for development. Empirical observations, however, illustrated that both the emigrants' will to return and the regional development had been overemphasised.[26]

Wyman's analysis of the effects of return migration was more positive. The transatlantic exchange of people, money and ideas contributed to a positive development for many European nations and the emigration era should not be interpreted in negative terms. Returning emigrants were important in several fields: politics, religion, labour unions and the temperance movement. They were enterprising and brought technical diffusion and the diffusion of new words to the European languages as well as new dishes to the European dining tables. Wyman stated:

> But instead of causing a deterioration, the era proved to be one of general advance and progress for the people of many nations. This pattern continues. Certainly many things, tangible and intangible, have contributed to this result, but one was the extensive flow of people, money and ideas.[27]

An earlier study taking a more positive attitude towards the influence of return migration was Theodore Saloutus's *They Remember America* from 1956. The main conclusion in the survey of repatriated Greek-Americans was that although they could not help Greece reach a material standard comparable to that of the United States, they brought money, higher standards of living, optimism, a reform-minded spirit and generally a positive picture of the United States. The money they invested was particularly important in a country that was in a "development stage" like Greece in the early twentieth century.[28]

In Norway, a returned emigrant project started in the 1980s by the ethnologist Knut Djupedal and the literary historian Dorothy Burton-Skårdal reached conclusions similar to Wyman's. The returnees often brought knowledge of new working methods and ways of solving problems and they had a great influence on Norway, since there were many people adopting American practices in different places and in different times.[29] Modern examples of return migration that were important are the return of migrants to Greece from northern Europe and return of software engineers from the United States to Asian countries.[30]

Hans Lindblad claimed that return migration and American influence was very important when Sweden developed into a democracy and forged its welfare state. He also saw this as the main reason why Sweden had the world's fastest economic growth before 1970. [31] He also assumed that American influences contributed to the emergence of several companies and the reconstruction of old ones. The development of popular movements such as free churches and the temperance movement also incorporated American ideas. The impact of returnees had also been underestimated both within Lindblad's own Liberal Party and in the Social Democratic Party.[32]

Thus Saloutus, Wyman, the Norwegian scholars and Lindblad have connected Americanisation and influences from the United States to return migration. In Sweden, this has been praised by some and criticised by others. Historian Torvald Höjer claimed that Americanisation was more due to international trends that for some reason had a more forceful impact in Sweden. He claimed that Ireland, Italy and Norway witnessed more emigration but not the same degree of Americanisation.[33] With regard to Italy, it seems obvious from previous research that Höjer was probably correct, but Djupedal's investigation showed another pattern for Norway. [34]

Influences from returned or immigrated engineers and technicians

Migration has been acclaimed as important for the diffusion of technology. In Sweden, technical inspiration came mainly from Britain in the mid-nineteenth century, hardly surprising as Britain was by far the most advanced industrial country and its influence was considerable all over Europe. Swedish technicians travelled to Britain on study trips and British master mechanics and engineers were called to Sweden as teachers. In some limited areas, particularly food processing, Sweden also borrowed from Germany but it was first and foremost the United States that took over Britain's role as prime industrial model in the decades before 1900.[35]

The exhibition in Philadelphia in 1876 meant an opportunity for a closer study of American technology. Swedes were sent over and they were no longer forced to trust other countries' descriptions of it. The Swedes could now make their own judgements and import directly. The result was a more positive attitude towards American technology and an admiration but also a fear for what the American efficiency might mean for Sweden's chances to compete on the international market.[36] Marie-Louise Bowallius stated that *Teknisk Tidskrift* (The Technical Journal) primarily reported about the United States when it came to railways and iron making in the early 1870s. The British influence was present and Germany also attracted more interest than the United States. In the 1880s, the United States was increasingly viewed as an industrial predecessor. This view was primarily based on developments in American electrical engineering. By the early 1890s the United States was established as the main model. The whole country was seen as progressive. Previously, however, such judgements had been limited to specific areas of American technology. The Norwegian historian, Sigmund Skard, noted a similar pattern in the Norwegian technical journals. [37] It was natural to go to the United States to gain knowledge about the latest development. The Swedish economist, Torsten Gårdlund, claimed that Swedish mechanics, foremen and engineers gained knowledge about mass production methods that later became important in Swedish industry.[38]

American innovations had made life easier in all parts of the world in 1930 claimed the Norwegian historian Halvdan Koht. The American standardisation system of interchangeable parts was established in Europe after a British governmental committee made a study trip to Samuel Colt's factories in Connecticut in 1854 and recommended the British government to apply the system at the Royal factory for armoury in Enfield. Koht claimed that this system was the key to making all technical commodities accessible to a larger number of people. According to Koht, European inventions were often improved with the help of American technology.[39] Hypothetically, the rise of the United States as an industrial superpower and the contemporary mass emigration probably made the United States play a more important role as industrial and technical model than the predecessors Britain and Germany. Wyman stated:

> Among the vast numbers emigrating into American cities were some who would carry home the memory of America as a cornucopia of gadgets, new machines, and technical know-how, The peasantry could remain untouched by these, but away from agriculture changes were under way among those prepared to welcome ideas from overseas. [40]

This contradicts Keijo Virtanen's conclusion that the returned emigrants were more influential in rural areas than in urban.[41] However, that pattern may apply to general return migration. Returning engineers, as a skilled group, were probably important within industry as previous studies have indicated, both in Sweden and other countries.

There are reasons to point out that engineers were not alone in the transfer of technology.[42] When it came to new machines, etc. the carrier may well have been a more or less common emigrant. Wyman described the interchange of technology:

> Contributions of remigrants in this interchange were extensive. These ranged from bringing back American phonographs, Singer sewing machines, bicycles, hatches and double-bitted axes, among smaller items, to developing rolling mills. New logging procedures were introduced in Finland and new fishing methods in Yugoslavian coastal waters, and in the Apennines of northern Italy the first regular bus service in Lucca was launched by a remigrant. Not far away in Fornaca di Barga, aging brick and cement kilns were transformed by a group of returnees into an industrial establishment that subsequently attracted large paper and textile mills and a munitions factory. [43]

Engineers were nevertheless the most important group when it came to the diffusion of technical skills.[44] Their contributions were extensive in several areas both before and during the emigration era.

Mass production, taylorism, rational organisation and labour-management relations

Mass production and scientific management were often brought over by returning engineers. These ideas were discussed as means of reforming the society in many countries.[45] In Sweden, the company *AB Separator* was a pioneer when it came to ideals of efficiency and rationalisation. The company sent their engineers to the factory in Poughkeepsie, New York, where mass production, workshop organisation, and scientific management inspired them.[46] Some parts of Taylor's system such as methods engineering was applied in Sweden but conditions in the country modified the system to a large extent. The relatively strong labour unions and the traditionally patriarchal structure of the Swedish iron works made it difficult to transfer the original system.[47] The impact of Taylorism by itself should not be overestimated, as historian Nils Runeby stated, but its theories as well as revised versions were of importance to modern conceptions of industrial relations as well as for management.[48] The labour movement's resistance led, according to historian Alf Johansson, to an unsuccessful introduction before the inter-war years. When it was introduced it was limited to overall planning and time studies. Modified variants emphasising the employer's social responsibility as well as participation became important, but Taylorism's main thoughts were still evident.[49]

Johansson stated that the specificity of Taylorism in different countries had to be located within the labour-management relations.[50] The Swedish paternalism of the nineteenth century was built upon preserving the mutual interests between employers and workers. The growing labour movement represented a threat to the old idea of the working place as a large family under the guidance of the owner. Finally, socialism and labour organisation caused the death of the form of paternalism present in nineteenth century Sweden. However, the basic idea of dependency, family relations and loyalty did not disappear. A new, more modern, paternalism described by historian Thommy Svensson occurred in the early twentieth century.[51] The roots of the so-called welfarism or welfare capitalism came from the United States and this will be dealt with more fully, particularly in the section about the Sandviken iron works.[52]

Welfarism developed as a strategy to combat strikes and union militancy in the United States. Courses were held at universities and many of the leading men in early twentieth century American industry contributed to the diffusion of the idea. The welfare institutions would convince the workers of the companies' real concern for their well-being. Larger companies, growth, immigration and increased boredom in the work processes were incentives for an idea that emphasised the mutual interests of capital and labour that increased productivity could serve. Labourers received material advantages, were integrated in the company and were given limited influence over how the company was run. This would encourage the workers to increase productivity and sacrifice themselves for the company. The idea of industrial democracy was cherished by representatives of the companies as a channel for promotion of mutual interests, but the socialist unions thought the ideas were hardly democratic but rather a means for the employers to regulate labour-management relations their own way. Welfarism became a strategy to combat labour unions in the usual sense and American companies spent a lot of money on the welfare institutions in order to do it. Programmes consisted of guarantees for life time employment for occupational groups that were strategically important, pension systems, dwellings for employees, libraries, schools, kindergartens, health care institutions, cinemas, theatres, sport activities and unit trusts. This latter idea, according to Svensson, was similar to the idea of wage-earners investment funds debated in Sweden around 1980.[53]

Taylorism was developed independently from welfare capitalism or welfarism and the schools had different advocats. However, there was no principal opposition between them. At the time of World War I, the United States saw an increase in companies combining Taylor's demands for efficiency with welfare capitalism. In the 1920s, many economists saw the synthesis as the way to meet the future as efficiency and productivity had increased and the companies were able to sell their products to increasingly larger markets.[54]

This synthesis also had advocats in Sweden. Hugo Hammar, who had spent several years in the United States, managed the Götaverken shipyard. He was a man who put the synthesis in to practise. Karl Fredrik Göransson at Sandvikens Järnverk had the same inspirational source and this will be dealt with later. Hammar described his American experiences as valuable. In the United States, Hammar made observations leading him to conclude that Sweden possessed the important qualities to become an industrialized country. The widespread belief that Swedish workers had less capacity than workers from other countries was wrong. On the contrary, he believed that Swedish workers were superior to their American counterparts and the higher productivity in the United States was due to the better use of machines. Hammar considered Swedes as a people that had a natural talent for mechanics. He was impressed with the personnel policy evolved at several companies in North America at the time. In the 1910s, he tried to establish a spirit of cooperation between the management and the workers at Götaverken. The wages were comparably high, the workers were given some influence in matters of production and his relations with the metal workers' union also were good.[55]

An area connected to welfare capitalism and rationalisation was industrial safety. The idea about company-based protection work and the roles of individuals had, according to historian Bill Sund, its roots in American industry. Engineers were the primary carriers of the American way of thinking whereas the specific carriers of ideas about industrial safety were the labour inspectors, who, together with other socially interested people, laid the foundations for Swedish industrial safety. Hammar was mentioned as one of the leading directors interested in it. One of Sund's major conclusions was that it was liberal politicians, engineers and officials that were the driving forces in the process of introducing industrial safety. The labour movement played a secondary role. The industrial safety became a crucial part of the "Swedish model", and this according to Sund has been totally overlooked.[56]

Other foreign influences with regard to industry

American ideas about mass production, Taylorism and rationalisation were important, but, as stated, Swedish industry was also influenced also by ideas from other countries. The engineering industry was inspired by British industry at an early stage. Many mechanical workers and engineers went to Britain for education and to learn occupational practices before the 1860s. The first three mechanical workshops in Sweden received British technical support. Samuel Owen arrived in 1806 and became the leader of Bergsund's workshop, which was famous for its machines.[57]

American technology and methods, characterised by mechanisation and interchangeable parts, began in small-scale in the 1860s. This represented the starting period of the diffusion of modern workshop technology from the United States. The influence grew as more Swedish technicians visited the United States. Returning engineers and technicians brought experiences and enthusiasm for American technology. They told people about the tools, the machinery and the templates used for drilling. Returning foremen, workers and engineers became agents for the Americanisation of the engineering industry.[58]

The method of inter-changeable parts was brought to Sweden by technicians sent out by the arms factory in Eskilstuna. It was used increasingly by the mechanical workshops. One of the most important things was the milling machine. Its rotating tools and mobile worktables replaced hand tools when complicated surfaces were tooled. The grinding machine replaced the file when the final tooling was done and this saved a lot of time. What followed were standardisations of measurement. The tools for cuttings had to be of the same size. A new work organisation was introduced and particular workers were employed to manufacture and grind the new tools and to control the machines.[59]

Diversified workshops were the foundation of the Swedish engineering until the late nineteenth century when a new kind of workshop became more common. They were specialised in for example electrical engineering and shipbuilding and applied foreign ideas to a large extent. The electrical industry took influences from primarily the United States, Germany and Switzerland. Jan Glete and Mats Fridlund have emphasised the importance of engineers with foreign working experiences. The United States was important for the Swedish electrical industry as younger Swedish electro-technical engineers went there to gain experience of new constructions, production technology and management methods. American and German rationalisation methods and mass production were introduced at ASEA under the newly returned engineer J. Sigfrid Edström.[60] Another area emphasised by Fridlund was the construction of circuit breakers. A Swedish engineer, who had received some training abroad, was used to reconstruct ASEA's breakers to bring them to a level with the more advanced American ones.[61] Fridlund stated that it was an often-used strategy to systematically give engineers leaves of absence so that they could go abroad, take employment at major foreign competitors, learn about their construction techniques and later return with this knowledge.[62]

ASEA's production and activity was closely connected to the growth of the Swedish waterpower technology and the establishment of waterpower stations. Fridlund and another historian of technology, Staffan Hansson, have described the two first state sponsored waterpower projects in Sweden. They were inspired by the waterpower stations at Niagara Falls and at Shawinigan Falls in Quebec. The director of the National Water Power Board and his assistant visited these places during a study trip in 1906 and they were both overwhelmed. After their return they modelled the Swedish projects after them and engaged engineers who had worked there.[63]

In the early twentieth century, a new generation of managing directors took over the largest shipyards. Apart from the fact that these new leaders had a higher theoretical education, they had also been working abroad – and particularly in the United States – to a higher extent than earlier generations of managing directors. Olsson claimed that Swedish naval architects learned how specialised shipyards were organised and run as well as work organisation, business methods and accountant principles. In Sweden, there was a demand for knowledge about how to produce warships and this could be studied in the United States. To a larger extent than the shipyards in Britain, the American ones used labour-saving machines. Practical know-how with regard to mechanised handling and template systems became valuable as the industry expanded and suffered from a shortage of skilled workers in the early years of the twentieth century. The introduction of the template system was one of the reasons behind the expansion of the Swedish shipyards in the early twentieth century.[64]

Britain dominated the world's shipbuilding, but Olsson claimed that the United States still was the most important inspirational source for Swedish naval architects.[65] With the steel and iron industry it was somewhat different. "Lancashire forging" was introduced after a technician returned from Britain, and the first ingot steel methods came to Sweden in the 1850s, when a merchant bought Sir Henry Bessemer's patent during a business trip. During the last twenty-five years of the nineteenth century many methods that improved iron making were fetched from the United States. In Carl Sahlin's work about the rolling mills he stated that ten of the thirteen rolling-mill technicians he claimed had made important contributions to technological development had been in the United States.[66]

Mining was an industry closely connected to the iron trade. Influences came first from Britain but the United States gradually increased its importance. In the search for ore the Swedes made the most importance contributions themselves. However, the engineer P. A. Craelius, who had worked in the United States for several years improved the drilling for diamonds. Machine drilling was introduced in Sweden after methodical studies, from the beginning on the European continent. At a later stage, the pneumatic drilling processes developed with the United States as the chief model and the American pattern became the pattern for Sweden's own manufacturing. Machines used for the sharpening of rock drills came from the United States, but Sweden made independent and epoch-making contributions to explosive technology.[67]

Around 1900 the United States was most influential when it came to transportation arrangements, lifts and so on, whereas the new mining methods introduced in the late decades of the century probably originated from mines in Germany, Belgium and France. After 1900 modern methods of storage and mining came from Britain and the United States. Methods were often viewed as American and mainly studied there, but it is believed that the Americans probably had brought some ideas from Britain. The United States had, however, become the prime model for Swedish mining in the early twentieth century. The mining community of Grängesberg was called "a piece of America in Sweden", especially because of the safe arrangements.[68]

The mineral industry was mainly inspired by Britain and Germany. Porcelain making applied methods arrived from Britain in the early nineteenth century and from Germany somewhat later. German and British foremen and workers were employed in the porcelain factories, but Germany exercised considerable influence in the glass works. Quarrying took influences from Britain and employed many British workers. Britain and France were the models for the cement industry until around 1870, when German techniques prevailed. Danish technology became important after 1900.[69]

The wood processing industry was another major branch in the early industrialisation of Sweden. Foreign influences on the sawmills were limited. The early ones often used British machines and Gårdlund assumed that the steam sawmills in the-mid nineteenth century largely were dependent on British technology and that British immigrants owned several of them in the 1870s. The planning-machines were probably made from British models until around 1900. Britain was very influential on Norwegian planning, and Gårdlund argued that British influences largely came via Norway. Foreign influences were more evident in carpentry. A British company equipped the first Swedish carpentry shop and Swedes who had experienced the business in Britain started most of the early workshops. The British influence on this industry remained relatively high even if the United States exercised some influence from the late nineteenth century. [70]

Two out of three sub-branches in the pulp and paper industry were foreign influenced. The mechanical wood-pulp technology was developed in Germany and one of the inventors lay behind most of the grinderies established in Sweden around 1870, through a Swedish agent. Norwegians also made important contributions. The sulphate pulp technology was transferred from Britain in the early 1870s, and most factories were established after studies of Houghton's method. British engineers and skilled workers helped to build several Swedish factories. The Swedes developed the sulphite pulp technology themselves, even if the factory where the experiments took place was under British technical supervision and the main inventor, C. D. Ekman, cooperated with a German technician. The impulses in the paper industry mainly came from Britain. It was common to study there and on the European continent. Around 1900 the United States became a model for large-scale production, and Germany took over as main deliverer of machines.[71]

The Swedish textile industry can be described as more or less imported from Britain. In the early stages, many of the chief engineers and factory managers travelled primarily to Manchester to buy machines. This was especially the case after 1842. British engineers often set up the machines and acted as instructors for Swedish workers. British influences were most obvious in the textile factories and in the cotton-mills. Continental influences were more present in the wool industry.[72]

The food and stimulant industry was established in late nineteenth century. The most important contributions came from Germany – in some cases via Denmark. The flourmill industry, sugar making, the tobacco industry, the breweries and distilleries were mostly influenced by German technology. Britain and the United States, however, contributed to the flourmills. Russian and later also American models were used to some extent in the manufacturing of cigarettes. Britain exercised some influence in brewing.[73]

In the area of constructional engineering, the most obvious example of American influence was in reinforced concrete. Ivar Kreuger, the world famous Swedish industrialist and financier of the Swedish match industry, worked in the United States and learned about it. When he returned to Sweden 1908 he founded a company together with Paul Toll. It grew fast and one of their most prestigious tasks was the construction of the Olympic stadium in Stockholm in 1912.[74]

Architects diverged from the engineers as art historian Lisa Brunnström has stated. They more often took their influence from Germany. Contrary to American factories, the German one were not only rational but also esthetical. There were also Swedish architects inspired by the United States. Adolf Emil Melander, Ture Stenberg, Carl Westman and Ferdinand Boberg had been in the United States and made drawings for several buildings in Sweden. Göran T. Rygert claimed that it was primarily the architecture of H. H. Richardson and Louis Sullivan that inspired them. Boberg became one of the main advocators of American architecture in Sweden. The fire station in Gävle was the first example of this influence.[75]

1.4. Definitions

What is an engineer?

The title engineer has medieval origins according to historian of technology Bosse Sundin. However, the creation of an educational system during the nineteenth century meant that the engineer in a modern sense appeared at that time.[76] This study follows this definition. An engineer is a person with a degree from a technical educational institute. In the quantitative study, a division is made with regard to educational level, which will be outlined there, but generally the term engineer has been used to define a person with any form of technical education.

Technology and technical change or development

The questions of how to define expressions like technology and technical development or change are not simple. One definition of technology that is comparably easy to handle is the one given by the Swedish historian of technology, Svante Lindqvist, i. e. activities aimed to satisfy human wishes by the use of physical artefacts. In his article, Lindqvist argued that a system like Taylor's principles of scientific management was to be defined as technology since it was a way to satisfy wishes about higher efficiency and included physical artefacts. The organisation of an education at a university, for instance, also included human wishes to communicate knowledge, but could not meet the requirement that physical artefacts were to be involved. Consequently, such an organisation could not be viewed as technology.[77] Thus, Svante Lindqvist's definition covers both innovative actions with regard to physical artefacts and the improvement of these artefacts but also organisation where physical artefacts were involved.

The question about how technical development should be defined is also not easy, even if the conclusion that development implies change can be viewed as rather obvious. But as Fridlund claimed, development has often been used in an uncritical way as synonymous with improvement or progress.[78] There is however no natural law stating that technical changes automatically lead to the betterment of society. Mostly, they have different impacts for different people. Technical development, therefore, is generally synonymous with technical change. It is obvious that the answers to questions about whether rationalisation was good or bad would depend upon the respondents. A company representative would probably answer "yes" and representative of the workers "no". The thesis views technical development as synonymous with technical change, which may imply different outcomes for different groups.

Emigration and return migration

For many engineers, the stay abroad was viewed as temporary. Should this be regarded as real emigration or simply called study trips? Gösta Bodman investigated the emigration of graduates from Chalmers. He used a criterion where employment was a prerequisite for emigration. Max Engman used the same criterion in his investigation of Finnish engineers going to work in Russia.[79] This classification will also be used in this study. Especially after the turn of the century, many other emigrants went to North America in order to find work, accumulate money and return to take over a farm or perhaps start a small business.[80] How shall we view these temporary moves to North America, if we cannot view moves that aimed to acquire experience and knowledge as emigration? Thus, a stay abroad that included employment and/or studies, and where the living was earned in a foreign country, will be defined as emigration. A journey to study workshops, power stations or the like for some months will not.

In line with this definition, a returned engineer will be viewed as a person who emigrated from Sweden, worked/studied abroad and later returned for work. The studies should include university or the like and they should imply that the engineer had a residence abroad while he was undertaking them. But a study trip for some months, for example to visit workshops or water power stations in the United States or Germany will not be regarded as emigration unless it also included employment. However, the borders between study trips and emigration can be blurred and this will be discussed later.

Sweden will be used as the defining geographical area. An engineer needed not to return to the same location in the country as before emigration. A foreign born engineer who emigrated from the native country to the United States for instance and later came to Sweden for work will be called an immigrant and not a returnee.

1.5. Theoretical framework

It has been stressed that geographical moves facilitated technological diffusion. In John M. Staudenmaier's investigation of the articles published in *Technology and Culture* between 1959 and 1980, he found that five major areas had been emphasised by the authors: (1) migration of skilled personnel; (2) journals, exhibitions and schools; (3) formal agreements; (4) colonial policy; and (5) industrial espionage.[81] In nineteenth century Norway technology was transferred in three ways: through (1) the immigration of skilled workers, (2) international companies taking patents in Norway, and (3) educated Norwegians going abroad to learn more about technical innovations.[82] This supported Even Lange's conclusion that engineers took over the craftsmen's role as technology carriers to Norway in the early twentieth century.[83]

In the *Technology and Culture* investigation, the first category dealt with migration per se. However, if articles in journals about foreign technology were to be written, there was a need for the writer to move, as Skard pointed out in his account of technical diffusion from the United States to Norway.[84] Geographical moves were also required if a potential carrier was to visit an exhibition, attend a school, or spy on another country's industry. The role of technical journals in the diffusion of technology to pre-industrial Sweden (1800–1870) was minor, and historian of ideas Henrik Björck claimed that they could not function as vehicles independently.[85] The same conclusion was reached in Lange's study. Even if knowledge spread through written accounts, etc. steadily increased its share of knowledge that was transferred, it was still a need for human beings to move if technology was to be diffused.[86]

The diffusion of technology was a process that often included a migrant or a mover as carrier. Björck launched the concept *teknikbärande skikt,* a "social group of technology carriers" to define the role of the engineers. By this, he meant a social group with the ability and interest to bring forth, maintain and develop technical systems. Björck included the whole collective of engineers in this group.[87]

Björck's concept was an elaboration of the concept social carriers of technology launched by Charles Edquist and Olle Edqvist. One distinction between the concepts was that the latter identified the technology carriers as either individuals or formal units. Their concept was primarily developed to analyse the introduction of new production techniques and physical artefacts. They wanted to combine an actor's perspective with an analysis of the socio-economic structure of a unit. Though their argumentation was primarily grounded in the actions of different social units in developing countries, the authors claimed that nothing could stop us from using the concept while also studying technological development in industrialised countries. [88]

The characteristics defining a social carrier of technology according to Edquist and Edqvist were information about the existence of the technique, access to it, interest in introducing it and knowledge about its operation. Apart from that the carrier needed to be properly organised and to have sufficient economic, political and social power. If a social unit fulfilled all the criteria the unit became a real carrier of technology. The only exception was that the organisation criterion was not relevant if the carrier was an individual. The exception has relevance for this study as the returned engineers acted as individual carriers. If some, but not all, criterions were fulfilled, the unit was only a potential carrier. A process where a social unit met some of the requirements and needed to co-operate with other social units was called connected carriers.[89] In this context, a returned engineer was not a real carrier the very moment he stepped on Swedish ground again. The returned engineer needed to interact with others and to get employment, for example as chief engineer so he could implement the ideas.

This study borrows expressions and criteria from Björck and Edquist and Edqvist, but the concepts will be modified to some extent. The whole engineering collective was a category of persons, who all were able to bring forth, maintain, and develop technical systems. However, in the processes of implementing their ideas the members of the category acted individually and not as a group. The criteria of Edquist and Edquist will be discussed related to the emigrating and returning engineers with references to other theoretical concepts. The presentation of the criteria will be made in a reasonable chronological order and it does not follow the order in which Edquist and Edqvist presented them. Information about the existence of the technology must have been first in order and a prerequisite for a fulfilment of the other ones.

Information, interest, access and knowledge

The direct importance of technical journals in technology transfer was thus small but Björck acknowledged that they could spur the interest for foreign technology among the engineers. In this way the journals became an informational source. Other sources to acquire this information were, for example, letters from colleagues abroad and lectures at the technical educational institutes.

When the engineers acquired information about interesting technological matters abroad it probably spurred an interest among them to work with and/or introduce this technology in Sweden especially if it was unknown or at least rare. According to Björck, the interest in introducing new technology could be connected to three criteria; interest in the technology itself; an interest in a rising status for the whole profession, and raise the position of the individual engineer.[90] In this context a fourth criterion has been added with regard to the returned engineers: a will to contribute to the native country's industry by fetching competence and practical know-how abroad and use it after their return.

The interest to implement technology had no value if the engineer had no access and/or knowledge about it. The way to acquire access and knowledge was mainly through a temporary emigration.[91] The Dutch sociologist Frans Bovenkerk suggested a typology of migrants which also has been used and elaborated upon by the American anthropologist George Gmelch and the British geographer Russell King. Bovenkerk divided migrants into four categories with regard to return intentions and outcomes of migration. The first group consisted of migrants with a return intention who did in fact return, while the second consisted of migrants who intended to return but changed their minds and settled for good. The third group was migrants who intended to settle for good but returned, while the fourth category consisted of migrants with an intention to settle for good and who did so.[92]

A majority of the emigrating engineers were to be found in the first group. Emigration could be seen as a prolonged education and the emigrant engineers aimed to return after it was finished. King described this type of migration:

> "Target migrants" who move abroad with a specific aim in mind – to accumulate a certain sum of money or to obtain an educational qualification – were part of this group; their plans were fixed and their return predetermined by the attainment of their migration target. [93]

The emigration of engineers could to a large extent have been a way to "obtain an educational qualification" to use for occupational improvement back home. King sketched a scheme with cause and effect factors of return migration. Economic and social factors were important to the context. "Target migrants" returned because they aimed to realise specific objectives. King's example concerned investments of savings in land or business, i. e. investment of fixed capital. However, the engineers could also invest their acquired human capital in the form of competence and practical know-how of foreign technology and set the ground for the career. The economic factors interacted with the social ones and the return to their home to begin a career may very well have been a combination of both. King placed the desire for an enhanced status among the social factors.[94]

It must be pointed out that this discussion concerns primarily an ideal type of emigrating engineer in a Weberian sense. The German sociologist Max Weber developed the ideal types as pictures constructed by the scholar, in which certain qualities were emphasised at the expense of others. Weber concluded that it was almost impossible that ideal types could exist in reality. They were more to be seen as pictures of what the ideas of the reality were.[95] Even if the engineers' moves to the largest extent could be connected to "target migration" – Bovenkerk's first category – some may have also belonged to other categories. Several factors might have worked as "intervening obstacles" for a return to occur. [96] These factors could be both personal and connected to their occupational careers. Examples were marriage in the adopted country and chances of rising occupational mobility. In these cases the primary motive can still be connected to the will to acquire competence and practical knowledge to use in Sweden after return. Among the engineers there were, of course, also people that belonged to the fourth and final of Bovenkerk's categories: those who emigrated to settle for good and did so.

The engineers' back-and-forth migrations abroad can be analysed by using the expressions developed by the French sociologist Pierre Bourdieu. Bourdieu viewed that one task of sociology was to explain why certain individuals with fixed qualities got certain positions. To explain this Bourdieu developed the expressions capital, habitus and field.[97]

There were different kinds of capital: social, economic and symbolic. As habitus in many cases could be a decisive factor in the awarding of a position it could also be compared to capital. Social capital referred to family ties, friendship relations and all social relations that exist between human beings. Symbolic capital was something that is recognised as valuable by social groups and its value was dependent upon how others valued it. Bourdieu acknowledged that different groups of people developed strategies in order to maintain or increase the amount of capital. He claimed that these strategies often were made unconsciously. Thereby, Bourdieu distanced himself from many economists who also influenced sociology and claimed that the actor was rationally calculating.[98] In the context of the returned Swedish engineers, the decisions to emigrate and return were hardly taken unconsciously. However, there are reasons to state that the purposes behind emigration may not necessarily have been the promoting of the individual career. This connects to Björck's reasons behind the will to become a technology carrier.

Bourdieu studied the literary field in France and used the author and philosopher Jean-Paul Sartre as an example. Sartre was born into the academy and took a degree in philosophy at an intellectually elite school in Paris before he went to Germany and studied the phenomenological tradition. After his return, Sartre had a symbolic capital that made him become an authority and gave him the influence to introduce his philosophy in the French literature. The symbolic capital was based on experiences of studies in the country that was at the phenomenological forefront. Sartre was able to weave together this symbolic capital with his old one and create a new habitus. For the emigrating and returning Swedish engineers, the accumulation of symbolic capital could go through target migration and temporary employment in countries in the technological forefront, such as the United States and Germany. [99]

Thus a higher value of their own capital contributed to lower the value of the competitors in the zero-sum game on the field. Bourdieu stated that symbolic capital was self-generating as the betterment of an actor's position went through a high sum of symbolic capital. The new position led to the accumulation of more such capital that later led to an even better position on the field. To enter the field it was not enough to have only social capital; there was always a need for a minimum amount of symbolic capital. [100]

On the engineering field this minimum amount could be compared to a degree from a technical educational institute. Presumably, a degree from the Royal Institute of Technology (KTH) was more highly valued than a degree from the Chalmers Institute of Technology (CTI) that in turn was more highly valued than one from the technical upper secondary schools or the mining schools. In light of that, accumulating symbolic capital to weave in to the habitus through target migration can be viewed as a mean to compensate for a lower technical education. On the other hand, a higher education could be an incentive to stay in Sweden as the accumulation of symbolic capital in the form of temporary employment abroad was less necessary. The same relation can be due with regard to social origin. Those who were born into ownership families presumably had less need to accumulate symbolic capital through target migration as they had a high amount of social capital that facilitated their move into high positions in the engineering field.

Organisation

In order to become a carrier of foreign technology an interaction with different organisations in the field of engineering could be a facilitating factor. As some studies stated, the engineers were active in several professional organisations and they helped the shaping of the engineering profession.[101] The Swedish engineers' societies in the United States should also be mentioned in this context as they made it possible for Swedish engineers to get employment and thereby also the opportunities to get access/knowledge of the technology.[102] However, there is also a need to consider the engineers' interaction with different companies.[103] For engineers who aimed to accumulate symbolic capital and return to Sweden there was a need to interact with foreign companies and use their existing contacts in order to get the appropriate employment. Formal and informal networks and contacts were important. From the universities, previous employment or occupational or non-occupational organisations engineers often had a geographically widespread list of contacts. This net could be used to get employment at American, German or other foreign companies and thereby a chance to study the wanted technology. The contact net, the social capital in Bourdieu's sense, was also important to get a powerful position back home after their return but probably not absolutely necessary. Hypothetically, it must have been possible to apply for a good position having such excellent qualities that it would not have mattered if the person did not know anyone in the whole country.

Power

The power criterion was described as the most crucial in Edqvist's and Edquist's theory. In order for a potential carrier of technology to become a real one there was a need for a powerful position. For example, a position as managing director or chief engineer of a company would facilitate technology transfer. The field was one of the central expressions in Bourdieu's theory. It was defined by the fact that human beings that were disposed in a certain way populated it. In the field, there was an ongoing competition over positions. The field populated by engineers was an engineering field where the participants were competing for high engineering positions. Bourdieu claimed that specific investments were demanded to get an entrance ticket to a field. In his own study of the photographic field he claimed that these tickets consisted of knowledge about photography and about its esthetical dimensions. In the engineering field, the ticket can be compared to a degree from a technical educational institute. Other things that defined a field were the specific stakes in the game. In Bourdieu's photographic field, an example would be the attitudes for or against one or another photographer. In the engineering field, one stake could be compared to a target migration, thus a temporary stay abroad in order to acquire competence and practical know-how. The field was also defined by specific gains. They could be economic, but also symbolic. In the photographic field, the latter was one's renown as a photographer while in the engineering field it was high engineering positions such as managing directors or chief engineers.[104]

The way to reach powerful positions on the field often went through the individual's habitus. Habitus directed an individual's actions and was also the directing factor of his or her values. The habitus was based on previous experiences and the different environments where an individual had been contributed to the creation and re-creation of it. It was used by the individual to act in different social environments and one central thought in Bourdieu's theory was also that the individual was able to influence the habitus by his or her own actions.[105] An individual's social origin was always the base for his or her habitus, but from that position the individual had possibilities and abilities to gain new learning in different situations. These possibilities and abilities may have differed from one individual to another but when the human being was confronted with new environments – often formed by other persons than those who were present in the individual's social origin, he or she wove previous and new experiences together and formed a new habitus.[106] In a sense it is perhaps possible to say that a returning engineer with a degree from, for instance, Chalmers and some years of domestic working experiences who was going to the United States to work was weaving the experiences of Pittsburgh, Chicago or Schenectady together with the domestic experiences and was thereby, creating a new habitus. The habitus expression had thus the ability both to represent and explain an individual's pattern of behaviour and how it was developed in different social environments.[107]

Thus, habitus was developed in a field as the ones described above. In order for an individual to advance on the field there was a need for him or her to create a new habitus. The way to that creation went through the accumulation of capital.[108] Habitus was a kind of incarnated capital. Bourdieu differentiated between the study of institutionalised capital and objective capital on the one side, and incarnated capital on the other. The incarnated capital had often to do with taste, good manners and ability to define art, music, literature, etc, whereas university degrees, titles, personal libraries and so on were examples of the other forms. The latter forms the habitus, and the abilities mentioned may be comparable to a returned engineer with, for instance, the "eye" to see what needed to be done in order to re-organise a workshop, rationalise a rolling mill and so on.[109]

Emigration and return migration was thus a strategy to accumulate symbolic capital in their form of work experiences from countries in the technological forefront. This symbolic capital was identified as valuable in Sweden. But once the returning engineers had reached the positions, they needed also to do something in order to build a successful career. The powerful positions awarded to the returned engineers gave them a greater ability to implement their ideas compared to engineers who had never emigrated. Consequently, the engineers who had returned were able to shape the technological development in several Swedish companies and they became agents of an internationalisation that to the largest extent was synonymous with what Runeby called a German-American blend.[110]

Returning engineers probably had more ability to implement foreign technology compared to those who never had been abroad as they were able to weave the competence and practical knowledge into their previous experiences and create a new habitus which led to their enjoyment of greater relative power. In this context, the competence and practical know-how of foreign technology is compared to Edquist's and Edqvist's criteria of knowledge regarding the operation of the technology and the access to it. Even if engineers who never emigrated were able to read about foreign technology in technical journals, look at drawings and perhaps were told about it in letters from friends abroad, the practical know-how was the factor that facilitated the way to power. But it was not only a symbolic capital that was recognised as valuable in the engineering field - it was also a capital that was valuable in reality. Returning engineers from abroad were better suited to implement foreign technology than those who had gained knowledge about it in other ways than through their own migration. The American historian Eugene S. Ferguson wanted to emphasise the importance of non-verbal thinking in technological development. "Much of the creative thought of the designers of our technological world is non-verbal, not easily reducible to words; its language is an object or a picture or a visual image in the mind."[111] When the engineers entered the second grade at KTH they learned the art of construction work as sociologist Boel Berner has concluded. With the help of lectures, hand books and many hours of drawing the engineers developed the mind's eye, i.e. an ability to see the technology in front of them and get a feeling for the forces in a complex structure.[112] This ability distinguished all engineers from other occupational groups. However, the mind's eye could also be a distinctive factor for the returning engineers – those who had seen a complex technical structure in reality had more of a feeling for it than those who had only read about or seen a picture. This decisive factor divided the collective of engineers – to use a sport metaphor – into two divisions with regard to their previous experiences and their practical know-how of foreign technology.

To sum up, the theoretical framework of this study connects primarily to Björck's and Edquist's and Edqvist's theories of technology carriers, the concept of target migration developed by King from an elaboration of Bovenkerk's typologies and Bourdieu's concepts of symbolical capital and field. The main thought is that the ideal of an emigrating and returning engineer looked as follows: the engineer acquired information (Edquist/Edqvist) about up-to-date foreign technology from different channels, mainly through technical journals (Björck). This information spurred an interest to emigrate, and stay for a few years in a foreign technical environment and return with experiences and knowledge. The engineer became a target migrant who aimed to return after a well-defined interval (King), after having accumulated the symbolical capital (Bourdieu) in the form of access/knowledge of the technology (Edqvist/Edquist). These experiences led to a better position on the engineering field after his return (Bourdieu). It was advantageous, both abroad and in Sweden after his return, if the engineer was organised (Edqvist/Edquist) and could use these contacts in order to get employment. The returned engineer acquired the necessary power (Edqvist/Edquist) in order to become a technology carrier. The theoretical framework will also be used for a discussion of the importance of foreign experiences compared to other forms of capital as well as what technology they brought back.

Factors influencing the implementation of technology

There were also a variety of factors surrounding the introduction of new technology and its outcome. In Svante Lindqvist's study of why the Newcomen engine, introduced in the Dannemora mines in central Sweden in the 1720s by the returnee from Britain, Mårten Triewald, failed to work properly and was later rejected, a variety of factors were emphasised. Technical factors had to do with availability of technical expertise in the recipient country and the recipient country's technical level compared to the exported technology. Geographical factors referred to differences in climate and natural resources, while economic factors had to do with the external backing in the initial stage and the possibility to achieve cost-effectiveness in the new environment. The social factors referred to the possibilities to adapt the technology in the country's social order and the possibility to integrate immigrant technicians, while the cultural factors were connected to reasons for the transfer that were not economic and the view of technical development in the recipient country.[113]

The factors emphasised by Lindqvist had to do with the success/adaptation of the technology. The concept of Edquist/Edqvist had to do with the initial transfer of technology and this was not the same as all technology transferred became successful. As a matter of fact, Mårten Triewald could adopt the criteria of a social carrier of technology to fit the Edquist/Edqvist concept. Lindqvist wrote about Triewald:

> When he returned to Sweden in 1726, he possessed some of the essential qualifications of anyone wanting to build a Newcomen engine in Sweden: practical know-how together with high social status and a proven knowledge of science. One prerequisite was lacking, however, namely the backing of a private group with the means of realising the project. A few months after his return, however, he succeeded in finding support for his idea of such a group, the Partners of the Dannemora mines.[114]

Triewald had the information, the interest, the access to the engine and the knowledge of how it was to be operated. He also managed to organise in order to get the power to introduce it. The engine was introduced and operated with severe problems between 1728 and 1736, when it was shut down for good.[115]

Lindqvist's concept will be valuable as a framework to discuss the degree of success of the technology implemented by the returning engineers. This has a clear connection to the question whether they were able to act as agents for technical development or change in Sweden.

Returning engineers as a source of development

Returnees from the United States influenced many areas of the Swedish society according to Lindblad. The Swedish historian Martin Alm stated that influences from the United States in many ways were difficult to ascertain but that Lindblad's thoughts were not unreasonable and could not be dismissed.[116] Sweden has clearly been influenced by the United States in many areas,[117] however, it must be pointed out that quantification on a general level and determining what influences came with returning emigrants and what influences took other channels are difficult questions to answer. Bimal Ghosh, former UN official and director of a programme for global migration management, concluded that the countries of origin could achieve the expected development from returnees when three conditions were fulfilled. First, they needed to return with more advanced knowledge and skills then they could acquire if they had stayed at home. Second, the knowledge and skills had to be relevant for the home country's economy. Third, the returnees had to have the willingness and the opportunity to use the skills after their return. In short, Ghosh concluded that this had happened in some cases but that it also had failed primarily because the skills they had acquired largely were insufficient in the home countries.[118] It was also dependent on who the returnees were and the numbers of them. In many studies, return migration has been interpreted as having some local influence. If the actions were made in only one place, return migration was probably not important in a wider regional or national context. But if returning emigrants acting in a similar manner influenced most villages and towns, the argument that their influence was also on a wider scale is more likely to be correct. Djupedal used this approach in his study about the returned emigrants in Norway in the twentieth century.[119]

The empirical observations about the return of software engineers from the United States to present-day India made by the German political scientist Uwe Hunger pointed in a direction that return migration could be influential. However, this return migration occurred in a specific context, and the success of the Indian software industry was also due to other factors. A large proportion of the key positions in it were filled by Indians who had emigrated – mainly to the United States – in the 1960s, 1970s and 1980s. From this study, Hunger developed the hypothesis in which he claimed that the emigration of intellectual and technical elites from the Third World to an industrialised country represented a potential resource for socio-economic development in the home country. The "brain-drain" was not the end of a negative development intensifying economic and social crises in the home country but rather a temporary stage within a longer process which in the end led to a possibility for a resource profit for the developing country. Hunger supported a contrary assumption to the one often stating that it was difficult for a developing country to attract their emigrated elites because of differences in living standard. The arguments for a return could be stronger than the arguments for a permanent settlement and then it was likely that a return would occur. A return could be beneficial and later the pioneer re-migrants became as important in the return process as the pioneers were in the initial process of out-migration. Networks and chain-migration were important also in the return migration process. The emigration of elites was always a process where they increased their human capital through university studies and employment abroad, and – if a return occurred – they invested the human capital in the development process of the native country.[120]

As previously mentioned, Lindblad wanted to emphasise pastors and engineers in the exchange between Sweden and the United States during the era of mass emigration.[121] Thus the patterns of present-day India and industrialising Sweden may be parallel in some senses. However, today's India is still among the world's fifty poorest countries.[122] Sweden before its large-scale industrialisation cannot be compared to a developing country even with nineteenth century standards. On the contrary, Walt Whitman Rostow discussed whether it would not be appropriate to place Sweden in a group of countries together with the United States, Canada, Australia and New Zealand when it came to the prerequisites for the take off of economical growth. The often awarded prizes for Swedish products at international exhibitions in the latter half of the nineteenth century was taken by historian Göran Ahlström as evidence that the country was at the international forefront in several areas. The areas were primarily mining, machinery and industrial chemistry.[123] In the latter part of the nineteenth century, it seemed, according to Ahlström, indisputable that the technical competence in the Swedish industry

> ..was on a par with that of the leading industrial nations, and the big industrial firms particularly had very well-educated and skilful management. The research and development work undertaken by firms was conducted by their engineers and technicians at a high level of prowess for its day. An early professionalisation of the engineering art in Sweden, almost comparable and lagging very little behind the German pattern, appears to have been an important explanation of the country's relative successful development. [124]

Despite the fact that large-scale industrialisation occurred later in Sweden than in other countries, it also seems indisputable that nineteenth-century Sweden was not a developing country. The technology transfer from the leading industrial nations to Sweden in the decades around 1900 is, therefore, not really comparable to the discussions of technology transfer to less developed countries of today. However, the newly returned engineers could contribute to technical change also in Sweden. If industrialising Sweden managed to repatriate the emigrating engineers it should have been possible to turn the emigration of engineers from the initial loss to a process where human capital was brought back through them. What may be problematic in this sense was how to look at the target migrants. As they aimed to return it is difficult to state that the sending country suffered a "brain-drain" when they were leaving. They may also have been out on grants, or missions from companies, etc. What is more relevant, however, is to speak about them as a source for technical change after their return. The very fact that authorities in many cases awarded them grants, etc. points in the direction of them viewing temporary emigration as a potential source of the technical change they thought was necessary if Sweden was to be on a level with the leading industrial nations.

We can note that returned engineers played important roles in some large Swedish companies during the early decades of the twentieth century as Olsson's studies of the shipyards have shown.[125] A return may also have been beneficial for a Swedish emigrant as he or she had knowledge that was not common in Sweden at the time. The competence and practical know-how from a country in the technological forefront was an incentive to return as it could be the base for the career. As practical know-how with regard to, for instance, American methods of mass production was uncommon in early twentieth century Sweden, engineers who had the know-how had good career opportunities and the possibility to become an expert about this at a Swedish company increased these opportunities. This expert role could lead to an enhancement of the status in a way similar to what King has sketched as one of the major incentives for a return to occur. As the methods were more widespread in the United States, these opportunities were not as strong and, thereby, the incentives to return were often stronger than the incentives to settle for good.

It is reasonable to assume that a country's stock of, for instance, engineers had a higher amount of human capital in case a share of it had been working abroad, especially in technologically advanced countries, than if the whole stock only consisted of experiences from the native country. Therefore, it was also a question of an additional gain of human capital acquired through the experiences the migrants gathered while they were living abroad.

We have revealed certain studies where the pattern of change and economic development through return migration did not hold true but the question is whether there was a difference between the return migrations of academics compared to others. If so, the assumption may have more relevance and it is possible that returning Swedish engineers were a source of technical development for Sweden during the "second industrial breakthrough" and in to the 1930s, something Lange assumed happened in Norway in the 1930s. [126]

The expressions "brain-drain" and "brain-gain" will be used with some caution in this study, as they are to some extent slippery and difficult to interpret. As stated, it is difficult to equate the concept of target migration in order to accumulate human and symbolic capital with "brain-drain" as these target emigrants had the intention to return, whereas a migration aiming to permanent settlement could possibly be viewed as a "brain-drain" in a theoretical sense. However, the outcomes of these migrations may be reversed. Still, an approach similar to Hunger's quantification of managers will be used in order to discuss the returning engineers as a possible source of technical development for Sweden during the large-scale industrialisation.

1.6. Limitations

This study deals with emigration and return migration of Swedish engineers in a period ranging from the 1880s to the 1930s. The breakthrough of American technology in the Swedish technical journals mainly came in the 1880s. Furthermore, the intensity in the movement of people between Europe and North America had started to reach a high level at that time.[127] A third reason is the second industrial breakthrough in Sweden which began during the 1890s. Historian Lennart Schön characterised the main periods in the economic history of Sweden from 1790 to the turn of the millennium in the following way: 1790–1850, the transformation of the agricultural society, 1850–1890, early industrialisation within the agricultural society, 1890–1930, the breakthrough of the modern industrial society, 1930–1975, the development of the modern industrial society with a growing production of services, and from 1975 onwards, the breakthrough of the service society or the post-industrial society.[128]

Productivity in the Swedish industry increased from the 1890s as did mechanisation, but most important, according to both Schön and historian Lars Magnusson, was the breakthrough of a technology that allowed for a capacity and quantities that had no counterparts in earlier Swedish industry.[129] During the same time – perhaps in the wake of it –"development nationalism" arose. This kind of nationalism will be described later. Engineers educated in the 1880s participated in the changes of the 1890s and it suggests an earlier starting year for this study than 1890. An alternative would have been to place the starting year in 1870, but at that time the real breakthrough of American technology had not yet occurred even if engineers had travelled to the United States already in the 1860s. The time period ranging from the 1880s to 1930s thus covers the breakthrough of the industrial society and includes one decade on each side of it.

The study ends in 1940 though the quantitative analysis of the engineers' migration patterns only runs until 1930. Therefore, it is the actions and impact of returned engineers which become the focus of the part of the study detailing the 1930s.[130] The group of engineers studied in the quantitative study graduated between 1880 and 1919 and their moves were followed until 1930. The engineers were followed for at least a period of ten years after their graduation. As most emigrations and returns took place shortly after graduation it is unlikely that moves made after 1930 would influence the results to any large extent. The final year of the study, 1940, also accords with the existing source material. The year 1930 also marked the end of era of mass emigration to North America and even if the engineers were exceptional in that context their emigration had connections to the general patterns. A long-time study of migration patterns of Swedish engineers throughout the twentieth century was not within the scope of this study. It is an interesting task for potential future researchers, not least because of current debates about emigration of academics.

The group studied in the quantitative context focuses on the engineers graduating from the Royal Institute of Technology (KTH), the Chalmers Institute of Technology (CTI), the mining schools in Falun (BSFA) and Filipstad (BSFI), and the technical upper secondary schools in Malmö (TESM) and Örebro (TESÖ). There were also other technical upper secondary schools in Sweden, but the institutes in Norrköping, Borås, Härnösand, Eskilstuna and Hässleholm did not have source materials allowing for an inclusion in the quantitative study.

The case studies will be limited to four companies in Sweden: the electrical engineering company *ASEA,* the steel and iron company *Sandvikens Järnverks AB,* the mining company *Bolidens Gruv AB* and mechanical engineering company *Bolinders Mekaniska*

Verkstads AB. The selection of branches and companies was made according to the following criteria: in chapter two, we can see that naval architects were most prone to emigrate and to return. However, Olsson has, as already mentioned, done studies of the shipbuilding industry and the foreign experiences somewhat similar to this study.[131] The possibilities to reach further in that area were therefore limited. The same could possibly have been true for the electrical industry and ASEA, a field where Fridlund has reached some results with regard to returning engineers, their importance and contributions. However, the quantitative material gave by hand that ASEA was extraordinary significant when it came to employ engineers with foreign experiences. Furthermore, when we looked at the real numbers of returning engineers, were most electrical, mechanical and mining engineers. It was, therefore, viewed as important to focus on branches where these engineers worked: the electrical industry, mechanical engineering, steel and iron industry as well as mining. The selected companies were the ones that employed most engineers from the United States, except within mining where Boliden was selected because it had foreign trained engineers in management, and because the establishment belonged to a latter part of the period. Another focus would possibly have over-emphasised the years around 1900. Furthermore, all the companies were important in Sweden during the era of industrialisation and the studies of the companies can, therefore, in the same way as historian Eva Dahlström stated with regard to her selection of three engineering workshops in nineteenth century Sweden, be viewed as having an intrinsic value.[132]

The study of the dispersion of returned engineers to the major companies within each industrial branch was limited to the largest companies within each of them. In the case of the electrical industry, it was easy as there were only three major companies in the country. All mining companies have also been included in the study as they were comparably few. In case of the mechanical engineering workshops only fifteen major companies were studied. The ten largest steel and iron works were also included. One reason for this was that it probably was the largest companies within each industrial branch that could make the most impact on the country as a whole when it came to applying foreign technology.

1.7. Sources

Some scholars have stressed the importance of using a combination of sources even if it has been relatively uncommon.[133] This thesis has been based on a varying number of sources: directories of the technical educational institutes, different books, letters, newspapers and newsletters, printed and unprinted travel accounts, written lectures and other unpublished papers, sources on the internet and other material, such as descriptions of patents. The reliability of the sources will be discussed below. The discussion is focused on the main sources. Minor sources will be commented upon in the text when it is necessary.

Directories

The directories of the technical educational institutes

The basic source materials for this study have been six directories which included graduates from the six technical institutes.[134] The information given in these directories diverged to some extent. In table 1:1, we can see what basic information was given in each of them as well as the last year available.

TABLE 1:1: Basic biographical information in the directories used in this study.

Information/directory	STF	CTI	BSFA	BSFI	TESM	TESÖ
Last year available	1936	1928	1949	1931	1928	1924
Date of birth	Yes	Yes	Yes	Yes	Yes	Yes
Place of birth	Yes	Yes	Yes	Yes	Yes	Yes
Social status (1)	Yes	Yes	Yes	Yes	No	No
Educational institute	Yes	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)
Educational sector	Yes	No	Yes (3)	Yes (3)	Yes	Yes

NOTES: STF= the directory of *Svenska Teknologföreningen* (The Swedish Technical Association), which includes all graduates fro the Royal Institute of Technology (KTH), but also some from other institutes that were given membership in the Swedish Technical Association; CTI = the directory from Chalmers Institute of Technology; BSFA = the directory from the mining school in Falun; BSFI = the directory from the mining school in Filipstad; TESM = the directory from the technical upper secondary school in Malmö; TESÖ = the directory from the technical upper secondary school in Örebro; (1) based on the father's occupation; (2) only one educational institute included; (3) mining was the only sector.

As we can see, the directories usually included basic information for a quantitative study of the engineers' migration patterns. The basic short falls were the lack of information about educational sector in the CTI-directory and that social status was not revealed in the directories of the upper secondary schools. This limited the possibilities for a "complete" study especially in the latter case as such an investigation would have required a thorough research in parish records from a large number of parishes. Occasionally, however, the social status of the upper secondary school engineers was identified if they were included in some of the other directories, mainly the one from STF. There are reasons to believe that social status could have been higher among the upper secondary school engineers who for some reasons were able to become members in STF than among other graduates from these schools. A higher social status probably facilitated the membership in STF. However, the lack of information may influence emigration and return rates of the engineers with lower social status as they probably also were more represented among those with lower technical education.

In writing his article on the Swedish engineers in Chicago, Sten Carlsson used the same source material, describing the directories of STF and CTI as excellent, while the others had some defects.[135] After a more thorough survey of the STF and CTI directories, it is possible to claim that Carlsson – probably involuntarily – exaggerated the quality of the directories from the two major institutes. The basis for this argument is the fact that if an engineer was included in both these directories the information occasionally differed. For instance, employment years at certain companies were occasionally different. In some cases one directory stated “study trip”, whereas the other stated that the engineer had been employed while abroad. In other cases information about a foreign stay may be included in one directory, whereas the same years were just left blank in the other. There are reasons to state that of these two directories, most defects were found in CTI’s, but occasionally it was also the other way around.

Carlsson correctly pointed out that the STF directory was the qualitatively best one. His point about the CTI directory as excellent, whereas the other had defects is more debatable. The directory from TESM was at least on level with the one from CTI, whereas the TESÖ directory had the disadvantage that it only included graduates who were alive in 1925 and wanted to participate. The mining school directories had in many cases information gaps that need to be taken into consideration. The CTI disadvantage with regard to educational sector has been solved by search in the yearly directories from CTI. In the same manner, geographical moves taking place after the years when the directories were edited have been identified through the CTI yearly directories as well as similar types of directories from TESÖ. As for TESM, no yearly directories have been found and, consequently, these graduates have only been followed until 1928. The yearly directories gave information on where the individual engineers were working each year, and should generally be reliable. One possible problem could be the cases when the editors of the directories could not get any information about the engineer. In such a case, they probably assumed that he still was working in the same place as the year before, but the impact of this should be marginal.

Another remark on the information in the directories concerns the sources used by editors. The TESÖ selection has already been mentioned. The directories have partly been based on notes collected by the editors from the individual engineers being alive at the time for the writing, and partly on notes in elderly directories, necrologies and biographies in newspapers, etc. The problems concern the reliability of the notes. Some of the informants were old at the time, and their careers took place many years in the past. Govert Indebetou and Erik Hylander also stated that it had been difficult for them to find notes, especially about engineers who were living abroad and in many cases impossible to state whether the persons were alive or not.[136] This fact may influence the results when it comes to emigration and return rates. However, it is reasonable to assume that persons recorded as emigrating, but about whom there are no further notes of explanation, had left the country for good. In some cases, only name, birthplace, etc. were given and these persons have been excluded from the study. It is possible that these engineers in many cases were emigrants but they were comparably few and their possible moves of emigration and return migration ought not to influence the results to any large extent especially as a large number of engineers were investigated.

In the other studies different directories have also been used: directory from the upper secondary school in Borås (TESB) and the directories of the Swedish steel and iron works as well as the mining companies issued in 1902 and 1921. The end year of 1912 made it difficult to include the graduates from TESB in the quantitative study even if there were yearly directories. However, with regard to information on individual engineers at the companies it has been used in the same way as the other directories, to identify their experiences. As have the directories of the iron works and mining companies, which also were valuable in the study of the dispersion of returned engineers into major Swedish companies. For both the case studies as well as the study of the dispersion, some of the biographies in different books and personnel files from ASEA have also been used. Qualitative issues with regard to these directories connected at large to the remarks made for the other ones. The information provided often differed. Furthermore, it should be taken into account that some iron works had expressed the desire not to be included in the directories.

The Swedish Trade Calendar (Sveriges Handelskalender)

Sveriges Handelskalender was issued for the first time in 1859 and contains information on the companies' location, activity, capital accounts, the name of the managing directors and in some cases also the leading engineers, as well as year of establishment. In this context, the trade calendars have been helpful in order to identify who were on responsible positions in the leading Swedish companies within the different branches. The ones that have been used were the issues from 1900, 1907, 1909, 1914, 1918 and 1922, due to availability. The notes with regard to engineers in leading positions differed, and in some cases the information was not given which may cause imbalances in the results. It has, however, been possible to cover longer periods with the help of the directories from the technical educational institutes. The overall judgement is that the trade calendars were a reliable source material even if more qualitative information with regard to who was responsible for what (for instance who were heading the rolling mills at each iron works, etc) would have allowed for a better and more thorough study of the dispersion of returned engineers to the different Swedish industries.

Books, newspapers, newsletters and journals

Printed source materials such as remembrance books, daily newspapers, newsletters and company papers for their staff, etc. have been valuable in this study. The printed sources will be more closely commented upon in each case study chapter. Some general statements can, however, be made already at this point, and these statements are to some extent also relevant for necrologies, obituaries, articles in the companies' own papers as well as written lectures. Persons who were involved in the management of the companies or responsible for a certain production often wrote the accounts. The advantage of this situation is that they were persons close to the development and, therefore, probably had a lot of insights. However, when it came to particularly commemorative books, but to some extent also articles in the papers, the fact that the writings were about to be published probably set limits for what the authors wanted and/or could write. Questions of imitating technologies from abroad probably belonged to the more sensitive matters to write about. Furthermore, the authors wrote from their own – or the companies' perspectives. Possible tendencies to exaggerate their own importance as well as putting the companies and friends/colleagues in a more positive light than they really deserved must be taken into consideration. This may also hold true for necrologies in daily newspapers, and obituaries in for instance the *Sancte Örjens Gille* collection. Those who wrote these accounts were generally close friends and/or relatives who wanted to celebrate the persons they were writing about. Exaggerations and withholding of information that could have been interpreted as negative for their friends/colleagues may very well have happened but this was more or less impossible to control.

As the companies published most of the books themselves, their very decisions of who was to write them suggests that these authors were persons who had a positive attitude towards the companies. To some extent this probably also held true when remembrance books were issued by the companies but written by authors outside of them. It seems more or less obvious that the companies wanted to check what was written about them even if the task was given to an academic outside the company sphere. It seems reasonable that a certain amount of company censorship must have influenced writings of both remembrance books, but also articles in the companies' own papers and journals such as *Teknisk Tidskrift* and *Jernkontorets Annaler* as well as local newspapers. It was one thing to diffuse company secrets in internal messages within the board, but another to spread the news among the work force in accounts that also could be read by others. It needs to be taken into consideration that results that could have been very interesting for this study may be hidden in the dark or presented as weak indications because of a fear from the companies' side to let out too much information.

The company paper most used in this study was *ASEA:s egen tidning* (ASEA's own paper) issued by the ASEA company from 1909.[137] It consisted of articles on technical, social and economic matters concerning ASEA as well as necrologies and other notes. At the end of each year there was a register with all the articles throughout the year. The register was useful when it came to finding valuable articles. The paper has been used in order to identify what the returned engineers worked with and for comparisons with their foreign experience through writings and other source material. These processes have been compared with what the engineers worked with and experienced while they were abroad, and conclusion about technical diffusion were drawn out of this material.

Other journals used were primarily *Teknisk Tidskrift* and *Jernkontorets Annaler.* The former consisted of articles within different areas of technology whereas the latter was limited to steel and iron works and metallurgy. Especially *Teknisk Tidskrift* included a large number of articles on varying topics and the registers made for both journals have been valuable in order to find articles of interest for the study. Both journals consisted of articles written by returning engineers as well as articles on foreign technical development that were of interest for the study. For instance, in both journals there were a large number of accounts of journeys. As for other journals, there are reasons to consider what the authors were able or wanted to write. The journals have been used in the same way as mentioned for the ASEA-journal above.

Letters

Another valuable source has been both personal and professional letters. The collection of ASEA's managing director J. Sigfrid Edström's letters at the National Archives of Sweden has been the most valuable but letters have also been used in the study of Sandviken. Edström's collection of letters covers the period from 1891 to 1940, and has been thoroughly gone through especially for the period 1903 to 1910. Thanks to Edström's own concern in the 1950s the collection is very well organised. The correspondence has been arranged chronologically with respondents and senders in alphabetical order each year. The letters are mostly connected to Edström's duty as ASEA's managing director but some more or less personal letters as well as letters connected to his engagement in the International Olympic Committee are also included.

Edström donated the collection to the National Archives for academic research in the 1950s. It was Edström's own demand that it was to be used only for this purpose. In this context, there are reasons to believe that Edström may have sorted out the most sensitive letters regarding activities that more or less could be characterised as industrial espionage and possibly also other matters. The judgement is, however, that Edström left surprisingly sensitive letters in the collection and there were reasons to call into question whether a filtering ever happened. The collection seems to be more or less complete but it is not possible to judge whether Edström after all may have had a higher threshold when it came to the matters mentioned above.

The Edström collection gave a fairly good picture of what many of the future ASEA-engineers experienced in the United States and to some extent also in other countries. In many of the letters written to engineers abroad by Edström himself he instructed them what to study. The collection must be considered as very good for this study. One minor problem, however, concerned the linkages between the experiences and the engineers' work after return. This has already been discussed and is primarily to be related to other source materials. Furthermore, the information in the letters from engineers abroad as well as Edström's own instructions gave a clear indication that it was these matters the engineers worked with after their return.

Some of the remarks made with regard to Edström's collection are relevant also when we are discussing the letters used in the case study of Sandvikens Järnverk. Some letters are from the future managing director Karl Fredrik Göransson during his time as a student in Lausanne and New York. The letters in that collection are surprisingly few and it seems reasonable that he wrote more letters to his family. The letters consist of information on what courses he was attending at Columbia University 1900–1901, his impressions of them, and from his study trips, mainly to different iron works in the United States. Some of his letters indicate the possible origins of his later interest in Taylorism and welfarism, even if the interval between his time as young student in New York and his early years as managing director of Sandvikens Järnverk in the 1920s was comparably long.

Another, larger, collection is the letters Ivar Magnusson wrote from the United States mainly to his father Tord Magnusson during the years 1904–1910. Ivar Magnusson later became departmental head of the cold rolling mills in Sandviken, and Tord Magnusson was at the time one of Sandviken's directors. The information consists of experiences of the iron works Ivar Magnusson worked at. He also discussed his plans for marriage as well as his possibilities to return to Sweden and Sandviken. The collection consists of one major gap – no letters between December 1907 and May 1909 are included. This may indicate that they have been sorted out possibly because sensitive material was included in the letters. Ivar Magnusson was a frequent writer, and even if his marriage plans caused a minor conflict with his parents he seems to have been so attached to them that one and a half year of silence from him is not reasonable. The period of silence covers almost the whole of his time at Carnegie Steel's plant in Duquesne, Pennsylvania, described as one of the most advanced iron works in the world. Possibly he gave his father valuable information from there which needed to be covered. The implications of this possible censorship for this study are that some of Ivar Magnusson's or Sandviken's future actions are hidden in the dark at least with regard to their possible Pennsylvanian origins.

Other sources

Additional sources have been other accounts of journeys, unpublished papers, lectures, investigations and different technical matters. As for published material, journals, etc. there are reasons to wonder about what could be written or said. For instance, when Ivar Magnusson lectured about the history of cold rolling in Sandviken in 1933, he mentioned rationalisations and actions he had taken and their successfulness. He did not refer to his time in the United States but it is reasonable to assume that the experiences were important in the context.[138]

Some descriptions of patents have also been used as well as some sources from the Internet, mainly the Ellis Island register. This register consists of the detailed passenger lists kept by the shipping companies and include a total of more than twenty-two million persons passing through Ellis Island and the port in New York City. It has been transcribed into an electronic archive by volunteers from The Church of Jesus Christ Latter-day Saints and is accessible on the Internet for free.[139] The main use of this source has been to identify whether persons appearing in responsible positions at the case study companies, but not in the directories, had been in the United States. As the original documents are included as photos in the database, there should not be any problems with the reliability of the material. One possible problem with the use of this database is that it leads to an overemphasis on the United States, as there is no similar database available for immigration to, for instance, Germany. One way to overcome this problem would have been to use the Swedish parish records for these persons. Most of the engineers in the case studies and the study of the dispersion of engineers to major Swedish companies appear in the directories and the problems described above may at worst have a marginal effect. In individual cases, however, parish records as well as other databases have been used. The possible problems with these sources must be considered as very marginal for the study.

1.8. Method

Collective biography

One of the methods used in this thesis connects to what usually is called collective biography or prosopography. The quantitative study takes its point of departure from a group of Swedes who graduated as engineers from the six technical educational institutes mentioned in the discussion about the source material. Prosopographical studies have often been based on a formal criterion to decide what individuals were to be included. One alternative for selection could be that all individuals in the group had a mutual background, whereas another may be connected to individual performances of a special kind. Such performances can for instance be connected to articles in certain journals, participation in conferences and so on.[140] The quantitative study in this thesis takes the point of departure in a mutual background, a graduation from one of the six technical educational institutes mentioned earlier. Out of this group, the main sub-groups are based on emigration and return, emigration without return and non-emigration and occupational careers, etc. are compared. It must be pointed out, therefore, that both the latter and the former criteria for a prosopographical analysis have been used in the study.

Material from the directories was collected and a database consisting of engineers who graduated in the years 1880–1919, was constructed. The database is not one of all engineers graduating in Sweden during that time period. As mentioned above, some institutes did not issue directories and there are some missing cases among graduates from the institutes included. The database consist as mentioned of 5.994 engineers. Basic statistics were registered for all the engineers whereas the entire careers were registered for emigrants and returnees, and for a group of 1.013 engineers with the last names beginning with the letters A-F. The aim from the beginning was to include all the graduates in the comparison, but this was more or less impossible due to time constrains. It is difficult to judge whether another statistical selection would have been more favourable. The group is comparably large, and it should therefore be an appropriate and representative selection. It is difficult to see how the first letters in the last name could influence the different patterns. Out of these came a study of emigration and return with regard to different criteria such as social, geographical and educational background as well as a study of the occupational careers in a comparative perspective.

Prosopography as a method has, according to Lawrence Stone, primarily been used for studies of elites mainly because it is these groups that have left source materials. Some studies have, however, also focused on other groups in the society and the method as the Swedish historian of technology Thomas Kaiserfeld has pointed out cannot be called elitist.[141] It must be stated that source materials such as the directories have facilitated this study. The directories have been a prerequisite for the collective biography and it is easy to agree that groups with a source material of this kind facilitate prosopography studies, whereas a combination of other methods can be valuable in studies of less privileged groups.

Case studies of companies

The studies of four selected companies also in a way connect to the collective biography, at least in the cases of Sandviken and ASEA. The mutuality in these cases has to do with the engineers at some point of time becoming managing directors, chief engineers or heads of department at these companies. However, their whole destinies were not investigated and their foreign experiences in the case studies will be discussed more in the light of the importance for the companies than for themselves even if the latter perspective still is persistent.

The studies of the companies can be called micro-studies and are close to what the Swedish historian Eva Österberg called local studies. They can be used in order to cast light on more general and national patterns. However, one general problem is that it is often called into question whether the local studies can be said to be representative or if the local conditions diverged so much from the norms that the environment could be called atypical. In most cases local studies have, as another Swedish historian, Peter Aronsson, has stated, been used in order to discuss the local segments in relation to the national ones. It has been viewed as important to discuss micro-studies in relation to a national level.[142]

Dahlström studied three mechanical engineering workshops in Sweden in the nineteenth century: one in the capital city, one in a smaller town and one in the country-side. Dahlström applied a comparative perspective to the workshops and discussed them in relation to the general development of the Swedish engineering industry at the time.[143] In this study, the importance of the returned engineers and their experiences are discussed with reference to the different industries as well as the general development and spirit in Sweden at the time.[144] Furthermore, the complementary study of the dispersion of retur-ned engineers to leading positions in major Swedish companies within the industrial branches strengthens the level of generalisation even more.

The case studies were done in a somewhat different way due to the existing source material. In the studies of ASEA and Sandviken, managing directors, chief engineers and departmental heads were identified through the commemorative books of each company. In the cases of Boliden and Bolinders, the books as well as other source material did not allow for such thorough studies and they became more or less limited to the top manage-ment. The main difference between ASEA/Sandviken on the one hand and Boliden/ Bolinders on the other is that the more or less complete picture given in the first two cases was not evident in the latter simply because it has not been possible to identify what engineers were responsible for what and how many they were. This is also the reason behind the differences in length between the case studies, which may look strange at a first glimpse.

When the responsible persons had been identified in the companies, their backgro-und was studied primarily from directories but also some other source material such as books, personnel cards, etc. A picture of the foreign experiences among these engineers was drawn. The studies were made in a systematic way; department for department in the ASEA and Sandviken cases, engineer for engineer for in the Boliden and Bolinders cases. As much as possible was collected with regard to each engineers' work, both abroad as well as in Sweden after their return, from various sources and also from literature. In some cases it was stated that the foreign experiences were important, but seldom why. The conclusions are in many cases based on linkages between the engineers' time abroad and the work in Sweden after return. The strength in the causality would have been stronger if it had been possible to engage more deeply and compare technical details. Such a perspective proved difficult, but in many of the cases it seems obvious that the engineers were influenced by their foreign experience.

The dispersal of returned engineers to major Swedish companies

It has already been mentioned that the study of the dispersion of returning engineers (Chapter eight) to major Swedish companies was carried out in order to obtain a broader, more general, perspective to support assertions made from case-study analyses. The largest companies within the branches and the leading engineers at these companies were identified from a varying number of source materials. As stated, the studies of electrical industry and mining were more or less complete, whereas a selection was made when it came to the engineering industry (15) and the steel and iron works (10). The reason for the higher number of engineering workshops was that it was more difficult to ascertain which were the largest ones. The selection of steel and iron works was based on the ranking in the year 1913, taken from the history of the iron works in Fagersta.[145] The selection of engineering workshop was made from different literature on the topic and the workshops that were emphasised as important there.[146] From a methodological point of view it would have been more favourable if these selections could have been made from some kind of yearly statistics, official ranking or the like. However, at the time, the way of selection described above looked like the only one possible and it should not be any doubts that the companies included in the study were the largest and most important ones. Therefore, the study should be able to give a true picture of the dispersion of returned engineers in these branches. Unfortunately, it is more or less limited to managing directors and chief engineers, due to the different information in *Sveriges Handelskalender* and the directories from the iron works and mining companies. The degree of how detailed the information was differed from company to company as well as from year to year. The managing directors and chief engineers, therefore, became the lowest common denominator, except in the case of the electrical industry where Helén's books gave the names of the leading engineers without specifying what they were doing. The small numbers of electrical companies made it in one sense important to include more positions than in the other companies. However, this difference in selection must also make the comparison between the different branches somewhat skewed. It is an unfortunate result of the character of the source material.

Managing directors and chief engineers were identified. Once it was established what engineers fulfilled these positions in the companies, the names were linked, to primarily the directories of the educational institutes but also to other source materials. From this a picture of how common American and other foreign experiences were among leading engineers at major Swedish electrical companies, mining companies, engineering workshops as well as steel and iron works appeared.

Notes

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3 Hans Lindblad, "Impulser som förändrade Sverige" in Ingvar Henricsson & Hans Lindblad, *Tur och Retur Amerika. Utvandrare som förändrade Sverige* (Stockholm, 1995), 269; H. Arnold Barton, *A Folk Divided. Homeland Swedes and Swedish-Americans, 1840-1940* (Uppsala, 1994), xiii.

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6 Kurt Samuelsson, *From great power to welfare state: 300 years of Swedish social development* (London, 1968), 265.

7 K Samuelsson, 265.

8 H Lindblad, 208.

9 Lennart Schön, *En modern svensk ekonomisk historia. Tillväxt och omvandling under två sekel* (Stockholm, 2000), 223-224, 334.

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81 J M Staudenmaier, 124, 218.

82 F Hodne, 324-327.

83 E Lange, 2; F Hodne 375-378.

84 For instance S Skard, 181

85 H Björck 1987, 294-295. Björck investigates an early pre-industrial era and stresses that the importance of technical journals may have been higher in a later period.

86 E Lange, 1-2.

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88 Charles Edquist & Olle Edqvist, *Sociala bärare av teknik. Brygga mellan teknisk förändring och samhällsstruktur* (Lund, 1980), 9, 40.

89 C Edquist & O Edqvist, 40-42.

90 H Björck 1987, 298. On the raising of the profession see for instance Nils Runeby, *Tekniken, vetenskapen och kulturen. Ingenjörsundervisning och ingenjörsorganisationer i 1870-talets Sverige* (Uppsala, 1976), 204-248; B Berner 1981, 204-222.

91 It must pointed out that the borders between *access* to the technology and *knowledge* of how to handle it are very blurred. If it was a question of technical artefacts such as machines, it was, of course, not enough to have it in front of you, if you did not know how to handle it. In such a case in order for the technology to be introduced, there must be a person capable of handling it. Then it was a connected carrier of technology. If it was a question of system such as implementation of Taylorism, access to the technology and knowledge about how to use it must virtually have been the same thing even if such a system may require certain technical artefacts, such as assembly lines.

92 Frans Bovenkerk, *The Sociology of Return Migration: A Bibliographic Essay* (The Hague, 1974), 10-18.

93 Russell King, ”Generalizations from the history of return migration” in *Return Migration. Journey of Hope or Despair?,* ed. Bimal Ghosh (Geneva, 2000), 11.

94 R King, 15.

95 Max Weber, *Vetenskap och politik* (Göteborg, 1977), 140-141.

96 Everett S. Lee, ”A Theory of Migration” in *Demography* 1/1966

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98 D Broady 1990, 171-179.

99 Donald Broady, “Inledning” in *Kulturens fält: en antologi,* ed. Donald Broady (Göteborg, 1998).

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102 Byron J. Nordstrom, ”Trasdockan: The Yearbook of the Swedish Engineers’ Society of Chicago” in *Swedish-American Life in Chicago,* 193.

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109 D Broady 1990, 229.

110 Nils Runeby, “Att organisera framtiden” in *Göteborgs-Emigranten 6,* 222.

111 Eugene S Ferguson, ”The Mind’s Eye: Nonverbal Thought in Technology. “Thinking with pictures” was an essential strand in the intellectual history of technological development” in *Science,* Number 4306, Volume 197, August 26, 1977, 835.

112 B Berner 1996, 48.

113 Svante Lindqvist, *Technology on Trial. The Introduction of Steam Power Technology into Sweden* (Uppsala, 1984), 291-307; Svante Lindqvist, ”Social and Cultural Factors in Technology Transfer” in *Technology Transfer and Scandinavian Industrialisation,* 15-36.

114 S Lindqvist 1991, 18.

115 S Lindqvist 1991, 19.

116 M Alm, 56.

117 H Lindblad 1995, 101-272.

118 Bimal Ghosh, ”Return Migration: Reshaping Policy Approaches” in *Return Migration. Journey of Hope or Despair?,* 187-189.

119 K Djupedal 1990.

120 U Hunger 2000, 7-21; U Hunger 2002, 1-22.

121 H Lindblad 1995, 214.

122 U Hunger 2002, 7.

123 Göran Ahlström, *Technological Development and Industrial Exhibitions 1850-1914. Sweden In An International Perspective* (Lund, 1996), 124, 210; Walt Whitman Rostow, *The Stages of Economic Growth. A Non-Communist Manifesto* (Cambridge, 1960), 17-18. During the exhibitions in Paris 1867, Vienna 1873, Philadelphia 1876, Chicago 1893 and Paris 1900, Sweden actually won more prizes than Great Britain, whereas the United States established itself as the leading industrial nation.

124 G Ahlström, 210.

125 See for instance L O Olsson 2000, 106. Olsson showed that the “new generation” of managing directors at the large Swedish shipyards in the early twentieth century had several years of foreign experiences, although he did not discuss it in terms of “brain-gain”.

126 E Lange, 16-17.

127 Berit Brattne & Sune Åkerman, ”The Importance of the Transport Sector for Mass Emigration” in *From Sweden to America,* 176.

128 L Schön, 24.

129 Lars Magnusson, *Sveriges ekonomiska historia* (Stockholm, 2002), 359-360; L Schön, 241-246.

130 Especially as regards Boliden

131 L O Olsson 2000, 47-55.

132 Eva Dahlström, *Verkstadsmiljöer under 1800-talet. Mekaniska verkstäder mellan hantverk och industri* (Stockholm, 1999), 22.

133 Quoted in Lotta Vikström, *Gendered Routes and Courses. The Socio-Spatial Mobility of Migrants in Nineteenth-Century Sundsvall, Sweden* (Umeå, 2003), 44-45.

134 *Chalmers Tekniska Institut 1829-1929. Matrikel,* ed. Gösta Bodman (Göteborg, 1929); *Tekniska Föreningen i Örebro 1875-1925,* ed. Emil Forsberg (Örebro, 1925); Govert Indebetou & Erik Hylander, *Svenska Teknologföreningen 1861-1936. Biografier,* 2 volumes (Stockholm, 1937), Govert Indebetou, *Bergsskolans i Filipstad elever 1830-1930* (Filipstad, 1931), Govert Indebetou, *Bergsskolans i Falun lärare och elever 1871-1930* (Filipstad, 1949), *Malmö Teknologförbund.*

135 S Carlsson 1991, 182.

136 *Svenska Teknologföreningen* I, VII.

137 The first issue of the Sandviken paper, *Konvertern,* came in 1943 and after the investigated period. Some articles in that paper referring back to historical events have however been used. Boliden and Bolinders did not issue company papers.

138 Ivar Magnusson, ”Kallvalsning och dess historia i Sandviken”, unpublished paper, 1933, SA SKCA, volume F14:3G.

139 http://www.ellisisland.org/search/index.asp?MID=06833889580064259584&, available on the Internet, 26/6-2003.

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141 T Kaiserfeld, 12.

142 Peter Aronsson, *Bönder gör politik. Det lokala självstyret som social arena i tre Smålandssocknar 1680-1850* (Lund, 1992), 10-13; Eva Österberg, "Rikshistorien och lokalhistoria: En fråga om centrum och periferi, central och perifert i historieforskningen?" in *Periferi og sentrum i historien: Foredrag ved den 10:e Nordiske fagkonferanse for historisk metodelaere på Røros 16-20 juni 1974. Studier i historisk metode 10* (Oslo, 1974), 175-178.

143 E Dahlström.

144 The basis for selection has already been discussed.

145 Artur Attman, *Fagerstabrukens historia. Adertonhundratalet* (Uppsala, 1958), 490.

146 E Dahlström, 27-64; T Gårdlund 1942, 233-259; T Gårdlund, 1945; Torsten Gårdlund, *Svensk industrifinansiering under genombrottsskedet* (Stockholm, 1947), 15-17; Jan Glete, *Ägande och industriell omvandling. Ägargrupper, skogsindustri, verkstadsindustri 1850-1950* (Stockholm, 1987), 236-248.

2. HISTORICAL BACKGROUND

2.1. Sweden's transition from an agricultural to an industrial society [1]

The large-scale industrial breakthrough in Sweden occurred 1890–1930. Schön claimed that few periods had been interpreted as more important in the country's economic history. Sweden was the number one country in economical growth and remained in that position until around 1950. Lars Magnusson has placed this breakthrough further back in time. However, he still called the 1890s a "second industrial breakthrough". Even Schön acknowledged that the country witnessed an early minor industrialisation before 1890.

One explanation for the rapid economic development after 1890 is the successful transformation of industry. The core moved from old branches such as the iron trade and the sawmills towards new branches within the engineering industry, pulp and paper and the manufacturing of consumer goods. The arrival of electricity brought about the changes. The new technology allowed for capacities and sizes larger than ever before. The diffusion to several industries began after the successful transfer over a longer distance in 1893. More power could be used and the electrical motors brought a more rational organisation to the work process. Commercial products based on electricity were developed and power as well as the machines allowed for mass production within several branches. Schön claimed that investments, innovations and institutions were crucial factors behind economic growth. The build-up of an electrical infrastructure in Sweden was made through far-reaching cooperation between private industry, banks and the state. The banks were able to raise and create money for the financing and the state got an increased role in the process after 1900, by taking responsibility for the organisation of the electrical system. Of course there were also other factors behind the growth. The increasing distribution of newspapers and the accumulation of capital in urban industrial areas were two other factors emphasised by Schön.

But why did Sweden in particular have the fastest growth in the world? Schön claimed that the global economy of the late nineteenth century influenced Sweden in a particular way and created a springboard in the form of new relative prices on labour and capital. In the United States the standard of living as well as the wages and the purchasing power were higher than levels even in the earlier industrialised parts of Europe. Thus the United States was characterised by mass production, mechanisation and growth of the machine industry.

Sweden had a position between the new and the old worlds. Compared with North America, Sweden was a part of the "old" one, rich in labour but poor in other resources. This led to low wages and spurred emigration. But the position compared with the old industrial countries of Europe was different. Sweden was rich in natural resources but poor in capital. At the same time as many Swedes emigrated, capital investments from primarily north western Europe came into the country. Schön argued that Sweden became an "America in Europe".[2]

The flows of capital and people reversed the prices of labour and capital. It was only Sweden's Scandinavian neighbours that came somewhat close to the Swedish raise of the real wages from the mid-nineteenth century to 1910. Wages grew faster than the Gross National Product, and this increased the domestic market. Consumption increased as well as did the demand for machines. Profitability fell among activities who relied on low wages and rich supply of natural resources, but rose in areas demanding more competence and technical skills as well as a higher degree of refinement. This created a pressure for industrial transformation.

In this context, the working class managed to strengthen its social position whereas the peasantry ended up on the losing side. From the 1850s, the farmers had been a driving force in the economy and also had a strong position in politics. Schön claimed that the changes that began in the 1890s meant a shift of the economic and political power from the agricultural class in the countryside to the working class and industrial owners in urban areas. This development occurred in the whole industrialised world, but was most evident in Sweden. This was due to the interaction with the international market and the floating of goods, capital and labour. According to Schön, these experiences helped create some of the mechanisms typical for the "Swedish model". The labour movement and the industrial owners agreed in principal that the international dependency was something positive and that economical growth and increased productivity were cornerstones leading to an increased living standard.

The growth in productivity was – in Lars Magnusson's words – "close to sensational" from the early 1890s until 1907.[3] That year the value of production and exports fell and unemployment rates increased. This led to the Great Strike *(Storstrejken)* in 1909 but the direct cause was the employers' decision to cut the wages. At the end of 1909, however, trade conditions improved and exports rose. Schön characterised the period from 1910 to 1930 as a "second investment cycle" based on the renewal created between 1890 and 1910. [4] The years before the outbreak of World War I were characterised by a boom. Production, export and prices increased and the engineering industry was the branch that gained most from it. The mechanical workshops were able to increase their exports, especially to Russia and Eastern Europe.

The consequences of the war struck Sweden less than several other countries. The industry witnessed an almost continuous boom during the war years. The home market industry was aided by the limitations the belligerent countries put on their export and it led to some import substitution. The nominal wages were low and stable thanks to the 1914 party truce between employers and employees. Inflation could not be compensated. Profits in the industry increased and it led to a boom of investments, especially in electricity. Distribution nets linking water power stations were created. Several railways, for example the one that was to transport the ore from the mines in northern Sweden to the Norwegian port city of Narvik, were electrified and the electrification within the industry was completed.

At the end of the war, the boom led to speculation and investments increased due to expectations of continuing inflation. Profit expectations were exaggerated and some companies overvalued their assets. When prices fell in 1920, it led to a backlash where industrial production dropped 25%, and the unemployment rate increased to about the same level. Companies went bankrupt or were merged with others. The crisis struck the export dependent companies within the sawmill industry and the engineering industry hardest. It was worse in 1921 but the recovery went comparably fast. From an international angle, the 1920s crisis struck Sweden only mildly because of the dynamic industrialisation from the 1890s and the relatively small consequences of World War I. In 1922, productivity increased again but from a very low point. Generally, the annual growth in Sweden was about 7-8% until 1929. The unemployment rate fell but was constantly around 10% all through the 1920s. This percentage that was significantly higher than before the war. This was also due to the fact that the 1920s more than any other period was the era of rationalisation. Less effective units disappeared and overcapacity was largely eliminated. But Sweden's position was still problematic due to competition on the world market and companies, especially within the steel and iron industry, were constantly forced to increase their efficiency and production. One way to rationalise was to increase mechanisation. A second approach was – as we have discussed – through the increase of the workers' production results by adapting more or less Taylorist methods. A third and according to Lars Magnusson more important way was to increase standardisation and specialisation within the industry. The specialised engineering workshop companies managed to adjust to the demands of increased efficiency and rationalisation whereas other companies and branches had difficulties.

The consolidation of the export industry meant that it was able to retain and, to some extent, even improve its position around 1930. The Wall Street crash in 1929 struck Sweden later than other countries. In 1931, there were more company closures and unemployment increased dramatically. The following year, the so-called "Kreuger crash", when the Swedish Match Company went bankrupt, made the situation worse. State authorities were forced to give extensive support in order to save the Swedish banking system from collapse. Several banks had given generous credits to the Kreuger group and they were on the verge of bankruptcy. Furthermore, Kreuger owned stocks in several large Swedish companies, which had to be sold at extremely low prices.

But the turning point came fast. Already in 1933 production and export increased again and unemployment fell. The international crisis did not strike Sweden as hard as many other countries. Several explanations have been given. One has to do with the rationalisation of the 1920s creating a positive transformation pressure in the 1930s, when new opportunities for enterprising and technical development occurred in the wake of the new possibilities for the electrification and the breakthrough of motoring. Another was the abandonment of the currency's tying to the gold standard in 1931. This decision led to devaluation of the crown and greater competitiveness for the Swedish industry. A third explanation has to do with the expansive finance policy begun by the social democratic government in office from 1932. The under-balanced budgets created public work, increased the employment and spurred demand in the economy. A fourth reason was the expansion of the home market industry. Purchasing power had grown despite the 1920s and 1930s crisis possibly because of the transformation from agriculture to industry. In comparison with other countries, Sweden was still comparably agricultural in the early 1920s. The transition and urbanisation led to higher purchasing power. A fifth possible explanation was the rejuvenation of the Swedish population. Younger people increased the demands for clothing, housing, food and other consumption goods.

The credibility of all these explanations can be discussed. What can be stated was that the country had an overall growth and positive economical development for more than forty years as the 1940s was standing for the door. The reforms transferring Sweden into a welfare state that stood at its zenith in the 1970s must have been facilitated by this positive development in the years of the large-scale industrial breakthrough.

2.2. Development nationalism

In Germany, Britain and Sweden new nationalisms arose in the nineteenth century that contributed to a changed view of the state's role in countries' industrial development. The state was to be more active.[5] In the German context, the development ideology occurring between 1870 and 1890 was an industrial nationalism. The German state was to be active in the uplifting of the private industry. Hans-Ulrich Wehler claimed that the aim was to create a mutual goal for the state and private industry as well as the private and the public spheres in the country; the development of the German nation and society. The state was to lead through an active economic and social policy.[6]

In Sweden a similar type of nationalism arose from the 1890s according to historian Svenbjörn Kilander.[7] Around 1900, Sweden was a country where the nationalistic values were in focus.[8] But it was not a nostalgia for the old great power days and Sweden's warlike past. It was not possible to build a great future on these images. Instead, it was a transformation from this idealistic nationalism to the modern industrial nation's image of itself.[9] The new nationalism emphasised industrial competition with other countries, and metamorphoses of the nation's place on the international scale of development became a common content.[10] The cooperation between the state and ASEA on the electric and waterpower technology studied by Fridlund can be seen as a Swedish example of the mutual goal that Wehler emphasised as important in Germany.[11] The Swedish development nationalism was spurred by the crisis in the relations to the union partner Norway and the conflict between free traders and protectionists. During the first years of the twentieth century, emigration was seen as the major threat.[12]

Sweden was a country that was industrialised at a later stage than several other countries, and the nationalism may be a reaction to the fear that more advanced nations would penetrate the country.[13] Even if the development nationalism was contemporary to the growth described by Lars Magnusson and Schön, it was rooted back in time. It is also reasonable to assume that the growth spurred the development nationalism. Schön's emphasis on supporting institutions as a prerequisite for the growth also indicates that the increased state support of the industry may have spurred it.

2.3. American and German models

As mentioned above, Sweden was a country of emigration. One of the tasks for the new nationalism became to combat it. In order to do so, it was viewed as necessary to use American examples and American organisation. It became important to learn from the United States and to "transfer America over to Sweden". Returning Swedish-Americans were to be one of the major contributors to the process.[14] In order to become a first ranked industrial nation, Sweden needed to be at level with the United States. The statistician Gustaf Sundbärg, who investigated emigration from Sweden, claimed that the country had to apply mass production of goods for export, rational management, efficiency and a modern large-scale industry. Germany was seen as one example of the latter, but the United States with its developed technology and large corporations was often the prime model.[15]

Nevertheless, Germany was also important.[16] The influences with regard to technological and industrial organisation was called a German-American blend by Runeby.[17] In line with Kilander's conclusion about the influence on the development nationalism, Runeby also stated that German cooperation between state and industry was inspiring.[18] Lindblad made a somewhat provocative assumption that America was the symbol of democracy and religious freedom for many grassroots people in Sweden whereas official Sweden viewed Germany as a model for their privileges and single religion. Lindblad also assumed that the American impulses were underestimated in the labour movement.[19] The former journeyman and social democratic pioneer, August Palm, came back in the 1880s and based his argumentation in experiences from a German model of organisation. The union was not only to be an economic, but also a political organisation for the working class. Claudius Helmut Riegler claimed that this argument failed, but it was clear that the labour movement largely took inspiration from Germany. Ideas of organisation, class struggle and international solidarity were spread through the returned journeymen. Swedes also studied workers protection in Germany.[20] It is reasonable to assume that the views on Germany diverged and that different matters inspired different groups, even if Lindblad has a point that the grass roots population generally had a more positive attitude towards the United States.[21]

The images and views of the United States differed. There were differences between the major political groups. Liberals viewed the United States as a modern and young country. With it as a model, the traditional hierarchies were to be dissolved and the lower classes were to be integrated in society. The conservatives, on the other hand, saw too much of Americanism as a threat to the traditional society. The United States' lack of traditional values created a society without authorities and without guidance, a society where people used each other instead of focusing on honest work. It was liberty and equality leading to anarchy, and in sharp contrast to the safety offered in the traditional and autocratic Sweden.[22]

Some conservatives added the inhumanity of American industry to their picture. Immigrants were used and transformed into poor slaves. Alm claimed, however, that the conservatives thought that they were able to learn the importance of industriousness, conscientiousness and enterprising spirit in the United States but the wise decision was to learn these characteristics in Sweden.[23] Some views were, however, common for liberal, conservative and, in a later stage, socialist views of the United States. The conservatives wanted Sweden to apply American ideas when it came to work methods and morality, but not the cultural and political conditions. The liberals wanted to combine these characteristics, and the socialists also viewed technology as a positive thing for humanity. In another economic system, American technology was not dangerous.[24]

The United States was used as a reference for Swedish self-knowledge and the debates about modernisation of Sweden constantly used American examples, both positive and negative. In a sense, the United States became, as Alm called it, Sweden's "other". [25] Whereas the views on the United States' political system differed, there was relative agreement on the country's superiority in technological and industrial matters. The same held true with regard to Germany. This was not surprising as both countries represented a kind of rationality that the industrialists, engineers and politicians thought Sweden lacked despite the country's economic growth.

2.4. Engineers in Sweden and abroad

Thus development nationalism and the models discussed were largely connected to industry and it was natural that the engineers' status rose in such a context. The same happened in several countries in the wake of the second industrial breakthrough. The engineers' special knowledge of motors, machines, etc, became increasingly important for the industry. Together with other scientists and innovators, engineers became one of the central groups in the economic and industrial development. [26]

In Sweden, the industrial growth became, according to Torstendahl, a measurement of the engineers' ability. They had become a self-aware elite around the turn of the century.[27] Berner argued that the technical education they received particularly at KTH and CTI distinguished them as a small elitist male group, distinct from women whose characteristics were viewed as unsuitable for technical work and responsible positions in the growing industry, but also from lawyers, militaries and men with lower education. Sundin stated that the engineers and their associations were constantly complaining about the tendency to put lawyers and military officers as leaders of state owned or municipal technical departments. These two occupational groups were the major competitors for the leading positions in the society. According to the engineers' own views, lawyers and those with military backgrounds lacked the specific technical expert knowledge. The engineers viewed themselves as more capable of understanding the needs of an increasingly mechanised society. The contradictions in the higher technical education in the decades around 1900 were several but it was clear that it aimed to educate an elite, which had its base in the most useful expert knowledge.[28] To be an engineer was a prestigious occupation in Sweden at the time and possibly the most prestigious of all.

The tasks of technical education was to foster leadership abilities and technical superiority, as these were essential for a society in transition from being agricultural to one characterised by large-scale industrialism. The comprehensiveness of the technical education was a way to achieve these goals. The so-called modern engineer was a person who not only had deep knowledge of technical matters. He also had a wide competence in a range of fields such as economy, administration and organisation.[29] We will soon return to the modern engineer. Education had also another task. It fostered both geographical mobility as well as mobility between different industrial branches. In 1906, the Chalmers student newspaper, *Rasp,* wrote that the engineer's knowledge could take him "to shipyards and workshops in America, to railway building in Russia and laboratories in Zurich, to draftsman's offices all around the earth".[30] This flexible mentality was another factor distinguishing engineers from other academics. It was also a gender specific pattern. Only men had the opportunity to change places, and to freely move between different environments and positions. Ethnologist Mats Lindqvist claimed that longer or shorter stays abroad were means among businessmen and industrialists to create an identity and become more mature and responsible men.[31]

As the importance of industry grew in Sweden, the earlier mentioned ideal of a modern engineer became increasingly important. Many engineers and technically interested industrial managers saw engineers as crucial in the new social context. The following was written under the headline *Moderna ingeniörer* (Modern engineers) on the editorial page of *Teknisk Tidskrift* in February 1909. "If it is true that another time has arrived, and that the sun has started to go down over the lawyers', perfectionists' and bureaucrats' epoch, it is also safe that a top rung place in the new time will be taken by the engineers".[32] According to some articles in the same journal after World War I, this had also happened. The increasingly technological society gave the engineer a place more in the core. Engineers held leading positions in public administration and in the industry, but also within the financial world.[33] To some extent it is possible to say that engineers were successful in striving for higher status.

The modern ideal probably contributed to this pattern. In the 1910s many engineers advocated a change from the older ideal of an engineer and the view of him as an impartial expert and a neutral third force in the battle between labour and capital. For the historical engineer, the devotion to technology was the highest ideal. This was rooted in the tradition of engineers in public or municipal administrations or as independent consultants. The modern engineer was something different. He was a manager in the private industry with no doubts of what side he was on in the social battle.[34] This ideal often went hand in hand with ideas about Taylorism. One example was Erik August Forsberg, chief engineer at a mechanical industry in southern Sweden, and believed to be Taylor's biggest admirer in the country. In the discussion, between the old and the "modern" ideal Forsberg clearly advocated the latter. He claimed that it was an engineer's duty to take the employers' side.[35] This viewpoint included, according to Johansson, a minority of the engineers and most of them still wanted to compromise.[36]

The conflicts between these contrasting ideals mainly took two expressions before World War I. The first was the work of, and demands for, membership in the Swedish Technical Association. It was criticised by spokesmen of the modern ideal for not being able to represent the country's industrial and technical interests in an appropriate way. Too much attention was paid to the scientific sides of technology at the expense of the economic aspects. Prominent business leaders without appropriate technical education were denied membership, which was annoying for these advocats. The other critical issue concerned the concentration of KTH's education. In 1906 a public investigation led to modernisation, but in the wake the whole education and especially the theoretical and scientific concentration was called into question. Many industrialists and engineers began travelling to the United States and became inspired by rationalisation ideas. In 1910 some engineers formed the Swedish Industrial Association that immediately began criticising KTH for the neglect of subjects as economy and management. The association took the initiative for a petition to the parliament demanding radical changes. It was signed by several of the leading men in industry and led to a debate where teachers and engineers in public institutions defended KTH. In general its course of study remained unchanged as several industrialists changed side and began viewing the role of science differently. An import result of the discussion, however, was the establishment of a department for industrial economy and organisation in the 1920s. It became something of a spearhead for Taylorism in Sweden.[37]

It is clear that these discussions were inspired by development abroad and particularly in the United States and Germany. In line with the idea of fostering stronger links between engineers and business leaders, it is possible to interpret Runeby's statement that the German technical educational system and its connections to industrial progress was viewed as superior.[38] The German roots of the Swedish system went back to its organisation in the early nineteenth century.[39]

There were also similarities between the self-awareness among engineers that followed industrial growth in Sweden and the one among American engineers in the years around 1900. Engineering had become a profession in late nineteenth-century United States.[40] The American engineer viewed himself as the creator of a new civilisation, even if he according to Berner had a more critical attitude towards the established finance and industrial interests compared to his Swedish colleague.[41] However, the identification with the corporations at which they were employed became increasingly stronger also among engineers in the United States. As historian of technology Terry S. Reynolds wrote: "The approval of one's superiors in corporate or governmental hierarchies became more important than the approval of one's technical peers, contrary to the values of the traditional professions of law, medicine, and the clergy".[42] The development in the United States was in some ways parallel to the discussions of modern engineers. The American Society of Mechanical Engineers (ASME) had ties to entrepreneurial and financial interests. However, around 1910, a movement arose in which the engineer's role as the employer's representative was toned down. He was instead to become the man of expert knowledge, to stand above the conflict between labour and capital, and serve the interest of mankind. In the late 1910s, the spokesmen of this view managed to come to power in ASME. In the 1920s the organisation's work and goals were changed. [43] In a way, this change echoed the contemporary discussions in Sweden even if the Swedish development to some extent differed and the engineers sought more of an employer's identity. However, in the 1920s, several leading employers in Sweden were as we have discussed looking more to the mutual interests of capital and labour. As we will discuss later, this development was possibly partly due to the their stays in the United States, which were a kind of study trip emigration that we to some extent already have discussed. Such migrations, however, had their roots back in time.

2.5. Swedish international migration until around 1930

Journeyman traditions and study trip migrations

An early and somewhat similar type of emigration was the one of Swedish students before the fifteenth century. They went abroad for university studies to for instance Paris, Prague and north Italian universities as Bologna and Siena. Later, an increasing number of Swedish students started to go to German universities instead. The explanations for this emphasis can be connected to geographical proximity and confessional as well as cultural affinity.[44]

Germany was also a focal point when it came to journeyman migrations. Before 1800, many craftsmen and skilled workers were circulating between Sweden, Denmark and Germany. Educational psychologist Eric Engström stated that journeyman migration had not been compulsory in Sweden for many hundred years in the mid-nineteenth century, but was still in practise and would be so for about another fifty years. The guild system was about to disappear, but practices remained long after. Thus, travel to learn was a tradition that went back in time and especially within the nobility it was common that young men's education was finished with a journey abroad in the seventeenth and eighteenth centuries. Labour market reasons could be another important factor behind journeyman migration. Over time, it also became possible for craftsmen to get new perspectives. Travelling was no longer a privilege of the upper classes.[45]

A massive journeyman migration from the poor forest districts in southern Sweden to Denmark and northern Germany began in the late 1860s. The migrants were seeking contractual employment in agriculture, brickyards and construction works. The number of migrants was about 250.000 from 1869 to 1914. Most of them returned but a substantial number also settled abroad. In the decades around 1900 engineers and selected skilled workers often went to Germany on state sponsored grants in order to work and study, and in some cases, also as industrial spies.[46]

As mentioned above, in the early- and mid-nineteenth century travel abroad in order to study technical development was focused largely on Britain. There were also other groups going to Britain for different kinds of studies. Economists, mathematicians, astronomers, physicians, naturalists, theologians and humanists were some emphasised by educational historian Sven Rydberg. This emigration connected to some extent to the older continental one and took place long before the nineteenth century. London hosted, for instance, a comparably large contingent of Swedes in the early eighteenth century. [47]

The educational emigration characterising the Swedes who went to Germany and Britain before 1800 continued into the epochs of industrialisation, rationalisation and international competition.[48] This is also in line with the previously described British and German influences. Emigration and travelling to these countries had in a general sense been of a temporary character. Many of the migrants aimed to return after having accumulated knowledge. The emigration and return of educated engineers can be viewed as connected to these traditions.[49] Engineers viewed the United States and Germany as leading industrial nations. It was important to learn from them.

These views also imply a connection to a tradition of temporary emigration to North America that has been seen as characterising newer emigration countries. It was, however, also relevant for older emigration countries from the late nineteenth century. Emigrants went to North America, worked for some years, and returned to take over a farm or start a smaller business. The emigrating engineers were a parallel to these emigrants, and the view of North America as a place of temporary residence gave their life in the United States a different orientation than the majority of the emigrants from their respective homelands. The destination of engineers from Sweden and Norway who travelled to United States differed for instance from the main body of emigrants. The area around Pittsburgh with companies like Westinghouse Electric and Carnegie Steel attracted many engineers, although the Steel City and its surroundings were not among the big destinations for Swedish emigrants in general. The same can be said about General Electric's hometown of Schenectady in upstate New York. [50]

Most Swedish engineers initially planned to return to Sweden after spending a few years abroad. They migrated to acquire competence because engineers fresh from school were often, as Stang expressed, "unfinished products".[51] There were much to learn and the connections to the journeyman tradition were reasonable. Improvements to transportation in the late nineteenth and early twentieth century made possible an extension of these older traditions to North America. The dispersion of technological competence to Norway in the pre-industrial era was connected to the craftsmen's journeyman migrations. No Norwegian craftsman could become a master without having spent time on the European continent. In the nineteenth and twentieth century, engineers took over the craftsmen's role and the United States became important for access to modern industrial technology.[52]

Labour market emigration and traditional emigration

Although engineers could often look back to a historical tradition of migration, their reasons to emigrate nevertheless differed. The Swedish historian Rolf Torstendahl found that it was primarily KTH-graduates with lower grades that emigrated. It was a way to compensate for the disadvantage on the labour market. [53]

The engineers had, according to Stang, been a very mobile social category since the mid-nineteenth century and migrated as they accessed a more or less worldwide labour market.[54] Labour market reasons such as better opportunities in a foreign country contributed. Such migrations could have been more or less permanent. In the case of North America we must also consider the general emigration.

Swedish emigration to North America [55]

Emigration from Sweden begun at a small-scale with the establishment of the Delaware colony in 1638 and lost to the Dutch in 1655. In the early nineteenth century there were a few emigrants of whom some can be called pioneers. One was Peter Cassel, founder of a "New Sweden" colony in Jefferson, Iowa. Another was the prophet Erik Jansson. He emigrated because of religious oppression in the 1840s. Together with his followers he founded the Bishop Hill Colony in Illinois, which attracted hundreds of emigrants before its dissolution in 1860.

In the years 1850–1863, emigration rarely exceeded 1.000 persons per year probably due to American recessions and the Civil War. The Homestead Act in 1862 became a pull-factor and in the subsequent years, emigration increased and peaked during the famine years 1868–1873 when more than 100.000 emigrants left Sweden. In the period 1879–1893 emigration peaked. The economic recession, which struck both the Swedish iron trade and the agrarian sector, was a prime reason. About 40% of the overseas emigration between 1845–1930 took place during this period. An economic improvement in Sweden contemporary to an American recession contributed to cut the rates in the years 1894–1900.

From the beginning, family emigration dominated. In the 1840s, almost 70% of the Swedes arriving in New York could be classified as family emigrants. This percentage constantly fell to 29% in the 1890s and around 25% in the early decades of the twentieth century. One reason for this shift was that the supply of cheap land in the United States diminished as the frontier moved westwards. The possibilities to emigrate in order to acquire land and start a new life for the whole family in North America became smaller. Instead, the main reason was to find better paid jobs than in Sweden. Emigration took the character of a transatlantic labour migration in which return migration often occurred. The shift from family to individual emigration almost entirely happened among emigrants from rural areas, and primarily from the big emigration districts in Småland, Östergötland, Västergötland and Värmland.

Another major shift in the late nineteenth century also had connections to the rural areas. The importance of emigration from these districts diminished, whereas the urban and industrial share increased. For instance, in the years 1891–1893, Stockholm witnessed its highest emigration totals during the whole period. During the latter part of the emigration era urban and industrial areas in general contributed more emigrants than earlier. From the 1840s to 1930, most emigrants represented agriculture, but viewed against the background of the agricultural sector's over-representation among the population of Sweden, the sector can hardly be viewed as being more represented than industry and crafts.

Emigration increased again after the turn of the century. The extension of military service in 1901 has been used as one explanation even if labour market factors and overpopulation probably were more important. Emigration rates remained high until 1908. After a short decline, they increased again due to unrest on the labour market in Sweden culminating in the Great Strike of 1909. These were two push factors, whereas a relatively good American economy was a pull factor before World War I.

The war made emigration go down, but it was not entirely stopped. The last peaks occurred in 1923 and 1924 perhaps due to the economic recession in Sweden in the early 1920s. The number of emigrants exceeded 25.000 and the Canadian share was more significant than earlier. When the economic curves pointed upwards again emigration rates declined and the recession around 1930 reduced job opportunities in North America. In the 1930s, the Swedish immigration rates were higher than emigration. The era of mass emigration to North America was over.

Swedish settlement and life in North America

The main area of settlement for the early emigrants was the mid-west. According to geographer Helge Nelson's calculations, more than 75% of the Swedes were residing there in 1880. Illinois accounted for 22% and Minnesota 20%. About 15% lived in the North East. This share increased to 23% in 1900, whereas that of the mid-west had decreased to 64%. Minnesota was now the most Swedish state, still on 20%, whereas Illinois had dropped to 17%. Thus, the Midwest states lost some of their status as prime destinations over time but remained the most significant partly because of the importance of the early settlement.[56]

Over time the emigration to urban and industrial centres in the United States increased. The most important of these settlements was Chicago. Many Swedes settled in the city and a substantial Swedish enclave was formed. In 1890, the Swedes represented about a tenth of Chicago's immigrant population and only the German and the Irish were more numerous among the immigrant groups. In 1900, Stockholm was the only city in the world with a larger Swedish population than Chicago, which had about 50.000.[57] During the emigration era, Chicago's Swedish population was twice, and occasionally even three times, as high as New York City's.[58]

The studies of Swedish life in the United States and to some extent in Canada have been numerous.[59] The anthologies about Swedish-America's two major metropolises, Chicago and the Minneapolis/St. Paul area, included articles about theatres, artists, labour, politics, education and lodges. Per Nordahl's studies have revealed that there also were radical political societies, temperance movements, labour unions as well as several provincial societies in Chicago.[60] As we shall see in next chapter, there were also societies for Swedish engineers in the United States.

Notes

1 This part is based on L Magnusson 2002, 359-374, 377-380; L Schön, 220-226, 241-251, 287-314, 341-343, 348-358.

2 L Schön, 225.

3 L Magnusson, 2002, 363.

4 L Schön, 273.

5 Quoted from M Fridlund, 40-41.

6 Svenbjörn Kilander, *Den nya staten och den gamla. En studie i ideologisk förändring* (Uppsala, 1991), 21-22; N Runeby 1978, 25.

7 Svenbjörn Kilander, ”Staten byter ansikte: Statsuppfattning och samhällssyn 1860-1910” in *Byråkratisering och maktfördelning,* eds. Torsten Nybom & Rolf Torstendahl (Stockholm, 1989), 178.

8 Gunnar Eriksson, *Kartläggarna. Naturvetenskapens tillväxt och tillämpningar i det industriella genombrottets Sverige* (Umeå, 1978), 197-199; Sverker Sörlin, *Framtidslandet: debatten om Norrland och naturresurserna under det industriella genombrottet* (Stockholm, 1988), 97.

9 S Sörlin 1988, 97

10 S Sörlin 1988, 9.

11 M Fridlund, 41.

12 A Elzinga, A Jamison & C Mithander, 131-132; M Fridlund, 41; N Runeby 1978 22-25; S Kilander 1991, 214; L Magnusson 2002, 382-383. The debate on customs duties in the 1880s has often been seen as a watershed between the restrained and the intervening state. The opportunities for the Swedish state to intervene in private business before the 1880s were, according to Kilander, principally closed even if it is not possible to speak about a totally passive state. Magnusson claimed that the state had been more or less interventionist all through the nineteenth century and that it is not appropriate to draw a sharp line between two such periods, but that it probably was true that it was more ideologically important to hold public and private apart before the 1880s. How strong the “shift” really was can thus be discussed, but it is possible to claim that a shift in the view of state intervention occurred and the spirit became more positive.

13 M Fridlund, 41, W W Rostow, 25-26.

14 M Alm, 89-90, 115-117; A Elzinga, A Jamison & C Mithander, 131-132; M Fridlund, 41; N Runeby 1978, 22-25.

15 M Alm, 110-111.

16 Kurt Genrup, ”’Förtyskningen av Sverige’ av Sverige som etnologiskt forskningsfält” in *”Förtyskningen” av Sverige. Tvärvetenskapligt symposium vid Etnologiska institutionen, Umeå universitet, den 26 oktober 1993,* ed. Kurt Genrup (Umeå, 1994), 9.

17 N Runeby 1997, 226.

18 N Runeby 1997, 222.

19 H Lindblad 1995, 102, 184

20 Cladius H. Riegler, ”Från August Palm to Jürgen Habermas: Impulser från Tyskland till svenskt arbetsliv” in *Förtyskningen av Sverige,* 68-71.

21 Also see H A Barton 1994.

22 M Alm, 87-88.

23 M Alm, 88.

24 M Alm, 135-141.

25 M Alm, 312.

26 L Schön, 213.

27 B Berner 1981, 207; R Torstendahl, 14.

28 B Berner 1981, 204; B Berner 1996, 45-46, 56, 84, 108-109; B Sundin 1981, 63-64.

29 B Berner 1981, 207-208; B Berner 1996, 44-45; B Sundin 1981, 65-66; B Sundin 1991, 254-255.

30 Quoted from B Berner 1996, 43. Swedish original: "till skeppsvarf och verkstäder i Amerika, till järnvägsbyggnader i Ryssland och laboratorier i Zurich, till ritkontors jorden rundt".

31 B Berner 1996, 43; Mats Lindqvist, *Herrar i näringslivet. Om kapitalistisk kultur och mentalitet* (Stockholm, 1996), 46-47; G Stang, 25.

32 Quoted from B Berner 1981, 207-208. Swedish original: "Om det är sant att en annan tid har kommit, och att solen börjar dala över juristernas, pedanternas och byråkraternas tidehvarf, är det äfven säkert, att en rangplats i den nya tiden skall intagas af ingeniörerna".

33 B Berner 1981, 232-233.

34 B Berner 1981, 207-208; B Sundin 1981, 65-66; B Sundin 1991, 254-255.

35 B Berner 1981, 217-218; A Johansson 1990, 94-99.

36 A Johansson 1990, 95.

37 B Berner 1981, 208-215; B Sundin 1981, 64-82; Arne Kaijser: "Ingenjörer i takt med tiden?" in *Vad är en ingenjör?,* ed. Ingela Björck (Linköping, 1998), 38-39.

38 N Runeby 1997, 223-224.

39 R Torstendahl, 38-39. France was also a major source of inspiration at that time. For more on the history of technical education in Sweden, see S Carlsson 1991; 181-182; N Runeby 1976; R Torstendahl, 38-43.

40 Ruth Schwartz Cowan, *A Social History of American Technology* (New York, NY, & Oxford, 1997), 141; Samuel Haber, *Effiency and Uplift. Scientific Management in the Progressive Era 1890-1920* (Chicago, IL. & London, 1964), 8-11; John M. Jordan, *Machine Age Ideology. Social Engineering and American Liberalism, 1911-1939* (Chapel Hill, NC, & London, 1994), 20; Terry S. Reynolds, "The Engineer in nineteenth-Century America" in *The Engineer in America. A Historical Anthology from Technology and Culture,* ed. Terry S. Reynolds (Chicago, IL, & London, 1991), 25-26.

41 B Berner 1981, 235.

42 Terry S. Reynolds, "The Engineer in twentieth-Century America" in *The Engineer in America. A Historical Anthology from Technology and Culture,* ed. Terry S. Reynolds (Chicago, IL, & London, 1991), 178.

43 B Berner, 1981 235-237; A Johansson 1990, 94.

44 Pär Eliasson, "Svenska studenter i Tyskland 1372-1800" in *"Förtyskningen" av Sverige*, 43-65; Sverker Sörlin, *De lärdas republik. Om vetenskapens internationella tendenser* (Malmö, 1994), 121-132.

45 Eric Engström, *Bokbindargesällen Karl Stellan Söderströms gesällvandring 1843-1858. Lärande i skråväsendet speglat i personliga dokument* (Stockholm, 1995), 93.

46 E Engström, 93; C H Riegler 1994, 69-71; Claudius Helmut Riegler, *Emigration und Arbeitswanderung aus Schweden nach Norddeutschland 1868-1914* (Neumünster, 1985); Agnes Wirén, "Den glömda utvandringen i nytt perspektiv. Om svenska invandrare i Danmark och Tyskland" in *Över gränser. Festskrift till Birgitta Odén,* ed. Ingemar Norrlid (Lund, 1987), 466-469.

47 S Rydberg 1951, 100-138, 202-343, 412; Hanna Hodacs, *Converging World Views. The European Expansion and Early-Nineteenth-Century Anglo-Swedish Contacts* (Uppsala, 2003), especially 143-145.

48 C H Riegler 1994, 71.

49 E Lange, 2-3.

50 Kenneth O. Bjork, *Saga in Steel and Concrete. Norwegian Engineers in America* (Northfield, MN, 1947), 35-38; S Carlsson 1991, 182; Dudley Baines, "European emigration, 1815-1930: looking at the emigration decision again" in *Economic History Review,* XLVII, 3, 1994, 533-534.

51 G Stang, 25.

52 E Lange, 2.

53 R Torstendahl, 45.

54 G Stang, 25.

55 The part was based on S Carlsson 1976, 114-132.

56 Helge Nelson, *The Swedes and the Swedish settlement in North America,* I and II (Lund, 1943); Hans Norman, "Swedes in North America" in *From Sweden to America,* 241-247; Per Nordahl, *Weaving the Ethnic Fabric: social networks among Swedish-American radicals in Chicago, 1890-1940* (Umeå, 1994), 33.

57 H Norman 1976, 252; Philip J. Anderson & Dag Blanck, "Introduction" in *Swedish-American Life in Chicago,* 2.

58 S Carlsson, 1991, 185; B Bodén, 271.

59 See for instance Ulf Beijbom, *Swedes in Chicago: a demographic and social study of the 1846-1880 immigration* (Uppsala, 1971); Dag Blanck, *Becoming Swedish-American : the construction of an ethnic identity in the Augustana Synod, 1860-1917* (Uppsala, 1997); Dag Blanck, "Constructing an Ethnic Identity: The Case of the Swedish-Americans" in *The Ethnic Enigma. The Salience of Ethnicity for European-Origin Groups,* ed. Peter Kivisto (Philadelphia, PA, London & Toronto, ON, 1990), 134-153; Lars Ljungmark, *Svenskarna i Winnipeg: porten till prärien 1872-1940* (Växjö, 1994); P Nordahl 1994; Per Nordahl, "Bland främlingar och norrlänningar i Chicago" in *Hembygden & Världen. Festskrift till Ulf Beijbom,* eds. Lars Olsson & Sune Åkerman (Växjö, 2002); Per Nordahl, "Lost and Found – A Place to Be: The organization of provincial societies in Chicago from the 1890s to 1933" in *Swedishness Reconsidered*), 65-91; Anita R. Olson, "A Community Created: Chicago Swedes, 1880-1950 in *Ethnic Chicago. A Multicultural Project.* Fourth Edition, eds. Melvin G. Holli & Peter d'A. Jones (Grand Rapids, MI, 1995), 110-121; Robert Clifford Ostergren, *A community transplanted: the trans-Atlantic experience of a Swedish immigrant settlement in the Upper Middle West, 1835-1915* (Madison, WI, 1988); Carina Rönnqvist, "Bröder och rivaler: svenskarna, norrmännen och den skandinaviska identiteten i Canada, 1905-1945 in *Hembygden & Världen,* 329-344; Lars Wendelius, *Kulturliv i ett svenskamerikanskt lokalsamhälle: Rockford, Illinois* (Uppsala, 1990); *Swedes in the Twin Cities: immigrant life and Minnesota's urban frontier,* eds. Philip J. Anderson & Dag Blanck (Uppsala & St. Paul, MN, 2001); *Swedish-American Life in Chicago. Cultural and Urban Aspects of an Immigrant People, 1850-1930,* eds. Philip J. Anderson & Dag Blanck (Uppsala & Minneapolis, MN, 1991); *Swedishness Reconsidered. Three Centuries of Swedish-American Identities,* ed. Daniel Lindmark (Umeå, 1999).

60 P Nordahl 1994; P Nordahl 2002, 235.

3. EMIGRATION AND RETURN MIGRATION OF SWEDISH ENGINEERS

> Now the matter is this: come over at once, without waiting any more time in Europe. There is nothing to be got there, everything here. You better start with the idea, that you will never go back except for a visit I never saw a sensible man, who had lived a few years in the United States, willing to go back to Europe to stay. [1]

The German-born[2] engineer Charles P. Steinmetz knew where the future for European engineers lay.[3] In his letter from 1895 to his Swedish colleague Eskil Berg, he clearly stated his opinion: it was without any doubt in the United States. Steinmetz, who later became the technical director of General Electric's Consulting Engineering Department and made many important technical contributions to the company, saw a good career lying ahead of him in the United States and this convinced him to stay rather than return to Europe for permanent settlement.[4]

Eskil Berg followed Steinmetz's advice and settled permanently in the United States but this was far from the most common practice among Swedish engineers either in Schenectady or anywhere else across the country in the decades around 1900. To a large extent, the migration of Swedish-born engineers was a two-way movement, conforming to the patterns Wyman described for many late nineteenth and early twentieth century European emigrants to the United States.[5] The emigration of Swedish engineers was, in many cases, a migration in order to accumulate knowledge – comparable to what Bourdieu has called "symbolic capital" – to use for a future career back in Sweden. Hypothetically, the knowledge the emigrating engineers had accumulated abroad could compensate for the initial loss that industrialising Sweden suffered when they emigrated.

People following the present day public debates ought to recognise some of the issues mentioned above, particular the idea of a "brain-drain": for this has currency in early twenty-first-century Sweden. Debates currently rage about the danger of well-educated Swedes emigrating to seek employment or study abroad. On January 19, 2001, the newspaper *Svenska Dagbladet*'s editorial page warned about the dangers of "brain-drain" and stated that about 1% of all university-trained engineers living in Sweden leave the country on a yearly basis.[6] During the years 1996–1998, the emigration of university-trained engineers corresponded to barely 27 % of the number of examinations for the same years.[7] In 1994, 6 % of the university-trained engineers with a degree from Sweden in 1990 lived outside the country's borders. During the years 1990–1998, almost half of the Swedish-born university trained engineers who emigrated during this period had returned before 1999.[8] Having this in mind, it is interesting to study how the patterns of emigration and return migration of engineers from Sweden during the period of the large-scale Swedish industrialisation differed from present day patterns.

3.1. Emigration and return of Swedish engineers in shares and numbers

Is it possible, then to say in a comparative perspective that Sweden is suffering more from emigration of engineers today than in the decades around the turn of the last century? Table 3:1 gives rates of emigration and return before 1930 as well as rates of engineers with foreign experiences working in Sweden.

TABLE 3:1: Emigration, study trips and return migration of Swedish-born engineers who graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ, 1880–1919 and emigrated and returned before 1930 (TESM before 1928).

CATEGORY	**N / %**
ALL GRADUATES, 1880–1919	5994
Emigration in numbers	2331
Emigration in %	38,9
Emigrants including study trips in numbers	2877
Emigrants including study trips in %	48,0
Return in numbers	1660
Return in %	71,2
Return including study trips in numbers	2206
Return including study trips in %	76,7
Engineers who never emigrated from/returned to Sweden in numbers	5323
Engineers who never emigrated from/returned to Sweden in %	88,8
Emigration experiences of engineers working in Sweden in %	31,2
Foreign experiences of engineers working in Sweden in %	41,4

SOURCES: *Chalmers Tekniska Institut 1829–1929. Matrikel,* ed. Gösta Bodman (Göteborg, 1929); *Porträttgalleri och medlemsförteckning över tekniska föreningen i Örebro år 1925,* ed. Emil Forsberg (Örebro, 1925); *Bergsskolans i Filipstad elever 1830–1930,* ed. Govert Indebetou (Filipstad, 1931); *Bergsskolans i Falun lärare och elever 1871–1930,* ed. Govert Indebetou (Filipstad, 1949); *Svenska Teknologföreningen 1861-1936. Biografier,* 2 volumes, Govert Indebetou & Erik Hylander (Stockholm, 1937); *Katalog över ingenjörer utexaminerade från Chalmers Tekniska Institut samt Chalmersska Ingenjörsföreningens aktiva medlemmar* 1928–1930; *Malmö Teknologförbund. Minnesalbum utgivet i anledning av Malmö Tekniska Läroverks 75-åriga verksamhet 1853–1928* (Malmö, 1928); *Tekniska föreningen i Örebro. Medlemsförteckning.* 1926–1927, 1931.

The statistics indicate that Sweden's position now is hardly comparable to the decades around the turn of the last century, at least not in a proportionate context. A significantly higher percentage of Swedish engineers left the country to take on employment and/or study abroad before 1930 than is the case today. In the long run, Sweden lost almost a tenth of the engineers who graduated from KTH and the five other technical institutes between 1880-1919. However, the process of emigration of engineers could have been useful for Sweden in the era of industrialisation. As we can see, barely one-third of the engineers working in Sweden between 1880–1930 had experiences of employment outside the country's borders and if we also include study trips as foreign experiences, the rate increases to slightly over 40 %. It is difficult to measure the long-term loss against the "gain" in form of these foreign experiences. However, it is one assumption that the presumptive economical loss Sweden suffered from "only" keeping 89 % of the engineers the country had educated was compensated for by the fact that around one third of them had worked abroad.

The Swedish engineers were to a large extent internationally oriented during the decades around the turn of the last century. This is in line with what Stang has stated was characteristic for the engineers from Sweden, Norway and Denmark.[9]

There are even reasons to believe that the real emigration rate was somewhat higher than the 39 % noted for the whole population as some engineers may have given the information to the authors of the directories that they were study travelling even if they had employment abroad, something that would make them be regarded as emigrants in accordance to the classification used in this study. One thing pointing in that direction is the fact that among engineers who were included in more than one directory, one may have stated for instance "study travelling in America" from one year to another, while the other may have given the information that the time in the United States included employment. It is, however, safe to assume that many of the engineers who only gave the information that they were study travelling during a certain time period also had employment. The fact that they often used this classification themselves may understate the emigration rate as this study follows the classification previously described, in which engineers who had employment or undertook longer university studies while abroad are regarded as emigrants. The floating borders between emigration and study travelling cause some uncertainties that need to be considered when discussing the emigration rates. What we can safely conclude however is that it is not a question of an over-estimation of the international migration streams. We do know that the emigration rate lay on at least 39% for this cohort and this was a considerably high rate compared to today's situation.

International destinations of Swedish engineers, 1880–1930

The United States' and Germany's rise as industrial models in Sweden, as well as the transatlantic mass emigration contributed to the dominance for these two countries as destinations for the Swedish-born engineers. This is shown in table 3:2.

TABLE 3:2: Emigration and return migration of Swedish-born engineers who graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ, 1880–1919 and emigrated and returned before 1930 (TESM before 1928). Includes all engineers who worked/studied one or more time in a country.

Destination Country	**Emigrants**	**% of emigrants (N=2331)**	**% of graduates (N=5994)**	**Returnees**	**% Return**	**% of "kept"/repatriated (N=5323)**
United States	1110	47,6	18,5	651	58,6	12,2
Germany	683	29,3	11,4	602	88,1	11,3
Great Britain	229	9,8	3,8	169	73,8	3,2
Norway	157	6,7	2,6	131	83,4	2,5
Russia	150	6,4	2,5	119	79,3	2,2
Finland	133	5,7	2,2	99	74,4	1,9
France	105	4,5	1,8	82	78,1	1,5
Switzerland	80	3,4	1,3	76	95,0	1,4
Canada	74	3,2	1,2	51	68,9	1,0
Argentina	53	2,3	0,9	22	41,5	0,4
Denmark	52	2,2	0,9	46	88,5	0,9
Belgium	50	2,1	0,8	34	68,0	0,6
Austria	34	1,5	0,6	28	82,4	0,5
Spain	33	1,4	0,6	19	57,6	0,4
Brazil	29	1,2	0,5	10	34,5	0,2
China	25	1,1	0,4	15	60,0	0,3
Japan	23	1,0	0,4	8	34,8	0,2
Mexico	22	0,9	0,4	13	59,1	0,2
Italy	22	0,9	0,4	10	45,5	0,2
Australia	19	0,8	0,3	8	42,1	0,2
South Africa	18	0,8	0,3	12	66,7	0,2
Poland	16	0,7	0,3	9	56,3	0,2
"South America"	14	0,6	0,2	9	64,3	0,2
Latvia	13	0,6	0,2	11	84,6	0,2
Chile	13	0,6	0,2	2	15,4	0,0
Czechoslovakia	11	0,5	0,2	7	63,6	0,1
India	10	0,4	0,2	4	40,0	0,1

8 emigrants: Netherlands, 7. Estonia, 6: Hungary and Peru, 5: Bolivia, Colombia, Turkey and Yugoslavia, 4: Iran, Malaysia and Uruguay, 3: "Africa", "Europe", Algeria, Cuba, Indonesia, Luxembourg, Panama, Philippines, 2: "Asia"; Burma, Dominican Republic, Greece, Iceland, Madagascar, New Zealand, Paraguay, Portugal and Romania, 1: "Central America", Bulgaria, Central African Republic, Ecuador, Egypt, Ghana, Greenland, Honduras, Hong Kong, Iraq, Ireland, Jamaica, Kenya, Mongolia, Morocco, Namibia, Puerto Rico, Singapore, Thailand and Venezuela. There were 20 emigrants going to "unknown" destination.
SOURCES: see table 3:1.

As we can see, almost half of all emigration of Swedish-born engineers from 1880 to 1930 was bound for the United States, but the dominance of the United States as destination was not nearly as big as it was for "common" emigrants.[10] The return rate for the United States was approximately 60 %, and this means that about every eighth (12,2 %) engineer working in Sweden in this cohort had experiences from American working life and industry. The return rates were generally lower from overseas destinations than from Europe. For example, 88 % returned from Germany. The lowest return rates were to be found from some South American and Asian destinations keeping in mind that the rates were calculated on small cohorts of emigrants. In this context, distance seems to have had some influence, as return – despite the transport revolution – was easier from nearby countries. Thus the return migration pattern showed some correspondence with a hypothesis developed by the Swedish historian Sune Åkerman and used by Virtanen in his dissertation on Finnish overseas return migration 1860–1930. Åkerman assumed that re-migration was more likely to occur the shorter the distance between the place or area of departure and destination. Virtanen found that the hypothesis held true for Finns going to the United States as the return migration to Finland was higher from the eastern parts of North America than from the western.[11] For engineers and other emigrants from Sweden it was easier to return from Germany, as Sweden was only some day away.

Another factor could also be important: the fact that the emigration to Germany was to a large extent based solely on gaining experiences. In contrast, the reasons for emigration to the United States were twofold: one stream had more in common with the stream of engineers to Germany and the other more with the general emigration stream to North America. Furthermore, even if Germany was geographically close, the country did not receive any mass emigration streams from Sweden

However, Germany's second place in this list of destinations was as clear as the United States' first. Almost 30 % of the emigrating Swedish engineers worked or studied in Germany at least once. Every ninth engineer (11,3 %) in the cohort who later worked in Sweden had experiences from work or studies in Germany. In this quantitative context, Germany was almost as influential as the United States. In Table 3:3, Canada has been added to the United States whereas Switzerland and Austria have been added to Germany. If this creation of a North American sphere and a German-speaking sphere[12] is used, we end up at almost the same number of returnees and the same percentage of engineers with "German" and "North American" experiences in Sweden. It is thus clear that the "influence" through return migration in this quantitative context did not stand in proportion to the initial "loss" on destination level. Sweden lost more engineers to North America than to the German speaking countries in Europe, but more engineers came back from the latter region.

TABLE 3:3: Emigration to, and return migration from, North America and Germany/Austria/ Switzerland of Swedish-born engineers who graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ, 1880–1919 and emigrated and return before 1930 (TESM before 1928).

Destination	Emi N	%	Return N	%	Experienced %
United States/Canada	1131	48,5	666	58,9	12,5
Germany/Austria/Switzerland	753	32,3	668	88,7	12,5

SOURCES: see table 3:1.

Thus, Germany primarily functioned as a pull-factor besides the United States. As we can see in Table 3:4, 70 % of the emigrating Swedish engineers went to one of these countries. All in all, a total 27 % of all the Swedish-born graduates went to Germany and/ or the United States. Almost 70% of them returned, and we find that a little more than every fifth engineer working in Sweden 1880–1930 had working experiences from one of these "model" countries. It indicates that impulses from the United States and Germany were important in the large-scale industrialisation of Sweden, even though one would perhaps have expected a higher share of engineers than the 7% of the emigrants going to work in both countries.

TABLE 3:4: Emigration to, and return migration from, the United States and Germany of Swedish-born engineers who graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ, 1880–1919 and emigrated and return before 1930 (TESM before 1928).

Destination	Emi N	%	Return N	%	Experienced %
United States and/or Germany	1622	69,8	1123	69,2	21,1
Both countries	159	6,8	117	73,6	2,2

SOURCES: see table 3:1.

In several letters in Edström's collection written to him by engineers in the United States they stated that they clearly aimed to return to Sweden even though they also expressed a desire to study or work in Germany before they returned. One example was the letter the electrical engineer Ture Steen wrote to Edström in 1904. Steen was twenty-four years old when he finished a stay in the United States that included employment at General Electric and an electrical railway company in Los Angeles. The rumour that Steen was to come back to Europe reached ASEA and Edström made perhaps what he thought was an irresistible offer of employment to him. This was how Steen responded:

> I must deeply regret, Mister Director, that it is impossible for me to accept your kind offer in the nearest future, because I think I am too young and inexperienced to be able to fulfil such a place you are offering me in a worthy manner. My intention is however, before I settle in Sweden, to complete my two years of valuable American practise with 3 or 4 years of equally valuable practise in Germany, and after that I would most certainly be more mature for successful work in my own native country, where the railway problem still awaits its "electrical solution". [13]

ASEA was an attractive work place for Swedish electrical engineers and it must have been the same for Steen. He was in his early twenties, and a life-long career awaited him. Steen's aim was clearly to return to Sweden sooner or later but his answer to Edström gives us an example of the spirit among Swedish engineers at the time. It seems, however, that engineers rarely realised plans to go and work in both these countries. As a matter of fact, Steen did not either. He had difficulties to find employment in Germany and decided instead to go to Switzerland and take employment at *Maschinenfabrik Oerlikon.* One reason for this pattern may be more cautiousness among German companies than among American at least within the electro-technical field. In his letter, Steen asked Edström for a letter of recommendation for him to use at the German companies and Edström later responded that it was almost impossible for him to write such a letter, as they would suspect that Steen was on a kind of espionage mission from ASEA. In the same letter Edström acknowledged that it was a clever decision by Steen to work for some years in Germany before his return.[14] He was hardly disappointed at Steen's rejection and it was not this that made Edström deny Steen the letter. In the electro-technical field, the German companies were ASEA's main competitors, and therefore it was probably more difficult to get employment in Germany.[15]

Countries all over the world attracted engineers from Sweden. The old "model" country of Britain held a position as the third most common destination for Swedish engineers until 1930. The neighbouring countries attracted a comparably high number of Swedish-born engineers, and so did continental destinations such as France and Switzerland as well as Russia. All in all, we find a total of 73 countries where the engineers worked or studied. Outside of Europe, they included for instance almost all South American countries, antipodal destinations as Australia and New Zealand as well as several destinations in South-East Asia. The conclusions of an access to a worldwide labour market for engineers certainly hold true. These educated Swedish men had access to a much larger geographical area where they could exercise their occupation than people with other educations and non-educated people during the same period.

3.2. Reasons for Emigration and Return

"Traditional" emigration

The evidence thus far presented makes it clear that emigration and study-travel were cornerstones of many engineering careers around 1900. No other well-educated group of people was as geographically mobile as the engineers.[16] A few explanations to the emigration pattern of engineers are necessary and can be outlined. For some engineers, emigration was a necessity as it sometimes was impossible to get employment in Sweden and sometimes the only opportunities concerned low-paid jobs.[17] Naval architect Hugo Hammar was such a case. Hammar graduated from CTI in 1888 and decided to go to Britain when he could not get employment in Sweden. Hammar was offered employment at Palmer's shipyard in Jarrow close to Newcastle-upon-Tyne. His stay on the south banks of the

Tyne, in one of the world's premier shipbuilding regions, was viewed primarily as an opportunity to find paid work. Hammar to some extent re-valued his years at Palmer's in his memoirs written fifty years later.[18]

Hammar's case is interesting as he largely fulfilled more than one of the reasons for emigration of engineers. In 1890, he got an offer from a shipyard in Boston and a possibility to participate in the construction of a cruiser for the American navy. It was an old dream coming true. Hammar revealed how as a little boy he stood on his native island of Öland yearningly looking westwards towards the United States – a place where many people from the province already had gone and become successful.[19] Hammar wrote: "It was however not an ordinary emigrant, who went out at a venture, but a completed engineer, who now was about to reap the fruit of his studies". [20]

Even if Hammar stated that we should not look at him as an ordinary emigrant, his childhood memories from Öland certainly remind us of one. The mass emigration from Sweden led to the occurrence of a public network between Swedes on both sides of the Atlantic and to the establishment of emigration traditions in Sweden.[21] Olsson assumed that Hammar must have witnessed people leaving for North America, both as a child on Öland and as a student in the nearby mainland town of Kalmar in the 1870s and 1880s. Kalmar was one of the ports of departure for late nineteenth century emigrants.[22] The general "America fever" was a factor that also influenced the engineers. Whereas most emigration of engineers was for "educational" purposes where an intention to return was included in the very decision to emigrate, a smaller share of the emigration is also to be regarded as more or less "common". One indication is the already mentioned diverging return rates for engineers who had been working in Germany and the United States. Germany was not a significant destination for Swedish emigrants in general and the registered emigration between 1861 and 1915 consisted of about 29.000 persons.[23] Only 8 % of the Swedish engineers that ever worked in Germany finally settled there whereas the corresponding share for the United States was 41%.

Swedish engineers in the United States

Many Swedes resided in the United States and there were Swedish cultural and provincial societies as well as engineers' societies that facilitated the engineers' assimilation. The engineers diverged from the general emigration pattern of Swedes going to North America and Carlsson calculated that Chicago received 237 Swedish engineers, and New York City received 335.[24] However, the engineers still were a part of the urban and industrial immigration to the United States. Their destinations differed because of their specialist competence. The extensive Swedish community in the United States made a difference to Germany. The United States received close to 994.000 emigrants from Sweden 1861–1915.[25] Even if there were Swedish clubs to join in some larger cities in Europe, the opportunities to socialise were greater in the United States, and especially in areas with large Swedish populations.

Thus it was possible for many emigrants to have a social life in the United States that included other Swedes as well as cultural activities that were of Swedish character. In his study of Norwegian engineers going to the United States, Bjork stated that they could step right into a well-organised Norwegian life.[26] The same held true for their Swedish colleagues. This life could also include membership in an engineers' society. In order to describe this pattern and thereby make the point about two-fold character of the engineers' emigration to the United States, the Swedish Engineers Society of Chicago will be used as an example.

The Swedish Engineers' Society of Chicago

In 1888, a nation-wide Swedish engineering organisation was formed in New York. The membership peaked at more than 500 members in 1928. There were also Swedish engineering societies founded in Chicago, Detroit, Philadelphia, Worcester in Massachusetts and probably also in other cities. In Schenectady there was a Scandinavian society where most of the Swedish engineers were members.[27]

In Chicago, a Swedish engineers' society existed already at the time for the World Exhibition in 1893. It was more or less based on visitors to the exhibition and the engineers remaining in Chicago afterwards were not able to sustain it. Around 1903 a new society was formed and it was decided that the base should be Scandinavian in order to make it stronger. However, the tensions surrounding the dissolution of the union between Sweden and Norway in 1905 had an impact on the possibilities to hold the society together and in the beginning of October 1908, twenty Swedish members announced their resignation from it and formed an exclusively Swedish society the following week.[28]

The new society had several purposes: professional, educational, ethnic, cultural and social. The weekly meetings included social functions, holiday celebrations as well as educational and informational programmes. The society also functioned as a kind of employment clearinghouse, especially for the newly arrived. Meeting rooms were used for food, socialising, relaxing and reading. The society also hosted a library with a variety of literature mostly on engineering topics.[29] The function of the engineers' societies as employment clearinghouses probably had a facilitating factor for the Swedish engineers in order to get employment when they had arrived in the United States. It probably had the same function as the Norwegian club of Chicago according to Bjork a place where a newly arrived engineer could go and meet old friends from the technical schools in Norway as well as establish the necessarily contacts for employment and social life.[30] The engineers' societies could, therefore, in the long run also facilitate technology transfer even if, as we soon will discuss, there are reasons to call into question whether the societies, or at least the one in Chicago, really were spurring factors for return migration.

These functions revealed above made the society in many ways a typical organisation within the larger Swedish-American context. In other ways it was exceptional. It was a professional organisation not based on provincial origin, religious or political views. In the society's publication *Trasdockan* (The Rag Doll) from 1923 it was stated that if the society was only technical it had no justification, as there were several other engineer's societies in Chicago. The same held true if the society only had been Swedish. Chicago consisted of a variety of Swedish associations. It was only by being both technical and Swedish it could justify itself.[31]

Trasdockan was to a large extent devoted to the preservation of the ethnic awareness but also to foster assimilation in the American society. To celebrate the ethnic origin was a mean for assimilation, a way to become Swedish-Americans.[32] In the miscellany in honour of the society's twenty-fifth anniversary in 1933 it was stated that the persons who had run the society ever since the start were men who thought that a Swedish-American was to be "hundred percent American among Americans and hundred percent Swede among Swedes".[33] It was also stated about the society's meeting place that they had tried to create a "Swedish home" for themselves and that this ought to be obvious for anyone who stepped in at the Dewes mansion on 503 Wrightwood Avenue.[34] In *Trasdockan* from 1923 the readers were told about the place, where two Swedish flags flanked an American over the main entrance. They symbolised the childhood and the youth, their life as adult engineers in the United States, but also a distant future when they were to enjoy the autumn of their life back in the native country.[35]

These attitudes seem to have been the core of the society. In the speech held by chairman Albin G. Witting at the celebration of the twentieth anniversary in 1928, the same emphasis on celebration of the ethnic origin in order to become the best of Americans was present. Witting stated: "We are getting better Americans, the more consciously Swedish we are".[36] The speaker also referred to the members as American citizens and he stated: "We have come here of our own free will, we have found our way about, and we have acclimatized".[37] Witting stated that the members were grateful to the United States for what it offered the engineers, and he also claimed that the country really had become "the land of unlimited opportunities" for some of them.[38] It seems clear that Witting did not consider himself speaking in front of an audience of potential return migrants. In the 1920s, Witting became chairman of *Svenska Kulturförbundet i Amerika* (the Swedish Cultural Society of America). This organisation claimed that every Swedish-American had a duty towards the United States to become members. The goal was to unite all Americans of Swedish origin in a work for "true Americanism" through the preservation of Swedish language and culture. Through a rise of the Swedish name a sense of responsibility arose that led to them becoming "better Americans".[39] The goals of the two organisations were to a large extent mutual.

Despite this focus, many society members probably planned to return, but it is more debatable whether in most cases it was a return that aimed to employment in Sweden and it is not possible to state that the society spurred return migration. It was more directed towards the assimilation process through the celebration of the ethnic origin. It has been concluded, for instance by the Swedish historian Dag Blanck as well as a group of American historians including Kathleen Neils Conzen and Rudolph J. Vecoli, that ways to celebrate ethnic origin in the American context included an emphasis of the contributions of the ethnic group to the American society. Italians tended to emphasize Columbus, whereas Swedes and other Scandinavians wanted to put Leif Eriksson in the forefront, as well as the protection of religious freethinkers in the New Sweden colony in the seventeenth century. The engineer John Ericsson was another important person for the Swedes. His construction of Monitor led to the Union victory in the Civil War, which was the base for the United States known by early twentieth century Swedish immigrants.[40] The unveiling of the John Ericsson Memorial in Washington, DC, in 1926, was celebrated in *Trasdockan* and John Ericsson's importance in American history was discussed. Other ways to celebrate the ethnic origins were, for instance, the nostalgic poems, greetings and articles about the native country that often appeared in *Trasdockan*.[41] The poems played as

Nordstrom has stated "upon the noncontradictory themes of ethnic identity and Americanization".[42] It was an overall tendency to romance Sweden but the poems and texts were almost never advocating return migration unless it was for retirement.

The last president of the society, John E. Jacobson, stated that it was rare that society members had an aim to go back to Sweden during his period as member from the 1930s onwards. It further underlined the unusualness of return migration among the society's members.[43] The society remained exclusively Swedish all through the emigration period but due to diminishing membership it accepted members without any connections to Sweden in the 1950s and 1960s. According to the society's President between 1967 and 1974, Reno Ahlgard, the Swedish language was still spoken besides English when the society met during those years.[44] The main focus of the society, thus, seems continuously to have been to foster assimilation in American society.

Keeping in mind that Jacobson referred to a later period than what is in focus of this study, return migration seems not to have been the common practice in earlier periods of the society's existence either. Among the persons who joined the society between 1909 and 1913, only 18% later returned to Sweden. Most of these people were still in Chicago (65%) ten years after they had joined the society; some had migrated to other places in the United States (15%), and a minority (2%) had moved to another foreign country. This pattern of return migration reminds us more of the general return migration pattern then of the one among engineers. What must be remembered is that many of the members who joined during the society's first years of existence already had been in Chicago for a substantial number of years and were already integrated. Furthermore, the society had several members who were Swedish-born but were educated in the United States and had arrived there as children.[45] The main body of the society's membership consisted of emigrants who had gone to the United States with the aim of settling there permanently. Alternatively there were target migrants fitting Bovenkerk's third category, those with an aim to return who changed their minds and settled for good. Nordstrom's statement that most of the members were educated in Stockholm and Gothenburg and came for temporary work experiences seems to be exaggerated.[46] In some cases it certainly was true, but probably not for a majority of the members. In a speech held in 1946 at the Dewes mansion in front of guests from KTH the city lawyer and society member Carl Hjalmar Lundquist claimed that twenty members over the years had been educated at KTH, but CTI had only contributed seven. These twenty-seven members certainly did not make up a majority. Even if twelve members educated at the lower Technical School in Stockholm were included the statement seems to be far from correct, as 218 members joined the society in the years 1909–1913.[47] Furthermore, the society was not a "purely" engineer's society. Lundquist was a lawyer, and the society also consisted of artists, architects and building contractors.[48]

Many of these persons were prominent in Chicago and well assimilated into American life. In a speech held at the Swedish Engineering Convention in Chicago in 1915, Sweden's minister in Washington underlined that Swedish engineers enjoyed a good reputation in the United States.[49] This probably facilitated occupational careers and became an incentive to settle for good on the other side of the Atlantic. In an article titled *En hälsning from moder Svea* (A Greeting from Mother Svea) and signed SVEA in *Trasdockan* 1913, the author wrote: "In the dream, my thoughts hasten to the main stronghold of Swedishness in America, to Chicago, where the Swedish engineers possess all official positions of importance, where a Swede is minister of justice and a manifold of Swedes are presidents".[50] These kind of statements must be considered cautiously, especially as the author went on to claim that the Swedish language had crowded out other languages in Chicago's schools, monuments were raised over great Swedish men and women and the Swedes were living in magnificent palaces of marble.[51] However, some Swedes and Swedish engineers had high positions in the city. One of them was John Ericson (namesake of Monitor's constructor), who was city engineer in Chicago between 1897 and 1927. He modernised Chicago's water system and built several bridges. Albin G. Witting, previously mentioned, was chief engineer at the Illinois Steel Company. Another member was the building contractor Andrew Lanquist. In 1904, he organised the Lanquist & Illsley Company, which became one of the leading building contractor firms in Chicago. Before that, Lanquist had also erected the Monon Building. The author of the article on architects and builders described this as the first real skyscraper in Chicago in the book issued on the three-hundredth year anniversary of Swedish settlement in the United States.[52] Despite the occasionally exaggerative articles and poems, it is clear that members of the Swedish Engineers' Society of Chicago played, and had played, important roles in Chicago's development, often together with Norwegian colleagues.[53] In a letter written to the chairman of the society in 1943, Fred Erickson, Chicago's mayor Edward J. Kelly wrote:

> I have known your Society long and favourably and regards its membership as being representative of all our city's finest engineering talent. Among your membership during the past 35 years have been men who have brought international fame and attraction to the City of Chicago. [54]

At least Chicago offered a different environment than what Swedish engineers encountered elsewhere, both in other places in the United States as well as in Germany and other countries. Possibly, the Swedish engineers societies formed in cities without an extensive Swedish-American life as in Chicago had other functions and possibly spurred return migration to a higher extent. Also for the target migrants, the encounter with the Chicago environment possibly led them to consider permanent settlement in the United States or at least to postpone the return. Postponements could, in the long run, lead to permanent settlement as the immigrants gradually became more and more assimilated into the adopted country. The role of the extensive myriad of Swedish organisations including those for engineers must be taken into account when the differences between the United States and Germany and target migration is discussed.

However, even if it was not necessarily to happen through return migration, the issue of how Sweden could gain from experiences of Swedish-born in the United States was discussed in the society. In the 1918 issue of *Trasdockan*, the Swedish consul in Chicago, Eric Einar Ekstrand expressed thoughts on this. He actually did mention return migration after employment abroad and studies as immensely important, although he discussed it in a general way and did not refer directly to the society's members.[55]

Hammar is a good example of a combination between a traditional emigrant and an engineer who moved since he could not get employment in Sweden. He revealed how, during his time at Palmer's, he dreamed of doing something great, and most of all he wanted to do it for Swedish naval architecture.[56] Despite his routine work, Hammar claimed he was happy with the stay in the Newcastle area but all the time he dreamed of returning to Sweden. For a while, he did not think that he was able to get employment back home and what was left was to earn enough money to be able to enjoy the autumn of his life there. He claimed that a longer stay in Britain would not enable him to make the appropriate amount of money even if he got an employment as head of a draftsman's office at a shipyard. Therefore, he looked towards Japan and the United States, where the wages were higher.[57]

Hammar can be interpreted as one example of what the Swedish-born engineer Lawrence E. Widmark called an "international engineer". He was a technical astute man who had left his native country in order to engage in engineering work all over the world. Widmark analysed the motives for such a man in a world, which he called self-sufficient and characterised by narrow nationalism. He concluded:

> Is it the lure of gold or other riches that causes a man to leave his native country and spend the rest of his life in some remote part of the globe, enjoying and gloating over an ever-increasing hoard of accumulated wealth? No! It is hardly that. A man, born with the inclination and capacity for solving technical problems, would never be truly satisfied until he reached the proper field of activity for his particular capability. If this is not available in his own country, he had to seek it outside of its border. In all probability, he will thereby do more honor to his native country than if he had stayed at home and languished in surroundings that did not require the very service which he was best able to render. [58]

If we examine return rates, Widmark's generalised statement can be called into question. He described the engineer more in the light of the traditional emigrant leaving the home country in order to settle for good and earn his living in an overseas country far away. In some cases, this was certainly true also for the engineers, but in most cases there are other factors that need to be taken into consideration.

Mats Lindqvist described the culture of the Swedish economic elite as a process mixing identity creation with the gaining of experience. Temporary visits abroad can be viewed as means to become a more mature and responsible man, a typically masculine and elitist process, where experiences of London, Berlin, Zurich or the United States led to a higher status within the limited group. The United States, for instance, was viewed as a "salvation" for the members of the economic elite and as a prototype for every modern individual or nation. A person who was there became, with time, totally influenced by the modern spirit.[59] Emigration as a part of such a process also, after a shorter or a longer period of time, included an intention to return, even if other things could have come in between. The difference between a temporary sojourn abroad in order to widen the experiences and a prolongation of the stay to a considerable part of the life was subtle for the engineer himself, Torstendahl concluded.[60] In this context, it is possible to refer to the statement made by Swedish-born electrical engineer Ernst F. W. Alexanderson, later a well-known inventor in radio technology and one of General Electric's leading engineers.[61] In an interview conducted in Schenectady in 1951, Alexanderson talked about the interest in the United States among engineering graduates in Europe around the turn of the century and said that most engineers travelled there with an idea of learning as much as they could and then return. The plans, however, were rarely definitive.[62] For engineers as for other migrants, there were certainly many factors that could influence the decision to return. Meeting a future wife and finding that there were good opportunities in the adopted country were two examples that could change an original decision to return while improved possibilities in the home country, unexpected homesickness or family reasons could work the other way around.

Alexanderson's statement indicated that Torstendahl's conclusion might have some relevance, but we still need to engage with it more deeply and question the central argument. Another interpretation would be that instead of Torstendahl's opinion that almost all engineers travelled with a return idea in mind, but without any fixed plans of return, other factors encouraged them to stay and these were dependent upon the initial reason for emigrating. Many places in Europe had a tradition of seasonal labour migration to nearby areas, that sometimes went as far back in time as to the middle ages.[63] As mentioned, journeyman migration had not been compulsory in Sweden for many hundred years by the middle of the nineteenth century, but was still in practise then and would be so into the early twentieth century. In the mid-nineteenth century, the Swedish guild system was about to disappear, but its practise remained long after the country officially abandoned the system. Thus, travel to learn had a long tradition. Within the nobility it was common in the seventeenth and eighteenth centuries that young men's education was finished with a journey abroad. The combination of travelling and learning was also one of the major forces behind the journeyman migrations, but labour market reasons could also be important. These migrations also made it possible for craftsmen to get new perspectives and travelling was no longer a privilege of the upper classes.[64] In the latter half of the nineteenth century, the transport revolution facilitated the extension of these European traditions to the other side of the Atlantic Ocean.[65] As Wyman has noted, "Now faster vessels brought North and South America securely within an Atlantic economy where both goods and workers could be transferred easily and cheaply".[66] Leslie Page Moch is another scholar who has noted how the improved communications over the Atlantic Ocean spurred both permanent and temporary labour migration in the late nineteenth century. The journey time to the Americas became progressively shorter while ticket prices dropped.[67] Communications during this period were immensely important for the exchange of people as well as goods and information between the continents. Åkerman and historian Berit Brattne stated that

> In several years at the beginning of the 1900s around 1 million persons annually crossed the Atlantic as immigrants to North America, and as early as the 1880s such movement had assumed a high level of intensity. The same was true of the extensive emigration and labor migration to Latin America, especially from Southern Europe, as well as emigration to South Africa, Australia, and New Zealand. The prerequisite for this type of movement was a newly organized maritime traffic and a tonnage capacity which was unthinkable during the 1850s. [68]

As Lange has concluded, engineers took over a position the craftsmen had during earlier periods in history.[69] The improved communications made it possible for engineers (and others) to extend the old tradition of journeyman migration in Europe to new continents and at the same time improvements in railways and other transcontinental means of transport further facilitated the possibilities of seeking employment in other European countries. As we can see from Appendix 3:1, the big break came among Swedish engineering graduates of the 1880s, who emigrated and study toured to a significantly higher extent than those of the 1860s and 1870s.

Lange connected the dispersion of technological competence to Norway in the pre-industrial era to the craftsmen's journeyman migrations and no Norwegian craftsman could become a master without having spent time with craftsmen on the European continent. In the nineteenth and twentieth century, the engineers took over the role of the craftsmen as carriers of technology to Norway and the United States became important for Norwegian access to modern industrial technology.[70] Stang claimed that the Scandinavian engineers crossing the Atlantic from the 1870s to the 1930s were preparing themselves for a future mission as innovators in their native countries.[71] This statement may be somewhat exaggerated. Perhaps the engineers were preparing themselves for a future career where experiences from abroad, especially from the United States and/or Germany were viewed as important as the foreign experiences are today. It was a question of accumulating competence that was highly valued at home and, thereby, the engineers promoted their own careers. Again, we can look to intra-Scandinavian examples to support claims about the purpose of these patterns of migration. Returned emigrants could play an important role in Norway, as they were able to individually implement their ideas in many places, Djupedal claimed.[72] The same held true for the Swedish engineers. Knowing how, for instance, the Americans organised a workshop constituted valuable experience in a country increasingly looking westwards for industrial inspiration.

Bourdieu's symbolic capital was relational. It had to be in a surrounding that highly valued it.[73] Once a system of values was established, the decision to emigrate and later to return had to do with a valuation of what experiences were suitable basis for a career. In this way, the emigration of engineers was similar to the old tradition of journeyman migration to the European continent. It also connected to the expression of target migration. Several studies, both of transatlantic return migration in the early decades of the twentieth century and more recent return migration, give evidence of the pattern of using the accumulated "real" capital to buy a farm or start up a small business.[74] Lange stated that many "emigrants" travelled to the United States in order to "look around" and accumulate some money and that it was common to work in the United States and Norway on a seasonal basis.[75] Engineers and technicians were the occupational groups that most actively took part in this interchange.

There was however one main difference between the Alpine villagers who spent several years in the lowland before they returned, the returnees from the United States in the southern Swedish parish of Långasjö, or post-war Turkish returnees from Germany. The character of the capital differed. While some engineers certainly accumulated considerable sums of money, the main reason for going was the accumulation of human capital in the form of knowledge and experiences valuable for a future career back in

Sweden. As claimed by Edquist and Edqvist, information about the existence of the technology, interest to introduce it as well as access/knowledge of it were prerequisites for a unit to become a technology carrier. Articles in technical journals and lectures probably spurred the potential emigrants and return migrants among the engineers while they were students. Edström became interested in electro-technology through the information given in the lectures by professor August Wijkander at CTI. It spurred his interest to work with this kind of technology in Sweden and to go to Polytechikum in Zurich as well as to the United States and learn more about it.[76] Electro-technology had just had its breakthrough in Sweden and a big field laid open for Edström. His temporary emigrations to Switzerland and the United States made him fulfil some of the requirements to become a technology carrier and it was also a means to accumulate symbolic capital in Bourdieu's sense. Edström probably recognised that studies at one of Europe's most renowned universities as well as working experiences would give him a higher status in a field that in many ways still was virgin soil in Sweden in the 1890s. This Swedish engineers' pattern paralleled that of their Norwegian colleagues. Bjork wrote:

> Unlike a large portion of those who left the country districts of Norway to take up land in the Middle West, the engineers burned no bridges behind them; in fact a majority had every intention of returning to the homeland after acquiring experience, perhaps a fortune, and possibly, too, a good reputation. They had no farms to sell and no families to care for. A ticket for the voyage to America, a few dollars to keep them going until they found a job, some articles of clothing - these with exceptions were all they carried with them. In a short time they would return to visit parents and friends in Europe; a few years more and they would return to take over engineering positions in Norway.[77]

It can be seen as a way to prolong the education; perhaps a temporary foreign stay made possible Swedish employers view them as more complete engineers.[78] The high return rate (71%) – compared to the general return rate for emigration from Sweden to North America of 18%[79] can thus be explained by the dominance of "target migration" among emigrating Swedish engineers. In this context, we need to consider that these overall statistics include all international destinations and not only North America, and this fact contributed to increase the return rate for the engineers to some extent. However, the return rate for engineers going to the United States was still considerably higher than for general emigrants.

Time between graduation and emigration

The hypothetical point of departure, that the emigration of engineers to the largest extent consisted of projects in which a return aim was included from the beginning and that it was a way to accumulate the symbolic capital Bourdieu described as most important in the "game" on the field is furthered strengthened when we look at the time elapsed between graduation and emigration. The will to acquire experience can be viewed as a means to prolong education, either by obtaining continued university education at some renowned foreign technical educational institution or by taking employment as a worker, draftsman or something else at a company known for their technical competence. Emigration to prolong education in some country that lay in the technological forefront occurred when the engineer was young and an "unfinished product".[80] The "need" to go abroad and accumulate capital possibly decreased with increasing time after graduation. In such a case, the engineer may have accumulated an appropriate amount of symbolic capital by his work at home or the time to achieve a career before retirement was shorter. Table 3:5 gives the time between graduation and emigration and return rates for 2094 emigrating engineers. In 237 cases (10,2%), it has not been possible to safely state the definitive time of emigration.

TABLE 3:5: Time-interval between graduation and emigration and return rates by time-interval for Swedish-born engineers who graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ, 1880–1919 and emigrated and return before 1930 (TESM before 1928).

Time interval	Emigrants	%	Cum %	Return	Return%	USA %	GER %
0-1 year	800	38,2	38,2	624	78,0	37,8	28,5
2-3 years	510	24,4	62,6	414	81,2	38,6	26,3
4-5 years	346	16,5	79,1	249	72,0	37,0	22,5
6-10 years	316	15,1	94,2	196	62,0	38,3	14,9
11-20 years	106	5,1	99,2	55	51,9	29,2	12,3
21-33 years	16	0,8	100,0	4	25,0	18,8	18,8
Total, known time of departure	2094	100,0	100,0	1542	73,6	37,3	24,0
Unknown time of departure	237	xxxxx	xxxxx	118	49,8	40,1	26,2
TOTAL	**2331**	**xxxxx**	**xxxxx**	**1660**	**71,2**	**47,6**	**29,3**

SOURCES: see table 3:1.

The pattern of emigration with regard to the interval from the graduation is clear. Almost 40% departed the same year as they graduated or the year after, and the latter may have been a very short interval if an engineer graduated in December and emigrated in January. As we can see, almost 80% of the engineers' emigrations occurred within a five-year period after graduation, whereas emigration after ten years or longer was uncommon. A look at the 237 "missing" cases would probably strengthen this pattern further, as the directories sometimes state that they had "gone abroad", "gone to Germany", etc. without mentioning anything about employment in Sweden in between, even if the low return rate may speak against it.

The return rates further strengthen the conclusion that the engineers were characterised by target migration. Except for the fact that engineers emigrating two three years after graduation were somewhat more prone to emigrate than those going abroad the same year or the year after they graduated, the return rate decreases with increasing interval between graduation year and emigration year. This indicates that the fresher the engineers were, the more their emigration had the character of target migration and with increasing time interval the element of "common" emigration also increased. But the overall character of the engineers' emigration was for a definite purpose, something that was virtually the same as target migration

As we also can see in Table 3:5, the proportion going to Germany (as first destination) constantly declined except for those who emigrated after 21 years or longer after graduation but that cohort was based on a small number of cases – with increasing time interval between graduation and emigration. As emigration to Germany was to be interpreted as very much of target migration, whereas the stream going to the United States can be viewed as two-sided, this pattern further strengthens the conclusion.

Duration of stay abroad

In Table 3:6, we can also see that the time abroad rarely exceeded five years. A little more than 60% of the returns occurred within three years and slightly more then three quarters of them within five years. Returns after more than ten years did not exceed ten per cent. In this respect, the pattern of engineers largely followed the patterns that have been noted for return migration in general, a phenomenon that also can be described as characterised by target migration.[81] For European emigrants to the United States who later returned it was rare that the stay lasted for more than five years even though there were some exceptions.[82]

TABLE 3:6: Duration of stay abroad for Swedish-born engineers who graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ, 1880–1919 and emigrated and return before 1930 (TESM before 1928).

Duration of stay abroad	**Returnees N**	**%**	**Cumulative %**
0-1 year	388	25,8	25,8
2-3 years	527	35,1	60,9
4-5 years	224	14,9	75,8
6-10 years	254	16,9	92,7
11-20 years	87	5,8	98,5
21-30 years	23	1,5	100,0
Total, duration of stay known	***1503***	***100,0***	***100,0***
Duration of stay unknown	157	9,5	100,0
TOTAL	**1660**	**100,0**	**100,0**

SOURCES: see table 3:1.

Anders Brändström and Tom Ericsson found that the new environment had more influence on a migrant spending five years or more in it.[83] It seems to be relevant also in this context, as the engineers became more prone to settle permanently in the adopted country after five years or more. In such a context it was a case of a migrant who had the intention to return, but changed his or her minds and decided to settle for good, in contrast to one who planned to settle permanently, but changed his mind and returned.

Also this pattern strengthens the conclusion that it was primarily a question of target migration for the engineers. A period of two or three years abroad seems to have been the appropriate time to gain the experiences and access/knowledge which was the purpose of the initial emigration. After that the engineers were ready to do successful work in the native country.

Several present day students at KTH were interviewed in an investigation about mobility and employment abroad among well-educated Swedish youth from the year 2000. One of them stated that it was enormously useful to have working experiences from abroad when an engineer returned to search employment in present day Sweden.[84] Late nineteenth and early twentieth century Swedish students of engineering seem to have done the same kind of valuation. Before 1930, a considerable high percentage, almost 40% of the Swedish-born engineers emigrated to take employment and/or studies abroad. If those claiming they were on study trips also are included, almost half of the cohort of engineers went abroad. Most often, it was a question of a round-trip migration, a migration in which a decision to return was included already from the beginning, even if some engineers, as already mentioned, also are to be regarded as common emigrants. The high return rates characterising engineers are evidence of these patterns; slightly more than 70% of the emigrating engineers returned to Sweden before 1930 and if we include study trips, the return rate approached 80%. If it had been possible to follow the whole careers of all engineering students, the rates would probably have increased some percent more. The reasons for emigration and return migration were to be found in the will to acquire capital to use on the labour market back in Sweden, comparable to Pierre Bourdieu's expression symbolic capital. Experiences from abroad could be a good foundation upon which to build for a successful career back in the native country. The information given in journals, lectures, etc. spurred an interest among the engineers to acquire access/knowledge of foreign technology. The latter was done during temporary stays abroad. In this respect, the returned engineers had fulfilled some of Edqvist's and Edquist's criteria. When they stepped on Swedish soil again they were potential technology carriers.

3.3. Emigration and return over time

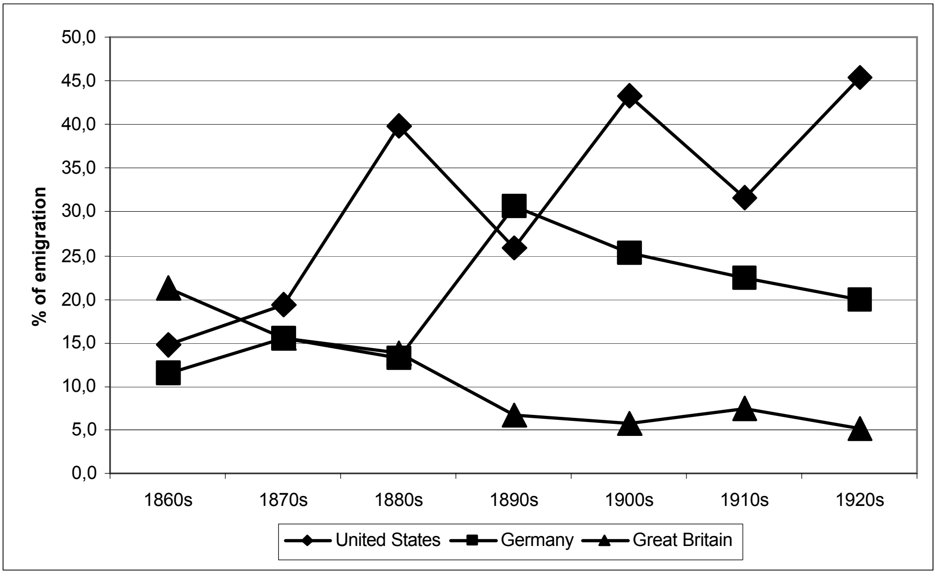
It has already been mentioned that emigration as well as study touring increased among the graduates of the 1880s compared to earlier decades. As Appendix 3:1 shows, the graduates of the 1890s and 1900s were also on high levels when it came to travelling abroad, whereas there was a dramatic decrease among the graduates of the 1910s. The return rates followed to a certain extent the emigration rates but they continued to increase and lay close to 80 % among the graduates of the 1890s and 1900s. The impact of the transport sector is a reasonable explanation even if Wyman stated that the steamships had won the battle over sailing vessels already in 1873 when only about three per cent of the European immigrants came to North America by sail.[85] We can note a ten percent drop both with regard to emigration and study travelling. World War I, of course, was a factor for the drop. The war curbed the general emigration from Sweden to North America, without entirely stopping it.[86] The same held true with regard to international migration of Swedish-born engineers.

The return rates followed the emigration rates until the graduates of the 1880s but they continued to rise and reached the top among the 1890s graduates of whom almost 80% returned to Sweden. Also among the emigrating graduates of the 1900s the return rate was considerably higher than among both earlier and later graduates except for those of the 1890s. The pattern, with study trips included, followed the real return pattern.

Sweden generally kept or repatriated around 90% of the engineers educated in the country over time. The exception was in the 1880s, when "only" 84% of the engineers educated in Sweden worked in the country. Among the graduates of the 1880s, 1890s and 1900s who later worked in Sweden, around 36-37% had foreign working experiences, whereas the rates were significantly lower for earlier graduates as well as for those of the 1910s. Seemingly Swedish engineering was most foreign inspired in the years from around 1890, when at least some of the 1880s graduates had returned, until around 1920 when most of the early century emigrating engineers also had come back to Sweden. This was thus contemporary to the second industrial breakthrough and it seems reasonable that it to a large extent was influenced by Runeby's "German-American blend", something that also was in line with the contemporary occurrence of the development nationalism. If study trips are included, almost half of the graduates from these decades working in Sweden had some kind of foreign experiences and they were – as the case studies later will show – important references in their occupational life in Sweden after return.

The German-American replacement of Britain as major source of technology is reflected in Figure 3:1, which also includes engineers who emigrated in the 1860s and 1870s. As we can see, technical influence was reflected in the emigration patterns as there was a gradual decline for Britain's popularity over time, from being the most popular destination with almost 20% of the first destination choices in the 1860s to a level of five per cent and widely surpassed by Germany and especially the United States in the 1920s. If we had gone further back in time than the 1860s, Britain's domination would probably have been even larger, as there were many cases of Swedish technicians taking employment and studying technology in Britain during the early nineteenth century and also back in the eighteenth century.[87] Germany's popularity increased dramatically from the 1880s to 1890s but decreased gradually from around 30% in the 1890s, to around 20% in the 1920s. The United States' popularity went "up and down", but it was the most common destination during all decades, except the 1890s, when it was more common for Swedish engineers to go to Germany. It is clear that these three countries were dominating the emigration of Swedish-born engineers during this period. Over time, there were only a few exceptions from the rule that they held places one, two and three.

FIGURE 3:1: Emigration (first international destination) to the United States, Germany and Great Britain 1860–1930 of Swedish-born graduated at KTH, CTI, BSFA, BSFI, TESM and TESÖ 1860–1919 by decade of departure (TESM before 1928).



SOURCES: see table 3:1.

3.4. Social and occupational background of emigrants and returnees

The social and occupational background of the engineering graduates influenced the decision to emigrate, settle permanently abroad, or return. The symbolic capital was the most important of Bourdieu's forms of capital, but another form was the social capital. It consisted of family relations, friendship ties or for instance the support given to each other by students at the elite schools. As for the symbolical capital, the social capital was relational. Social capital only existed and was working when the assets could be transferred into something that was considered as valuable.[88] On the engineering field, it is reasonable to assume that a higher social status based on family ties facilitated the possibilities to get good engineering positions. Having a father who was director or chief engineer at a large company was hypothetically an asset valued as higher than a working-class or peasant background. The need, therefore, to accumulate symbolical capital in form of experiences was perhaps stronger if an engineer came from a lower social origin. One may assume that the engineers with a lower origin to some extent had been assimilated into more of an upper-class cultural sphere at the educational institutes, and that they shared some of the values Mats Lindqvist has emphasised as important for the elitist groups. Temporary stays abroad were a part of a masculine maturity process.

Was it the case that engineers with a lower social origin felt more of a need to emigrate in order to promote their careers after return? In Table 3:7, emigration and return by social status is given. As we can see, the emigration rates were generally higher among engineers with fathers who had a higher social origin; sons of large scale entrepreneurs, higher officials and small businessmen including freehold farmers were around 40%, whereas lower officials and working-class groups were between 30 and 35%.

TABLE 3:7: Emigration, study trips, and return migration (all destinations) of Swedish-born engineers graduating from KTH, CTI, BSFA, BSFI, TESM and TESÖ 1880–1919 who emigrated before 1930 (TESM before 1928) by social classification (father's occupation).

CATEGORY/SOCIAL STATUS	1	2	3	4	5	6	9
Graduates	640	1927	1229	525	295	45	1333
Emigration N	264	798	488	183	101	14	483
Emigration %	41,3	41,4	39,7	34,9	34,2	31,1	36,2
Emigrants including study trips N	336	975	605	238	119	19	585
Emigrants including study trips %	52,5	50,6	49,2	45,3	40,3	42,2	43,9
Return N	206	619	329	121	68	5	312
Return %	78,0	77,6	67,7	66,1	67,3	35,7	64,6
Return including study trips N	278	796	446	176	86	10	414
Return including study trips %	82,7	81,6	73,7	73,9	72,3	52,6	70,8
United States %	40,9	50,0	55,1	51,4	48,5	57,1	37,9
Germany %	25,4	26,7	22,3	23,5	25,7	28,6	43,7

1. Large-scale entrepreneurs, 2. Higher officials, 3. Small businessmen including freehold farmers, 4. Lower officials, 5. Trained/skilled workers, 6. Other workers, 9. Unknown, not definable
SOURCES: see table 3:1.

In this context, it is not possible to state that emigration was a mean to "level out" the total amount of capital. It seems like the mobility traditions among persons with an upper-class background played an important role. If we follow Mats Lindqvist, it is possible to interpret the patterns of emigration as if the engineers from a lower social origin were not fully assimilated into the elite group. The elderly traditions still mattered.

The return rates were also higher in the two "highest" groups, whereas in this context the small businessmen had more in common with the "lower" groups. The group of "other workers" stands out with a rate of only about 35% whereas the other groups were all between 65% and 80%, but that group is based on a very small population. In this context the social capital in Bourdieu's sense seems to have been important. Engineers with an upper-class origin presumably valued their chances for a good career in Sweden higher than those lacking the family channels to the elite world.

Augusta[89] was born in Sweden, came to the United States as a child together with her parents, and there married the Swedish railway engineer Harald Fegraeus. In 1904, she wrote a letter in English to her parents-in-law on the island of Gotland, discussing Harald Fegraeus's hesitation about staying in the United States or returning to Sweden for good. Augusta Fegraeus stated that, in her opinion**,** the family should stay in the United States:

> I have no doubt that Gothland(sic!) is an ideal place to live with people of means, but for anyone who must make a living there is no place like our own glorious United States, where all men are created free and equal and where it is not your ancestors but your own individuality that will help you carve your fortune. I do not mean to say that family and wealth are disregared(sic!) here or should be, but everything does not depend upon it. [90]

From some of Harald Fegraeus' letters it is possible to get the impression that he wanted to stay in the United States but perhaps he was afraid to hurt his family.[91] His father was a land-surveyor on the island (in group two in the classification above) and he was probably an important person in the local community.[92] Harald Fegreaus would probably have easily gotten the job as chief engineer for the local railway on Gotland, but the lack of ties to the national Swedish elite and his hesitation about being competent to work in Sweden after a long stay in the United States perhaps made the family value that the chances for a good life was better if they stayed. The fact that Harald Fegraeus was forty-two years old and had been in North America for twenty years when Augusta wrote the letter must have contributed to the decision. The Fegraeus family never returned to Sweden.

In Table 3:8, emigration and return migration is given with regard to occupational sector. The differences were small with regard to emigration and they are difficult to interpret; those with father's working within trade and public service were most prone to emigrate, but the difference down to those within industry and craft – where those with fathers who also are engineers were to be found – was only five percent. As regards capital, the need for symbolic capital could be smallest in this group and thereby they would be least prone to emigrate. That was also the case but the differences are too small to allow any definitive conclusions.

TABLE 3:8: Emigration, study trips, and return migration (all destinations) of Swedish-born engineers graduating from KTH, CTI, BSFA, BSFI, TESM and TESÖ 1880–1919 who emigrated before 1930 (TESM before 1928) by occupational classification (father's occupation in the directory).

CATEGORY/OCCUPATIONAL SECTOR	FF	IC	T	TC	PuS	PrSU
Graduates	663	1304	705	357	1251	1714
Emigration N	255	481	299	134	517	645
Emigration %	38,5	36,9	42,4	37,5	41,3	37,6
Emigrants including study trips N	329	617	353	165	630	783
Emigrants including study trips %	49,6	47,3	50,1	46,2	50,4	45,7
Return N	154	348	228	96	408	426
Return %	60,4	72,3	76,3	71,6	78,9	66,0
Return including study trips N	228	484	282	127	521	564
Return including study trips %	69,3	78,4	79,9	77,0	82,7	72,0
United States %	57,3	46,8	45,5	60,4	49,7	41,1
Germany %	22,7	23,1	26,4	21,6	28,2	38,8

FF = Farming and forestry, IC = Industry and crafts, T = Trade, TC = Transport and communications, PuS = Public services, PrSU = Private services, other, not spec.
SOURCES: see table 3:1.

The return rates differed more than the emigration rates. As we can see, engineers with a family background in the sector farming and forestry distinguished themselves mostly by returning to an extent of "only" 60%, whereas the two sectors with the highest emigration rates also had the highest return rates between 76 and 79%.

3.5. Geographical background and emigration

What was the geographical background of the engineers, who graduated at the six technical educational institutes in Sweden from 1880 to 1919? Table 3:9 shows the distribution with regard to urban or rural birthplace.

TABLE 3:9: Emigration, study trips, and return migration (all destinations) of Swedish-born engineers graduating from KTH, CTI, BSFA, BSFI, TESM and TESÖ 1880-1919 who emigrated before 1930 (TESM before 1928) by urban (Stockholm, Gothenburg, Malmö and other towns) or rural birth place.

CATEGORY/BIRTHPLACE	Sto	Got	Mal	Oth t*	Urb T	Other	*Unkn
Graduates	771	398	227	1717	3113	2820	61
Emigration N	286	200	109	662	1257	1051	23
Emigration %	37,1	50,3	48,0	38,6	40,4	37,3	37,7
Emigrants including study trips N	362	238	120	791	1511	1341	25
Emigrants including study trips %	47,0	59,9	52,9	46,1	48,5	47,6	41,0
Return N	233	150	82	480	945	703	12
Return %	81,5	75,0	75,2	72,5	75,2	66,9	52,2
Return including study trips N	309	188	93	609	1199	993	14
Return including study trips %	85,4	79,0	77,5	77,0	79,4	74,0	56,0

Sto = Stockholm, Got = Gothenburg, Mal = Malmö, Oth t = Other towns (including places with town privilegies), Urb T= Urban total, Other = rural and industrial parishes without town privilegies.
SOURCES: see table 3:1.

The table indicates that the difference in emigration rates between migrants from urban or rural birthplaces was small. Engineers born in cities and towns were somewhat more likely to emigrate and return. Those born in Stockholm, however, were less willing to emigrate than engineers born in other urban areas. A comparison of these cities further strengthens the interpretation that the size or character of the childhood environment was weak as a decisive factor. Gothenburg and Malmö born engineers had among the highest emigration rates in the country, whereas the Stockholmborn ones were below the urban as well as the national average. This indicates that the geographical location of the childhood environment was more important than the above-mentioned size or character of the birthplace. Appendix 3:2 shows all these statistics at the county level. The results point in a direction that engineers born in the southern counties were the ones who were most eager to go abroad. All counties located in Götaland, the southern main part of Sweden (Östergötland, Jönköping, Kronoberg, Kalmar, Blekinge, Kristianstad, Malmöhus, Halland, Göteborg och Bohuslän, Älvsborg and Skaraborg) were above or just slightly under the national average, whereas several counties in Svealand, the central main part of the country (Stockholm, Uppsala, Södermanland, Värmland, Örebro, Västmanland and Kopparberg) and Norrland, the northern main part of it (Gävleborg, Västernorrland, Jämtland, Västerbotten and Norrbotten) were far below the average of 39%. We must remember that the rates for some of the northern counties generally were based on smaller populations, and that this could influence the results.

Shorter distances to the European continent as well as the location of the main port for Swedes who wanted to go to North America, i.e. Gothenburg, were possible explanations. In the official Swedish statistics the northern counties were among those where the general rates of overseas emigration were smallest. Carlsson concluded that the absence of a strong tradition to emigrate could explain why certain districts had low emigration rates despite obvious prerequisites for emigration. In this context, we may interpret the low rates of emigration among engineers from the northern part of Sweden even if they met another tradition when they encountered the educational institutes. Traditions of emigration seem to have been important also when looking at patterns by county of birth both with regard to the United States and Germany. The German shares stand out when it comes to engineers born in the provinces of Skåne and Blekinge in southernmost Sweden: Blekinge county, Kristianstad county and Malmöhus county. The closeness to Germany from these parts of Sweden was probably important and these counties were also the ones that were most influenced by the elderly tradition of journeyman migration to Germany and Denmark.

During the period from 1851 to 1930, the county of Halland had the highest emigration to North America followed in order by Jönköping, Värmland, Kronoberg, Kalmar and Älvsborg counties. Together with single regions in neighbouring counties, they formed what Carlsson called a coherent nucleus of Swedish emigration. When looking at the emigration rates of engineers born in these counties there was no clear agreement with the general emigration rates. Rates among engineers born in Kronoberg and Värmland lay above averages, whereas the other counties were about average. The discussion above is based on emigration to all international destinations. A look at engineers' emigration to the United States only gives, however, by hand a stronger coherence, even if the highest rate was noted for those born in the northernmost county of Norrbotten, which was not characterised by high emigration rates in general.[93] However, the Norrbotten share was calculated on a small group, and the same holds true for the second northernmost county of Västerbotten. Apart from these figures, four out of the six counties mentioned with the highest shares of engineers born there and went to the United States. Jönköping comes second, Älvsborg fourth, Kalmar seventh and Halland eighth in this context, whereas Värmland and Kronoberg had lower rates.

The size of the birthplace seems to have been more important for return migration. Once again, the rural born engineers were least likely to return, the ones from urban areas excluding the three largest cities lay in between the rural districts and Gothenburg/Malmö, whereas Stockholm-born engineers had the highest return rate. It seems to be a fact that the larger the birthplace, the more prone the engineers were to return to Sweden. Many scholars have stated that return migration in the past as well as in the present, most often goes to the place or area of origin.[94] As many of the employment opportunities for engineers in Sweden were located in the larger cities, the structure of the labour market gave the engineers born in these cities more of a chance to return to their place of origin.

Also when comparing return migration to the Swedish counties with the figures for engineers born in each county, there was no agreement. Engineers born in the counties of Västerbotten, Östergötland and Stockholm were most prone to return. As for Swedish return migration in general, rates for Stockholm were around 18%, which was comparably high, whereas the other two lay between 11 and 13%. Generally, we can note low return rates for engineers born in the traditional emigration counties. The statistics support this discovery and it applies also to the common return migration.[95]

All in all, the very location of the birthplace seemed to have some importance for the decision to emigrate as we can find high rates from counties located close to the European continent as well as from some of the traditional "emigration" counties. The size/structure of the birthplace was probably more important for return migration. The larger the birthplace, the more likely the engineers were to return. A reasonable explanation was that engineering largely was an urban occupation, where most employment opportunities lay in the bigger cities and especially in Stockholm. The possibility to return to the birthplace and work was thus stronger for engineers from Stockholm and the other cities and weaker for those from countryside districts.[96]

3.6. Educational background

Level of education and its influence upon migration

How did the patterns of emigration differ with regard to the different education the engineers had? In Table 3:10 rates of emigration and study tours are given with regard to educational institute and educational level. First, some notes on what is meant by educational level. The status of the different educational institutes differed. KTH was the only official technical university in Sweden until 1937, when CTI was placed on equal terms. Practically, however, the Gothenburg institute functioned as a university already from the turn of the century. CTI had thus an official position on the same level as the upper secondary schools and mining schools, while unofficially it was on level with the KTH.[97] A classification following the official Swedish education would have included only two categories, the ones graduated from KTH in the "high" status group and the rest in the "low" group. However, CTI's position in between makes it useful to classify the engineers into three categories; those with *high-level education* came from KTH, those with *middle-level education* from CTI and those with *low-level education* from the upper secondary schools and mining schools. A small minority of the engineers had grades from two or even three of the institutes in this study. Two criteria have been used to classify the engineers. First, the highest education has been counted: if an engineer had grades from both KTH and CTI, he has been included in KTH. Second, an engineer with grades from CTI and one of the upper secondary schools or mining schools has been counted among the CTI-graduates. Third, if an engineer had education from two schools on the low level, his first education has been counted.

The hypothesis here is that engineers with a lower level of education were more prone to emigrate since it was more difficult for them to get employment in Sweden. Another hypothesis can be based on Torstendahl's findings that international migration and return migration could be a way of levelling out the opportunities on the labour market in Sweden for engineers with lower marks from KTH.[98] Hypothetically following Torstendahl and Bourdieu an emigration with a return in mind could work the same way for engineers with a lower level of education. A testing of this hypothesis will be done in Table 3:10.

TABLE 3:10: Emigration, study trips, and return migration (all destinations) of Swedish-born engineers gaduating from KTH, CTI, BSFA, BSFI, TESM and TESÖ 1880–1919 who emigrated before 1930 (TESM before 1928) by educational institute and educational level.

Educational level/institute or university	**High-KTH**	**Middle-CTI**	**Low**	**BSFA**	**BSFI**	**TESM**	**TESÖ**
Graduates	2658	1432	1904	377	363	606	558
Emigration N	1008	647	676	132	113	250	181
Emigration %	37,9	45,2	35,5	35,0	31,1	41,3	32,4
Emigrants including study trips N	1205	813	859	169	157	283	250
Emigrants including study trips %	45,3	56,8	45,1	44,8	43,3	46,7	44,8
Return N	803	416	441	71	65	172	133
Return %	79,7	64,1	65,2	53,8	57,5	68,8	73,5
Return including study trips N	1000	582	624	108	109	205	202
Return including study trips %	83,0	71,6	72,6	63,9	69,4	72,4	80,8
Engineers kept or repatriated N	2453	1201	1669	316	315	528	510
Engineers “kept” or repatriated %	92,3	83,9	87,7	83,8	86,8	87,1	91,4
Emigration experiences of engineers working in Sweden %	32,7	34,6	26,4	22,5	20,6	32,6	26,1
Foreign experiences of engineers working in Sweden %	40,8	48,5	37,4	34,2	34,6	38,8	39,6

SOURCES: see table 3:1.

As we can see, the hypothesis does not hold true in this case, as engineers on the middle-level had the highest rates of emigration even if study tours are included. The low-level engineers, on the other hand, had the lowest rates of going abroad although the difference was small compared to the engineers on the high-level. If we add the study tours we find a pattern where the rates lay close to each other, once again with CTI as the exception. The engineers educated at the Gothenburg based institute were the ones most prone to go abroad for employment and/or studies.

In one way, the pattern of emigration is difficult to interpret as the emigration rate increased from high to middle level, but decreased among the low level graduates. If we are to interpret the pattern in line with Torstendahl’s conclusion about the marks, and also Bourdieu’s expression of symbolic capital, the emigration rate would hypothetically increase more at the low-level. This was not the case, even if the generalization about high, middle and low level graduates is somewhat difficult considering the differences between the four institutes on the low level. It seems to have been other factors – such as the social background – that guided the decision to emigrate rather than a will to compensate for a disadvantage in the Swedish labour market based on a smaller amount of symbolic capital in form of education. One reasonable explanation may be the location of CTI’s hometown Gothenburg. At the same time as Gothenburg was also more close to the European continent than all the other institutes’ location, except TESM, whose graduates also emigrated to a significantly higher extent than those from the other institutes on the low level. This is comparable to the earlier discussion on geographical background of the emigrating engineers. In the same way as the young Hugo Hammar watched emigrants leaving from his native island of Öland and was inspired to go himself, the graduates of CTI must have seen and heard – perhaps in a more direct way than other graduates – about the steamers departing to Hull and the continuing journey from there to the United States through the great Atlantic seaport of Liverpool.[99] In 1915, the Swedish-America Line opened a connection directly from Gothenburg.

An education from KTH was thus a symbolic capital, which made engineers that graduated from there more inclined to return to Sweden than others. As we also can see, the country kept or repatriated a higher percentage of engineers from KTH compared to the other institutes, even if TESÖ comes close. Without counting pre-emigration employment for engineers who went abroad, Sweden employed 92% of the graduates from KTH and the long-term loss was thus 8%. The loss of graduates from the upper secondary schools or mining schools was about 12%, whereas the loss of CTI-engineers was 16%. Obviously industrialising Sweden was more successful in keeping/repatriating those with the highest education than it was in keeping engineers from lower levels. More than 92% of Swedish-born university-trained engineers thus became useful for their native country in the long run and among those almost a third had experiences from employment abroad.

Educational sector and its influence upon migration

The engineers thus came from different educational institutes and were on different levels with regard to their education. There were also different sorts of engineers. At KTH, CTI, TESM and TESÖ the engineers were divided into different educational sectors and a classification formulated, as follows:

1. *Chemical engineers* include graduates from the sectors for chemistry at KTH, CTI, TESM and TESÖ.
2. *Civil engineers* include graduates from the sectors for civil engineering at KTH and CTI.
3. *Constructional engineers* include graduates from the sector for architecture at KTH, the sectors for construction and house building at CTI, and the sectors for construction at TESM and TESÖ. Many of those who graduated as building engineers from CTI, TESM and TESÖ were later noted as working as architects, thereby the including of architects in this sector.
4. *Electrical engineers* include graduates from the electro-technical sectors at KTH, CTI and TESÖ.
5. *Mechanical engineers* include the sectors for mechanical engineering at KTH, CTI, TESM and TESÖ.
6. *Mining engineers* include graduates from the sectors for the science of mining at KTH[100] and graduates from BFSA and BSFI.
7. *Naval architects* include graduates from the sectors for naval architecture at KTH and CTI.

The unknown (*) group consists of engineers graduated at CTI. It has not been possible to establish what educational sectors they came from due to the shortcomings in the source material discussed earlier.

*TABLE 3:11: Emigration, study trips, and return migration (all destinations) of Swedish-born engineers graduating from KTH, CTI, BSFA, BSFI, TESM and TESÖ 1880–1919 who emigrated before 1930 * by educational sector (TESM before 1928).*

Category/Educational sector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	*****
Graduates	680	791	478	794	1767	1033	156	295
Emigration N	282	178	105	362	788	378	98	140
Emigration %	41,5	22,5	22,0	45,6	44,6	36,6	62,8	47,5
Emigrants including study trips N	346	218	197	413	947	489	105	162
Emigrants including study trips %	50,9	27,6	41,2	52,0	53,6	47,3	67,3	54,9
Return N	214	119	85	274	562	251	80	75
Return %	75,9	66,9	81,0	75,7	71,3	66,4	81,6	53,6
Return including study trips N	278	159	177	325	721	362	87	97
Return including study trips %	80,3	72,9	89,8	78,7	76,1	74,0	82,9	59,9
Engineers kept or repatriated N	612	732	458	706	1541	906	138	230
Engineers, "kept" or repatriated %	90,0	92,5	95,8	88,9	87,2	87,7	88,5	78,0
Emigration experiences of engineers working in Sweden %	35,0	16,3	18,6	38,8	36,5	27,7	58,0	32,6
Foreign experiences of engineers working in Sweden %	45,4	21,7	38,6	46,0	46,8	40,0	63,0	42,2

SOURCES: see table 3:1.

As we can see, most sectors lay between 37 and 47% emigration, and from 40 to 55 % emigration including study trips. The extremes were the naval architects with emigration and study trip rates of between 60 and 70% and the civil engineers with rates between 20 and 30%. Return rates were high for all the sectors and highest for the naval architects and construction engineers who both returned to an extent reaching slightly more than 80%. Civil engineers and mining engineers had the lowest rates, but still about two-thirds returned.

The main difference from Carlsson's study of emigration to the United States among KTH-graduates between 1850-1929 was that he used a longer period and only included KTH. However, Carlsson's results were in line with the ones outlined here. For instance, Carlsson found that naval architects consisted of only 3% of the KTH graduates, but 6% of the emigrants, whereas civil engineers made up 29% of the graduates but only 12% of the emigrants. In line with this study, Carlsson also found that the architects – included in the constructional engineers in this study – went to the United States to a smaller extent.[101]

Except for the "unknown" sector (78%), between 87 and 96% of all the graduates stayed or repatriated to Sweden. The constructional engineers had the highest rate, whereas the mechanical engineers had the lowest. As for influences on Sweden, the figures show that naval architecture took most influences from abroad and almost 60% of the naval architects had foreign working experiences. Electrical, mechanical and chemical engineering lay between 35 and 39%, mining around 28%, whereas constructional and civil engineering had the least foreign impulses. The unknown sector was between these extremes at 33%. With regard to constructional engineering, it is important to remember that architects and constructional engineers often went on study trips and that their share of foreign experiences approached 40% if study trips are included. Let us underline that this quantitative approach gives far from the complete picture of foreign impulses on Swedish engineering in the period of 1880-1930. Certain individuals could have been very active carriers of impulses and technology to Sweden, but the stay abroad may not have influenced other individuals to any extent at all.

Appendix 3:3 shows the number, return rates and percentage with experiences from a specific country of all engineers in the sector. The United States seems to have been most influential in naval architecture and almost 40% of the engineers had working experiences from there. The shipbuilding sector stood out as there was no other sector/country that came close to such a proportion. The electrical engineering also seems to have been "American" as a little more than every fifth engineer had working experiences from the United States, but American experiences played a less important role in civil and constructional engineering. On the other hand, no single country seems to have been important among the graduates from these sectors.

Germany also had its highest share in naval architecture and a little more than every fourth naval architect had been working there. It was nevertheless a fact that Germany was outnumbered by the United States in this sector. It was more influential than the United States in chemical, construction and mechanical engineering. Civil engineers had the smallest rate of emigration.

The quantities were well in line with the technical influences on Sweden. Gårdlund mentioned that the German influence was considerable in the food processing industry as well as in the pulp and paper industry and these were branches where chemical engineers worked. In almost all other industrial branches, Gårdlund emphasised the American impulses as most important.[102] It is as mentioned difficult to safely conclude facts about technological impulses by studying quantities of returning engineers. However, if we assume in the same manner as Djupedal did, that the returnees were able each in their place to implement technology, methods of organising the work, etc. we find several Swedish industrial branches to a higher or lower extent took influences from abroad.[103] If those engineers with experience of working or studying abroad (usually 15-20%, though sometimes more) were able to reach influential positions based on their foreign experiences, they had the possibility to play an important role in the industrialisation of Sweden. In such a case, the returning engineers fulfilled the crucial power criterion in Edqvist's and Eqquist's theory of technology carriers. The question is did they reach these positions?

3.7. Occupational careers of the returned engineers

Swedish shipyards began employing managing directors with experience from abroad in the early decades of the twentieth century. It was a new generation of leaders that took over within Swedish naval architecture.[104] Glete argued that the management of companies became more powerful in the industrialisation era at the expense of the owners. Owners interfered less with the company's daily activity and adopted more modern theories about the role of ownership in industrial transitions. These theories emphasised the role of owners as investors with several investing alternatives, but the company leaders were able to go between different companies that were interested in their leadership abilities.[105] In the management of companies we can find the managing directors with their assistants, chief engineers and technical directors *(verkställande direktörer, vice verkställande direktörer, disponenter, överingenjörer, chefsingenjörer, tekniska chefer, tekniska direktörer*). Such a position offered opportunities for a returned engineer who wanted to implement ideas from abroad. In the research quoted above, ownership and management were separated. They were, however, a part of the same sphere and foreign experiences were also valued in the boardrooms, as some examples in the case studies will show.[106] Based on a share of the total population of engineers, Table 3:12 gives returned engineers who reached management level in comparative perspective.

TABLE 3:12: Returned and non-returned engineers graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ reaching "management level" (M) (managing director, director, chief engineer, technical chief, technical director) in Sweden 1880–1930. (TESM to 1928).

CATEGORY	M	%
Returnees from the United States (1) (N=651)	212	32,6
Returnees from other destinations (2) (N=1009)	299	29,6
Returnees total (N=1660)	511	30,8
Study trips (3) (N=168)	50	29,8
Foreign experiences (4) (N=1828)	561	30,7
Never abroad (3) (N=845)	133	15,7
TOTAL (N=2673)	**697**	**26,1**

(1) Could also include other countries, (2) Not including the United States, (3) Based on the engineers graduating from the six institutes with last names beginning with the letters A-F. (4) Emigrants and study trips.
SOURCES: see table 3:1.

As we can see, it was clearly an advantage to have been abroad, regardless if it was a real emigration or a study trip. However, it was almost as advantageous to return from other countries than the United States and the difference with regard to this was only three percent. Returnees from the United States more often took positions in the larger companies. In Glete's examination of the Swedish engineering industry he mentions the companies that were most important in Sweden during the years 1870–1930. The larger ones were ASEA in Västerås, Bofors, the Stockholm companies Atlas, AB Separator, L. M. Ericsson and Svenska AB Gasaccumulator (AGA), the Gothenburg based shipyards Götaverken and Lindholmen and Svenska Kullagerfabriken (SKF) and the Malmö based shipyard Kockums.[107] Olsson has shown that the new generation of managing directors at the major shipyards had foreign experience. Hugo Hammar took over Götaverken in 1906 and had worked six years in the United States and two in Britain, but his deputy managing director from 1912 and onwards, Ernst A. Hedén, had five years of experience in the United States and two years in Germany. The managing director of Eriksberg, Gunnar Engberg, had been three years in the United States and Georg Ahlrot at Kockums had been working for ten years in Germany.[108] Other returnees in the management of these companies were Olof Ekman and Uno Forsberg at SKF and Gottlieb Piltz at L. M. Ericsson. In 1921, several of the largest iron works in Sweden had returnees from the United States as managing directors. These men were found in Sandviken, Fagersta, Oxelösund, Smedjebacken, Dalkarlshyttan, Kallinge and Ljusne. In ASEA's management, we found Sigfrid Edström and also the chief engineers Ernst Danielsson, Emil Lundqvist and Carl Silvander. The higher positions within the industry leaders in Sweden at the time were to a large extent reserved for people that had been working and practising abroad and particularly in the United States.

As mentioned earlier, there are reasons to assume that a temporary stay in a foreign country could be an asset on the labour market back in Sweden. In Table 3:13, the shares reaching management level by educational level are given.

TABLE 3:13: Returned and non-emigrating engineers graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ reaching "management level" (M) (managing director, director, chief engineer, technical chief, technical director) in Sweden 1880–1930 by educational level.

EDUCATIONAL LEVEL	**Returnees**	**M**	**%**	**Non-emigrants (1)**	**M**	**%**
High (KTH)	803	300	37,4	443	105	23,7
Middle (CTI)	416	114	27,4	220	28	12,7
Low	441	97	22,0	350	53	15,1
TOTAL	**1660**	**511**	**30,8**	**1013**	**186**	**18,4**

1. Based on the engineers graduating from the six schools with last names beginning with the letters A-F. Includes study trips.
SOURCES: see table 3:1.

A temporary stay in a foreign country could thus be viewed as compensation for a lower level of education in this context. The rates reaching management level for returned engineers on the middle and low educational levels were above and close to the rate of non-emigrating KTH-engineers who reached management level. However, engineers at all educational levels gained from emigration as we can see that the rate reaching management level among the returned KTH-engineers was significantly higher than the other rates and reached almost 40%. It seems to have been the CTI-graduates that gained most from a temporary foreign stay as their rate for returnees reaching management was more than twice as high as for the non-emigrants.

Bourdieu claimed that social background was an important social capital. One example was that a highly valued exam did not automatically lead to a successful career because there was also need for the social capital. The occupational careers and other successes were dependent on support from family, friends and colleagues.[109] In this context we need to consider that other assets than the exam must be taken into consideration and one was the social background. In Table 3:14 a comparison between returning and non-emigrating engineers by social status is given.

TABLE 3:14: Returning (Return) and non-emigrating (Non) engineers graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ reaching "management level" (M) (managing director, director, chief engineer, technical chief, technical director) in Sweden 1880–1930 by social status.

SOCIAL STATUS	**Return**	**M**	**%**	**Non (1)**	**M**	**%**
1. Large-scale entrepreneurs	206	93	45,1	143	42	29,4
2. Higher officials	619	224	36,2	265	49	18,5
3. Small businessmen including freehold farmers	329	95	28,9	213	36	16,9
4. Lower officials	121	30	24,8	102	22	21,6
5/6. Trained/skilled workers, other workers	73	12	16,4	57	9	15,8
9. Unknown, not definable	312	57	18,3	233	25	10,7
TOTAL	**1660**	**511**	**30,8**	**1013**	**183**	**18,1**

1. Based on the engineers graduating from the six schools with last names beginning with the letters A-F.
SOURCES: see table 3:1.

Among sons of large-scale entrepreneurs, higher officials and small businessmen including freehold farmers, there were considerable differences between returnees and non-emigrating engineers, whereas the differences were smaller in the lower groups. Thus it seems like the social background was very important for the careers of the engineers and that foreign experience was an additional capital that worked for engineers from a higher social origin but seldom for those from a lower. In some cases, the engineers were sons of owners to large Swedish industries and were predestined to take over from their fathers. Bourdieu claimed that social capital was a form of capital, which can explain why other forms of capital gave certain bonuses.[110] In this context, group one, two and three clearly gained from having been abroad, whereas the gain was small or insignificant for engineers with a lower social status. A temporary stay in a foreign country could compensate for a lower amount of social capital for engineers from groups two and three in relation to never emigrating engineers from group one. However, group one engineers with foreign work experiences were the ones who had the most advantageous position on the field.

Temporary emigration, by an engineer intending to return home can thus be viewed as a mean to accumulate symbolic capital, an investment and a stake in the game on the field. As some studies showed, American and German experiences were highly valued among leading positions in the industry.[111] This can be connected to the Swedish development nationalism and the will to combat mass emigration with American examples and the use of returned Swedish-Americans. As stated, in a society where the views about the United States differed, the industrialists and engineers were mostly positive and there was also a relative political agreement on the United States' superiority in technological matters. At the same time, Sweden had old cultural links with Germany and German examples were also important. The positive sound of these two countries made experiences from them a valuable symbolical capital on the engineering field.

A short definition, found in Broady of this Bourdieuan expression is that it is a "system of relations between positions possessed by specialised agents and institutions that are battling over something that was mutual for them".[112] The field was characterised by the fact that the symbolic rewards were distributed from positions on it. In a somewhat general way, the opportunities in the labour market for engineers in industrialising Sweden could be summarized in the following way: the group with the best opportunities were engineers educated at KTH, who had been abroad and were of upper-class origin. Their chances to reach management level were approximately 35–40%. Next came a group that consisted of engineers from KTH who lacked foreign experiences, and those from the other institutes who had been working/studying abroad. Their chances lay around 20-30%. In contrast, only 10–15% of engineers from the mining and upper secondary schools who never went abroad reached this management level.

The foreign experiences can be seen as an additional symbolic capital, which had the effect of elevating CTI- and mining- and upper secondary school-educated engineers up to the same level as non-emigrating KTH-educated engineers. Emigration could also work as an asset for KTH-educated engineers in relation to their non-emigrating student colleagues.

These are, of course, generalisations and certain emphases or qualifications are necessary. First, the size of the companies they led differed a lot. Some returned engineers such as Edström and Hammar were at the top of large, export minded companies in the forefront, whereas others were leading small companies that only employed a few workers. It was not possible to rank all the Swedish companies by size. Second, it is not safe to state that all engineers were striving towards management positions in companies. Some of them may have been perfectly satisfied with their positions as departmental heads, consulting engineers, city engineers or the like and had no other intentions. This issue of ranking was, to some extent, imposed on these engineers. The goal was, however, to measure their relative positions objectively. Third, the information in the directories differed and the head of a rolling mill at an iron works may have been described as a chief engineer at one company and as a departmental head at another. Therefore, it can be difficult to ascertain the status of such a position. Fourth, no attention has been paid to grading. It may be the case that the engineers who reached management level were those with the highest grades.

What kind of engineers had most to gain by working temporarily abroad? In Table 3:15 we can study the rates reaching management level by educational sector.

TABLE 3:15: Returned emigrants (Return), engineers on study trips (Study) and engineers never abroad (Never) graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ reaching "management level" (M) (managing director, deputy managing director, director, chief engineer, technical chief, technical director) in Sweden 1880–1940 by educational sector.

SECTOR	Returnee	**M**	**%**	**Study**	**M**	**%**	**Never**	**M**	**%**
Constructional	85	16	18,8	36	5	13,9	84	5	6,0
Chemical	214	78	36,4	21	7	33,3	98	23	23,5
Civil	119	25	21,0	13	3	23,1	149	26	17,4
Electrical	274	78	28,5	15	4	26,7	94	10	10,6
Mechanical	562	171	30,4	42	14	33,3	211	36	17,1
Mining	251	93	37,1	34	14	41,2	166	28	16,9
Naval architecture	80	26	32,5	4	2	50,0	13	3	23,1
**Unknown*	*75*	*24*	*32,0*	*3*	*1*	*33,3*	*30*	*2*	*6,7*
TOTAL	**1660**	**511**	**30,8**	**168**	**50**	**29,8**	**845**	**133**	**15,7**

SOURCES: see table 3:1.

Engineers from all sectors gained from going abroad, either as emigrants or study travellers. Except from the unknown sector, constructional, electrical and mining engineers seem to have had most to gain, whereas civil engineers, chemical engineers and naval architects had least. It is worth noting that the sector that was most likely to emigrate actually seems to have had the least to gain, whereas one of the sectors least prone to go abroad had the most to gain. The results for naval architects were based on small numbers. Once again, we also need to consider that the size and status of the companies that the engineers were managing differed.

Olsson, Fridlund and Glete have all stated that American experiences were important in several branches of the Swedish industry. Therefore it is interesting to see what kind of engineers who gained most from emigration to, and return from, the United States. This is shown in Table 3:16.

TABLE 3:16: Returning engineers from the United States (RetUS) and returned engineers from other destinations (Retoth) graduated from KTH, CTI, BSFA, BSFI, TESM and TESÖ reaching "management level" (M) (managing director, deputy managing director, director, chief engineer, technical chief, technical director) in Sweden 1880–1940 by educational sector.

EDUCATIONAL SECTOR	RetUS	M	%	Retoth	M	%
Constructional engineers	48	5	10,4	37	11	29,7
Chemical engineers	39	19	48,7	175	59	33,7
Civil engineers	20	9	45,0	99	16	16,2
Electrical engineers	147	48	32,7	127	30	23,6
Mechanical engineers	203	61	30,0	359	110	30,6
Mining engineers	112	46	41,1	139	47	33,8
Naval architects	55	15	27,3	25	11	44,0
Unknown	27	10	37,0	48	14	29,2
TOTAL	**651**	**213**	**32,7**	**1009**	**298**	**29,5**

SOURCES: see table 3:1.

The civil engineers had most to gain by going to the United States. The proportion of return emigrants from the United States who reached management positions was almost three times as high as for those who went to other countries. Chemical, electrical and mining engineers also gained from choosing the United States, the mechanical engineers lay on about the same level both for engineers who had been in the United States and in other foreign countries, whereas naval architects and constructional engineers gained from choosing other destinations. As stated, this context does not give the complete picture and the civil and chemical engineer cohorts of returnees from the United States were the two smallest ones and this leads to uncertainties about the credibility of the results.

The electrical, mechanical and mining sectors were three sectors where we can observe both an advantage to go abroad and a comparably high advantage for returnees from the United States. Therefore, the remainder of this thesis will focus on industrial branches where these engineers worked. There will be four case studies of companies: ASEA (electrical industry), Sandvikens Järnverks AB (steel- and iron industry), Bolinders Mekaniska Verkstads AB (mechanical industry) and Bolidens Gruv AB (mining). Within each branch, these companies can also be viewed as leaders in the industrialisation of Sweden[113] and they were also prone to engage engineers with experience from the United States.[114]

3.8. Concluding discussion

In all, a substantial share of the engineers who graduated in Sweden between 1880 and 1919 emigrated and with study trips included, it was almost half the cohort. A huge majority of them later returned to Sweden. In a Weberian sense, it seems to be clear that the ideal type of an emigrating engineer was a target migrant, i.e. a person aiming to return after a well-defined interval. Higher social origin, being born in a large city and a high education as well as emigration shortly after graduation, often to Germany, and a few years of stay abroad were facilitating factors for a target migration to occur. The education of a target migrant often was in naval architecture, mechanical engineering, electrotechnology and chemistry. In a generalised way and with some exceptions, it is possible to state that all these factors also spurred emigration in the first place. However, if an engineer from a rural lower social origin with a lower level of education still emigrated, often in mining or civil engineering, he was more likely to settle in the adopted country permanently. The settler more often went to overseas destinations also including the United States. However, the emigration of engineers there had a twofold character connecting partly to the more or less traditional patterns of emigration and partly to target migration. We also need to consider that it occasionally was difficult to get employment in Sweden and that this could have been a push factor when it came to emigration.

The pattern of international destinations confirmed the target migration: during the second industrial breakthrough from the 1890s and in the light of the contemporary development nationalism occurring, the United States and Germany were the prime models in Swedish industry. These countries dominated largely among the destinations of the engineers; the United States was ranked first and Germany second. The destination pattern over time showed that these two countries gradually took over from Britain. Forming part of a larger economic cycle, this Swedish phenomenon demonstrates the rise of the German and American economies and the relative but by no means absolute, decline in the British world position.

In the late decades of the nineteenth century, American technology became increasingly emphasised in *Teknisk Tidskrift*. In this kind of technical journals, lectures, and probably also through letters from friends and colleagues who already were abroad, the engineers were informed about interesting technological matters primarily in the United States and Germany. It spurred an interest among them to emigrate, acquire access/knowledge of these technologies and then return to Sweden. While abroad, personal contacts and Swedish engineering societies could facilitate for them to acquire access/knowledge. However, the engineering societies such as the one in Chicago emphasised more the integration into the American society through the celebration of the ethnic origin than spurred return migration to Sweden. Still, a huge majority of the engineers who worked and/or studied in the United States and Germany returned, but the infrastructure of Swedish organisations in the United States probably contributed with the twofold character of the transatlantic emigration of engineers. This helps explain why the American return rate was significantly lower than the German. In all, every fifth engineer in Sweden had experienced one of the model countries, whereas a minority had experienced both. Almost as many engineers returned from Germany as from the United States, and the German influence on Swedish industry was almost as big as the American. Every eighth engineer in Sweden had been working/studying in the United States and every ninth in Germany. When these returning engineers stepped on Swedish soil again they were potential carriers of technology. They fulfilled all but one of the criteria Edquist and Edqvist emphasised as important for a unit that wanted to become a real carrier of technology.

The engineers still lacked power. However, in a country looking towards the United States and Germany for technical inspiration and where the values connected to development nationalism were flourishing, the access/knowledge of American and German technology worked, in a Bourdieuan sense, as symbolical capital on the engineering field. To a significant degree, the returnees reached high positions in the Swedish industry. Social capital such as family background as well as symbolical capital such as a higher level of education was important, but the foreign experiences worked as a mean to lift engineers with lower social origin and lower levels of education up to equal terms with non-emigrating colleagues of higher social origin and with higher level of education. However, the most advantageous positions were those of engineers with high social origin, high level of education and foreign experiences. The experiences from abroad lifted them above non-emigrating colleagues with high levels of education and with upper-class background. The symbolical capital in the form of access/knowledge of foreign technology gave the returning engineers the power to become real carriers of technology. This was due for all kinds of engineers but the electrical engineers were a group that could gain a lot from target migration. They, and their main employer, ASEA, are the subjects of the next chapter.

Notes

1 Excerpt from a letter written by Charles P. Steinmetz to Eskil Berg, 1895, GEHA.

2 Steinmetz was born in the city of Wroclaw in today's Poland, which was then (1865) the German city of Breslau.

3 On Steinmetz's views on America, also see the letter to his father in Breslau from Yonkers, NY, June 7, 1890, quoted in *The Steinmetz Era 1892-1923. The General Electric Story. A Photo History. Volume 2* (Schenectady, NY, 1977), 6.

4 Ronald R. Kline, *Steinmetz. Engineer and Socialist* (Baltimore, MD, 1992), 3-24.

5 M Wyman 1993, 3-15.

6 "Hjärnflykt eller sänkta skatter?" in *Svenska Dagbladet,* 19/1-2001.

7 Ronnie Andersson & Harald Theorin, "Kompetensflykt – myt eller verklighet?" in *Välfärdsbulletinen,* 4/1998, 4-6; Ronnie Andersson & Harald Theorin, "Civilingenjörerna stannar i Sverige" in *Välfärdsbulletinen,* 2/1999, 6-7.

8 Per-Olof Grönberg, "International migration and return migration of Swedish engineers before 1930 and in the 1990s" in *Nordic demography. Trends and differentials. Scandinavian population studies, volume 13,* ed. Jørgen Carling (Oslo, 2002), 269, 276.

9 G Stang, 25.

10 Statistics taken from S Carlsson 1976, 117-119; C H Riegler 1985, 27, 31.

11 Sune Åkerman, "Theories and Methods of Migration Research" in *From Sweden to America,* 21; K Virtanen, 160.

12 The ASEA-engineer Albert Elfström wrote a report stating that he viewed the Germans including the Swiss as ASEA's main competitors. Most of the emigration of Swedish engineers was also directed towards the German speaking part of Switzerland, mostly to Zurich for studies at the Polytechnical institute (Albert Elfström, "Reserapport", Unpublished paper 1907, ENDA, volume H:N8 01-002).

13 Ture Steen to Edström, 22/1-1904, JSE, RA, volume 89. Swedish original: "Jag måste djupt beklaga, Herr Direktör, att det är mig omöjligt att i den närmaste framtiden antaga Edert vänliga anbud, emedan jag ännu anser mig för ung och oerfaren för att kunna värdigt fylla en sådan plats Ni erbjuder mig. Min afsikt är emellertid att innan jag bosätter mig i Sverige komplettera mina två år av värdefull amerikansk praktik med 3 á 4 års lika värdefull praktik i Tyskland, och skall jag helt säkert därefter vara mera mogen för framgångsrikt arbete i mitt eget fosterland, där järnvägsproblemet ännu väntar sin 'elektriska lösning'".

14 Edström to Steen, 4/2-1904, JSE, RA, volume 89.

15 M Fridlund, 31; J Glete 1983, 18.

16 S Skard, 180-181; G Stang, 25.

17 S Carlsson 1988, 58.

18 Hugo Hammar, *Minnen I. Från Ölands alvar till livets* (Stockholm, 1937), 230.

19 On emigration from Öland, see Margot Höjfors Hong, *Ölänningar över haven. Utvandring från Öland 1840-1930 – bakgrund, förlopp, effekter* (Uppsala, 1986).

20 Hugo Hammar, *Minnen II: Som emigrant i U. S. A.* (Stockholm, 1938), 11. Swedish original: "Det var emellertid ingen vanlig emigrant, som här gav sig ut på vinst och förlust, utan en färdig ingenjör, som nu skulle skörda frukten av sina studier".

21 H A Barton 1994; H Lindblad 1995; M Wyman 1993, 32.

22 M H Hong, 121-122; L O Olsson 2000, 50-51.

23 C H Riegler 1985, 31.

24 S Carlsson, 1991, 185.

25 Statistics are derived from S Carlsson 1976, 117-118; C H Riegler 1985, 31.

26 K O Bjork, 432.

27 S Carlsson 1991, 181-192; M Fridlund, 74; Per-Olof Grönberg, "'My Kind of Town?' Ethnicity and class as determing factors for return migration or permanent settlement among Swedish engineers in Chicago, 1910-1930" in *Swedishness Reconsidered,* 121-142; B J Nordstrom, 193-212.

28 *Svenska Tribunen-Nyheter,* 10/10-1928, SESC, SAAGC, volume B1:F5. However, Swede-Finns seem to have been accepted as members from the beginning.

29 B J Nordstrom, 193-194

30 K O Bjork, 435.

31 "Vår förening" in *Trasdockan,* 1/1923, 3.

32 B J Nordstrom, 194

33 *Festskift utgifven av Svenska Ingeniörsföreningen i Chicago, Ill. 25-årsjubileum* (Chicago, IL, 1933), 7. Swedish original: "hundra procent amerikan bland amerikanare och hundra procent svensk bland svenskar".

34 *Festskift,* 7.

35 "Vår förening", 3.

36 "A. G. Wittings tal vid Svenska Ingeniörsföreningens jubileumsfest den 6 oktober 1928" in *Monthly Bulletin of the Swedish Engineers Society of Chicago,* November 1928, 6. Swedish original: "Vi bliva bättre amerikanare ju mera medvetet svenska vi äro".

37 "A. G. Wittings tal", 6. Swedish original: "Vi ha kommit hit av vår egen fria vilja, vi hava funnit oss till rätta och vi hava acklimatiserats".

38 "A. G. Wittings tal", 6.

39 "Svenska Kulturförbundet i Amerika", advert in *Trasdockan,* 1931, 19.

40 D Blanck 1990, 135-150; Kathleen Neils Conzen et al, "The Invention of Ethnicity. A Perspective from the U.S.A." in *Journal of American Ethnic History,* Fall 1992.

41 A few examples were Albin G. Witting, "En hälsning till Fädernas Land" in *Trasdockan* 1/1918; "En nyårshälsning" in *Trasdockan,* January 1924.

42 B J Nordstrom, 202.

43 Interview with John E. Jacobson, President of the Swedish Engineers' Society of Chicago, 1974-1988, in Evanston, IL, USA, 8/9-1998 by Per-Olof Grönberg.

44 Interview with Reno Ahlgard, President of the Swedish Engineers' Society of Chicago, 1967-1974, in Sandwich, IL, USA, 22/2-1999 by Per-Olof Grönberg.

45 P-O Grönberg 1999, 126-127.

46 B J Nordstrom, 193.

47 Carl Hjalmar Lundquist, "Tal hållet af Stadsadvokat Carl Hjalmar Lundquist vid Middagen för gästern (sic!) från Kungliga Tekniska Högskolan i Stockholm i Svenska Ingenjörsföreningens i Chicago klubbhus i 503 Wrightwood Ave., Chicago, Ill., Söndagen den 14 juli 1946", SESC, SAAGC, volume B1:F7; P-O Grönberg 1999, 126.

48 Interview with J E Jacobson.

49 C. G. Axell, Carl Säve & K. G.Lindwall, *Minnesbok af Svenska ingeniörskongressen i Förenta staterna 1915 på uppdrag av kongresstyrelsen utgifven af C. G. Axell, Carl Säve, K. G. Lindwall* (Chicago, IL, 1916), 38.

50 "En hälsning från Moder Svea" in *Trasdockan,* 1913, 1. Swedish original: "I drömmen ila mina tankar till svenskhetens hufvudfäste i Amerika, till Chicago, där de svenska ingeniörerna besitta alla ämbeten af någon betydelse, där en svensk är justitieminister och en mångfald svenskar äro presidenter". "Mother Svea" is the Swedish equivalent to for instance the American "Uncle Sam".

51 "En hälsning från Moder Svea", 1-2.

52 *Svenska Teknologföreningen* I, 217; S Carlsson 1991, 184-186; C. Theodore Larsson, "Architects and Builders" in *Swedes in America 1638-1938,* eds. Adolph B. Benson & Naboth Hedin (New Haven, CT, 1938), 421-422; Lawrence E. Widmark, "Engineers" in *Swedes in America*, 415.

53 K O Bjork, 221-227.

54 Edward J. Kelly to Fred Erickson, 29/12-1943, SESC, SAAGC, volume B1:F7.

55 Eric Einar Ekstrand, "På vad sätt kunna av Svenska Ingenjörer i Förenta Staterna vunna erfarenheter komma Sverige till godo?"in *Trasdockan,* 1/ 1918.

56 H Hammar, 1937, 254.

57 H Hammar, 1937, 264.

58 L E Widmark, 409-410.

59 M Lindqvist, 46-47, 49, 59.

60 R Torstendahl, 45.

61 On Alexanderson, see James E. Brittain, *Alexanderson: pioneer in American electrical engineering,* (Baltimore, MD, 1992).

62 Frank Ernest Hill & C. D. Wagoner, "Interview with Ernst Fredrik Werner Alexanderson by Mr. Frank Ernest Hill and Mr. C. D. Wagoner on 22 February 1951 at Building 37, General Electric Company, Schenectady, New York. This interview taken on tape-recorder", Unpublished paper, 1951, GEHA, 8-9.

63 M Wyman 1993, 17-22.

64 E Engström, 93.

65 M Wyman 1993, 22-25; B Brattne & S Åkerman, 176.

66 M Wyman 1993, 22.

67 L P Moch, 152.

68 B Brattne & S Åkerman, 176.

69 E Lange, 2-3.

70 E Lange, 2.

71 G Stang, 27.

72 Knut Djupedal, "150.000 amerikafarande kom attende" in *Populaervitenskaplig Magasin,* 1992.

73 D Broady 1990, 172-173.

74 Ulf Beijbom, *Amerikaminnen: berättelser i utvandrarbygd* (Stockholm, 1996), 279-280; L Berrocal, 21-25; J Bodnar, 54; D Cinel, 164-167; K Djupedal 1993, 105; *En Smålandssocken emigrerar,* 817; R Fakiolas, 37-42; D Gabaccia, 109; J- P Garson, 11-12; Ali S. Gitmez, "Geographical and occupational reintegration of returning Turkish Workers" in *The politics of return,* 113-116; Russell King, Jill Mortimer & Alan Strachan, "Return Migration and the development of Italian Mezzogiorno" in *The politics of return,* 79-83; O Korsfeldt, 11; Silva Meznaric et.al., "An action program to attract Slovene workers to return home" in *The politics of return,* 137-140; L P Moch, 157; Mirjana Morokvasic, "Strategies of Return of Yugoslavs in France and the Federal Republic of Germany" in *The politics of return,* 87-91; Pia Nyman-Kurkiala, *Kedjeåtervandringen från Jakobstadskolonin. En fallstudie i innovationsspridningens betydelse för finlandssvensk migration* (Vaasa, 1990), 87-89; E Reyneri & C Mughini, 37-39; E Sacareno, 67-72; T Saloutos, 78-79, 88-91, 93-97, 100, 101; Karen Schniedewind, *Begrentzer Aufenthalt im Land der unbegrentzen Möglichkeiten. Bremer Rückwanderer aus Amerika 1850-1914* (Stuttgart, 1994), 177-181; I Semmingsen, 148-152; E S Ferreria & J J.R. L Pereira, 21-25; Klaus Unger, "Occupational profile of Returnees in three Greek Cities" in *The politics of return,* 93-95; K Virtanen, 195; A Walaszek,1981, 213-216; A Walaszek 1995, 109; M Wyman 1993, 127-150.

75 E Lange, 5.

76 Karl Axel Bratt, *J. Sigfrid Edström. En levnadsteckning. Förra delen* (Stockholm, 1950), 33.

77 K O Bjork, 35-36.

78 S Carlsson 1988, 58.

79 L-G Tedebrand 1976, 209.

80 G Stang, 25

81 M Wyman 1993, 16-17.

82 L P Moch, 156; L-G Tedebrand 1972, 258; L-G Tedebrand 1976, 226; K Virtanen, 225, all stated that return migration in general took place after less than five years, whereas K Schniedewind 1994, 100-101, finds that the returnees to Bremen more often had been in America longer than five years.

83 Anders Brändström & Tom Ericsson, "Social mobility and social networks: the lower middle class in late nineteenth century Sundsvall" in *Swedish urban demography during industrialization,* eds. Anders Brändström & Lars-Göran Tedebrand (Umeå, 1995). Compare with Fred Nilsson, *Emigrationen från Stockholm till Nordamerika 1880-1893: en studie i urban utvandring* (Stockholm, 1970).

84 *Riskerar Sverige en kompetensdränering? Om utlandsarbete och rörlighet bland unga akademiker* (Stockholm, 2000), 40.

85 M Wyman 1993, 22.

86 S Carlsson 1976, 128.

87 T Gårdlund 1942, 234; T Gårdlund 1945, 20-23; S Rydberg 1951, 139-202.

88 D Broady 1990, 179-181.

89 Augusta's maiden name is unknown.

90 Augusta Fegreaus to her father-in-law, 17/7-1904, HF, letter 250, SEI, volume 22:15.

91 One example is Harald Fegraeaus to Emelie Fegreays, 11/12-1899, HF, letter 94, SEI, volume 22:15. In that letter Harald Fegreaus discussed the possible employment as chief engineer at the local railway on Gotland arranged for him by his brother Axel. "It would be alright, if I had any kind of idea about work methods and the like at the railways in Sweden, but without possession of it, it would only bring shame on myself and Axel, who has got me the place – Isn't it so? (Swedish original: "Det vore allright, om jag hade någon slags aning om arbetsmetod och dylikt vid banorna i Sverige, men utan besittelse deraf vore det bara att bringa mig sjelf och Axel, som anskaffat mig platsen, till skam – Är det inte så?")

92 Gunnar Werner, "Från Gotland till Nordamerika. Några drag ur en gotländsk emigranthistorik 1884- ca 1900". Unpublished paper, Linköping University, 1979, 5; For more about Harald Fegreaus, especially regarding his views on Indians, see Johanna Hedenquist, "En klarsynt man? Möten mellan en svensk emigrant och nordamerikanska indianer under 1800-talets sista decennier", Unpublished paper, Department of Humanities, Växjö University, 1998.

93 S Carlsson 1976, 133-134, 136, 139.

94 M-L Gentileschi, 61-64; I Semmingsen, 461; C-E Måwe, 152-153, 157; E Sacareno, 67-71; K Schniedewind 1995, 345; L-G Tedebrand 1972, 237-240; L-G Tedebrand 1976, 218; K Virtanen, 75-76.

95 The statistics were taken from L-G Tedebrand 1972, 227.

96 Compare the discussion in P-O Grönberg 1999, 131-136.

97 A Kaijser, 39; B Sundin 1991, 249.

98 R Torstendahl,. 45.

99 Kjell Nordqvist, "Amerikaresa via Göteborg-Hull-Liverpool" in *Göteborgs-Emigranten 4* (Göteborg, 1988), 136-147.

100 In this group, the metallurgical engineers were included. Sten Carlsson makes a distinction between the sectors *gruvvetenskap* and *bergsvetenskap* (both must be translated to "science of mining" in English) on the one side, and the metallurgists on the other (S Carlsson, 1991, 187). In Indebetou's and Hylander's directory, however, the metallurgists were a sub-group to the sector B. Therefore, they were counted as mining engineers in this context.

101 S Carlsson 1991, 185-188.

102 T Gårdlund 1942, 233-259.

103 K Djupedal 1992.

104 L O Olsson 2000, 103-109.

105 J Glete 1987, 18.

106 Wilhelm Sebardt to Henrik Göransson, 16/9-1905, SA, SKCA, volume 9.

107 J Glete 1987, 248-263

108 L O Olsson 2000, 98-108

109 D Broady 1990, 179-180.

110 D Broady 1990, 180.

111 Edström to Bernt Unger, 8/6-1903, JSE, RA, volume 85; Edström to Hellman, 10/10-1912, JSE, RA, volume 113; Sebardt to H Göransson; K A Bratt I, 75-76; O Gasslander, 152; J Glete 1983, 45.

112 D Broady 1990, 270. Swedish original: ”Ett system av relationer mellan positioner besatta av specialiserade agenter och institutioner som strider om något för dem gemensamt”.

113 Torsten Althin, *Bolidenföretaget från fjällgränsen till skäret* (Skelleftehamn, 1945); G Carlestam; *Ett svenskt jernverk. Sandviken 1862-1937,* ed. Göran Hedin (Uppsala, 1937); T Gårdlund 1945; J Glete 1983; J Glete 1987, 255-257; Olle Hedebrant, *Omvandlingen. Sandvik 1862-1937. Från järnverk till högteknologiskt verkstadsföretag* (Sandviken, 1987).

114 Per-Olof Grönberg, ”Returned engineers in Sweden 1890-1930”, Paper presented at the conference People on the Move in Stavanger, Norway, 3-6 May 2000; Per-Olof Grönberg., “Tillbaka till Framtidslandet. Ingenjörsmigrationen mellan Nordamerika och Norrland före 1940” in *Oknytt,* 3-4, 2000 (Umeå, 2001), 57-60.

4. ELECTRICAL INDUSTRY: Allmänna Svenska Elektriska Aktiebolaget (ASEA)

In late April 1932, the chairman of the Sweden-America Foundation, J. Sigfrid Edström, broadcasted a radio-speech in the United States. He talked about the long-time relations between the two countries, his expectations of the upcoming Olympic Summer Games in Los Angeles – where he was to function as main leader of the Swedish troop[1] – the world's economic depression and what to do about it. He ended his speech with a single sentence which carried enormous expectation: "We are looking for Light, for Hope and for Initiative to come from U.S.A".[2]

When he made the speech, Edström had about one year left as managing director of Sweden's largest electro-technical company, *Allmänna Svenska Elektriska Aktiebolaget* (ASEA). For thirty years, Edström had developed the company into one with subsidiaries all over the world. Edström was himself a returnee with four years of experience in the United States as well as five years in Switzerland. He was also a firm believer in the possibility of establishing a Swedish electrical industry that would be competitive on the world market. Around the turn of the century, German electro-technical companies viewed Scandinavia as a natural part of their "territory".[3] Edström wanted to meet the German competition.

The company had extensive contacts with the United States. Over time the contacts stretched from the years around the turn of the century into the nuclear age and the most important ones were those with General Electric even if contacts with Westinghouse also were present. It was more difficult to uphold the contacts with German companies due to the competition.[4] In a book issued on the hundredth anniversary of Edström's birthday Marcus Wallenberg Jr. stated that Edström was "a modern technician and businessman of the American-fashioned type".[5] He looked for light, hope and initiative to come from the United States also in his duty as managing director of ASEA. In this chapter, we will look more closely into ASEA, both before Edström and also during Edström's time. The direct English translation of the company's name – which was used by the company itself – was the Swedish General Electric Ltd. Naturally it brings to mind the American electro-technical company. But was ASEA a Swedish General Electric also in practise?

4.1. Electrical engineering in Sweden

The year 1903, ASEA's twentieth year of existence, can be viewed as a turning point in the company's history. The same might be said for the history of the Swedish electrical engineering industry more generally for such was the importance of ASEA.[6] In 1883, engineer Ludvig Fredholm founded the company whose main purpose was to make use of the invention of three-phase alternating current made by the engineer Jonas Wenström. The historical roots of the growth of the electrical workshop industry were to be found in the scientific discoveries about electricity from the late eighteenth century and onwards.

Sweden's geography ensured far-flung internal markets which thus gave ASEA early opportunities to develop high competence in transferring large quantities of electrical power over long distances. The company reached a position of world leadership in this area, but ASEA was also early with the manufacturing of electrical locomotives, tramways and trains.

However, the company witnessed financial crises in the early twentieth century and was re-organised in 1903. ASEA had ambitions to be a company with a full range in the power-generation industry. Therefore, ASEA bought several smaller companies in Sweden as well as in the Nordic neighbouring countries throughout the twentieth century. In 1988, ASEA merged with the Swiss company Brown Boveri and is nowadays called ABB (ASEA Brown Boveri). Around 1990, ABB had about 180.000 persons employed and was active in about 140 countries all around the world mainly through subsidiaries.[7]

The home of the company has always been the province of Västmanland, north west of Stockholm. In 1891, the main office moved from the smaller town of Arboga to the provincial capital Västerås, which today is still the location of the company's main office in Sweden, whereas the ABB Group headquarters are located to Zurich.[8]

4.2. Previous research about ASEA

ASEA is a fairly well-investigated company. On several of its anniversaries, there have been histories written about it – many of them commissioned from within. The one from 1908 was more or less an official presentation of the company. The same can be said about the economist Johan Åkerman's study of 1933. The foreign experiences of several of the leading persons and engineers were in some cases mentioned but there was no analysis of their importance.[9] The most valuable company histories for this study were Martin J. Helén's three books from the 1950s and Jan Glete's company history for the hundredth anniversary in 1983.[10]

The major advantage of Helén's work is that he surveyed almost every engineer in a responsible position up until the late 1940s. Thus his work facilitates a systematic study of the engineers' foreign experiences through linkages of Helén's information to the one given in the directories. As Glete stated, Helén's work is a kind of encyclopaedia of ASEA before the 1950s.[11] Sometimes Helén also revealed that foreign experiences were important in the engineers' work at ASEA and that the engineers were successful and important for the company. Helén was an engineer educated at the technical upper secondary school in

Norrköping. He was employed at Siemens & Halske in Berlin and made a study trip to the United States and Canada. In 1916, he was employed as chief assistant at ASEA's branch in Stockholm and from 1920 until his retirement in 1944 he headed ASEA's so called Bergslagen-branch, which also was located to Västerås.[12] It is worth remembering that Helén was a part of ASEA's inner circle. His possible personal relations as well as the very fact that the books were issued by the company itself may influence his judgements.

The company also published Glete's book on the hundredth anniversary. Glete recognised the importance of foreign experiences, particularly the American ones, both on a general scale for Swedish electrical engineers and for some of the individual engineers at ASEA.[13] The two-part biography of Edström written by Karl Axel Bratt in the early 1950s contains some interesting information about the man as well as other engineers who had worked abroad. Bratt indicated that foreign experiences on a wider scale were important, but did not analyse how and why.[14] Bratt's two books must be taken with some care as they were intended to celebrate Edström.

The most recent study of ASEA is Fridlund's concerning the cooperation between ASEA and the National Water Power Board on the Swedish electrical power technology. Fridlund is the scholar who has gone most deeply into foreign influences. He discussed the strategies to achieve competence and the importance of American know-how for the development of the Swedish electrical industry. Study trips, repatriation of Swedish engineers from American and German major competitors, giving leave of absence to engineers in order for them to go and take employment abroad as well as strategic alliances with foreign companies were strategies used to gain the much needed competence.[15]

Edström's inspiration of the American ideals of mass production and rationalism was also emphasised in Brunnström's study about rational factories and workshops in early twentieth-century Sweden. Her conclusion was that the old factory building at ASEA was impossible to use for effective mass production. The Mimer workshop, inaugurated in the 1910s, was inspired by AEG in Berlin. It was planned and built by the Västerås town architect Erik Hahr, who also had experience in Germany. However, both Edström and AEG's managing director Emil Ratenau were inspired by American ideas of efficiency. The Arvid workshop, planned and build in the 1930s was more of a "purely" American inspired factory, much like the day light factories made by AB Industribyrån.[16]

Engineers with foreign experiences have been studied with regard to ASEA, but it has not been done in a systematic way. This will be done by going through the sub-departments in the construction and production departments. In this sense, hopefully, it can contribute to a more complete picture of the important foreign influence. As indicated, Edström was an important person in this context and this examination will begin with a biography of him.

4.3. The managing director: J. Sigfrid Edström (1870–1964)

Edström, ASEA's managing director (1903–1933) and chairman of the board (1933–1949) was born on the west-coast island of Orust, north of Gothenburg. His reason to apply for a grant to study in Zurich after his graduation from CTI in 1891 was to develop his knowledge in the electro-technical field. During his time at CTI, Professor August Wijkander had only dealt with this field briefly in his lectures. In the late summer of 1893, Edström left Polytechnikum with good marks. He then wanted to make use of his newly acquired knowledge and was attracted by the United States in order to obtain practical experience in his main field of interest, electrical engineering. No other country had reached so far in the development and Edström certainly was informed about it during his time as student in Gothenburg and Zurich, perhaps from reading *Teknisk Tidskrift,* where American technology became increasingly emphasised, partly because of the inventions in electrical engineering.[17]

One acquaintance Edström made in Zurich was a man named Jules Neher, who he competed with in rowing. After finishing his studies at Polytechnikum, Edström wrote to Neher – who at that time was employed at Westinghouse, and asked him whether there was any chance for him to get employment in the United States. Neher replied that if Edström was well acquainted with the English language he could get a place in East Pittsburgh. In September 1893, after having spent a week at the World Exhibition in Chicago, Edström started to work at Westinghouse. He stayed for about two and a half years. According to Edström, the work in the factory was manifold and he learned a lot. For a time he worked directly under the inventor George Westinghouse. The activity in the American electrical industry was high during the-mid 1890s and the building of power stations with transmission lines had started on a bigger scale. In 1893, Westinghouse got an order to build the biggest power station in the world at that time for Niagara Falls.[18]

In 1897, Edström returned to Switzerland and worked three years as tramway engineer for the City of Zurich. He married Illinois-born Ruth Miriam Randall in Chicago 1899 and resettled in Sweden the year after. Edström spent three years as director for the tramways and for the power station in Gothenburg. He made a name for himself as a tramway technician during his second stay in Zurich as well as during his time as director of the Gothenburg city tramways.[19]

When Göran Wenström resigned in 1902, district judge Marcus Wallenberg, representative in the ASEA board for one of Sweden's largest banks took as his task to try and find a new managing director for the company. Wallenberg has described his mission as difficult. ASEA was on the verge of bankruptcy, competent people were about to abandon the company, there was a lack of capital and ASEA was commonly seen as an easy prey for German competitors. In the end of 1902, Wallenberg had found the right man for the job, Edström.[20] His foreign experience were important.[21]

As stated above, engineers were a powerful occupational group in Sweden during the decades around 1900.[22] ASEA's economic situation made Edström hesitate about the decision and in January 1903, Wallenberg made a second journey to Gothenburg in order to try and convince him. He was successful and Edström signed for five years. However, Wallenberg was forced to guarantee him 100.000 Swedish crowns in case ASEA went bankrupt during his time as managing director.[23] Wallenberg's willingness to accept this claim shows how anxious the board was to recruit Edström. It was thus natural that Edström was given a free hand to organise the company as he wanted. ASEA wanted to compete as a first class company in electrical engineering and no price was too high to pay in order to avoid being ranked as a second-class company, and thereby threatened to become a mere German satellite. Therefore, the German competition became a stimulus for technical development at ASEA.[24]

One reason behind Edström's interest in introducing new technology and other ideas from the United States was that they were largely unknown in Swedish electrical engineering. If he went to the United States and gleaned expertise in the most advanced practises, and returned with good ideas, he would have a good foundation upon which to build a successful professional career in his home country. In the 1890s, Swedish electrical engineering was not especially developed. The United States and Germany lay ahead of Sweden. Thus, by introducing ideas from at least one of these two countries, Edström perhaps could become one of the Swedish pioneers in the field.

Edström's American wife was of immense importance for Edström's lifework and Wallenberg described him as "modern and Americanised".[25] But it is also important to remember that Edström was first and foremost a Swede. While abroad he actively participated in Swedish and Scandinavian organisations and in contacts with foreigners he always spoke well about his country and his native province of Bohuslän.[26]

Edström made several journeys across the Atlantic. In 1905, he joined *Svensk-Amerikanska Sällskapet i Stockholm* (The Swedish-American Society in Stockholm) founded that same year.[27] The purpose of this society was to work for the spreading of knowledge about conditions in Sweden and the United States and to support the interaction between Swedes and Swedish-Americans. People who had been active in American working life or as students or who showed an interest in the society's purpose could be elected as members.[28] In 1918, Edström was one of the founders of the Sweden-America Foundation, an organisation awarding grants to Swedish scholars to go to the United States as well as for Americans to come and study in Sweden.[29] In 1926, Edström wrote a letter to his colleague and friend August Herlenius at the Uddeholm Company asking him for support. Edström described the importance of young Swedish men and women going to the United States for studies. He regretted that the Foundation had not gained the same support and understanding in Sweden as in the United States and continued:

> The importance of the Foundation being able to give around 20 young Swedish men and women, with the best qualifications, the opportunity to gain increased knowledge and experience, each of them in their own special field, in the great future and present day country United States with it's seething development in almost every field is striking. And it is <u>Swedish</u> science, <u>Swedish</u> trade and industry, <u>Swedish</u> banking, that at the last stage will gain from the work of the Foundation. [30]

Edström continued to comment on the strict American immigration laws of that time and the fact that almost all the Foundation's scholarship holders had returned to Sweden.[31] The letter to Herlenius showed clearly Edström's views on the importance of American ideas for Sweden.

Thus Edström had a good reputation, a name as technician and thought highly of the United States. As we will soon see, this influenced his leadership and recruitment of engineers to ASEA.

4.4. Engineers in leading positions at ASEA

The activity to give engineers leave of absence in order to take employment at major competitors abroad lay, according to Fridlund, in the borderland of industrial espionage.[32] In 1907, the journal *American Machinist* suggested that General Electric and Westinghouse were controlling American electrical engineering to such an extent that it was almost impossible for new men with new ideas to come forward.[33] Most American electrical engineers worked for these companies as well and they were also important for engineers from foreign countries.[34]

If the engineers were able to implement ideas from abroad, the development of a large-scale Swedish company within electrical engineering might hypothetically have paralleled the pattern Djupedal saw for Norway as a whole. In the examination that follows, the leading engineers at ASEA's construction and the production departments as well as at the branches in Ludvika, Stockholm and Härnösand will be scrutinised between 1890 and 1940. An overall picture of the emigration and study trips experiences of these engineers is given in table 4:1.

TABLE 4:1: Emigration experiences of engineers in leading positions at ASEA's management, the construction and production departments in Västerås and the branches in Ludvika, Stockholm and Härnösand, 1890–1940. By time period and total.

PERIOD	**Returnees**	**Immigrants**	**Only study**	**Foreign experiences**	**%**	**Non-emigrants**	**No information**	**TOTAL**
1890-1902	8	0	0	8	50,0	8	*2*	**18**
1903-1910	20	5	0	25	92,6	2	*3*	**30**
1911-1920	21	5	1	27	69,2	12	*8*	**47**
1921-1940	16	2	3	21	53,8	18	*6*	**45**
TOTAL	**65**	**12**	**4**	**81**	**66,9**	**40**	***19***	**140**

SOURCES: *Svenska Teknologföreningen* I and II; *Chalmers; Porträttgalleri; Malmö Teknologförbund;* ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010; M J Helén 1955, M J Helén 1956.

As we can see, during the whole period a significant majority of the leading engineers had been working and/or studying abroad. If those only on study trips also were included, it was two-thirds. The foreign experienced engineers were probably able to make an impact, as they could implement their practises in many departments of the company. The impact was probably even more significant when it happened within a smaller unit as a company compared to a whole country.

Most of the engineers in leading positions were Swedes who had returned from employment in other countries but there was also a minor share of foreign-born immigrants among them. In accordance with Lindqvist's criteria for successful technology transfer, their Swedish background probably facilitated the integration of these technicians in the ASEA environment and thereby also the success of their technical implementations. Furthermore, the immigrants were often Norwegian and Danish something that must have facilitated integration at least when it came to the language. It was also stated with regard to the British-born chief engineer of the workshops in Västerås 1908–1913, Frederick Vickers, that he could easily adjust to the Swedish conditions, even if the language occasionally caused some problems and Vickers sometimes had to use interpreters.[35] The integration of the technicians in the existing social order in Västerås was probably also facilitated by the fact that many of the returnees were electrical engineers and had worked for the company before they had emigrated. A third (34%) of the returning engineers were employed at ASEA also before they went abroad. This pattern and, as we will see later, some of the correspondence between Edström and engineers abroad, further underline the conclusion of an activity bordering on industrial espionage.

From Table 4:1, we can also see that the practice of employing engineers with foreign experiences was most evident during the first years after Edström's appointment as managing director, when more than 90% of the engineers employed as departmental heads, chief engineers, etc. were returnees or immigrants. The importance of foreign experiences declined with time, leading to the conclusion that these impulses were most important in the beginning of Edström's reconstruction of the company. Over time the rates of returnees/immigrants declined possibly because the foreign production methods had been established on a wider scale and it was not as important as in the beginning. However, we can still observe relatively high shares of foreign experienced engineers in the leading positions after 1910. It was a continuous process and it clearly indicates that the strategy was successful. The emigration of primarily electrical engineers, therefore, cannot be seen as disadvantageous for the large Swedish electro-technical corporation. On the contrary, Edström's aim to recruit Swedish engineers and foremen from American and German workshops and the continuous process show that emigration and return in the longer run were sources of development for a company that dominated Swedish electrical engineering in the early decades of the twentieth century.

The letters to August Tinnerholm, dated May 22, 1903 and to Bernt Unger dated June 8, the same year, show how Edström from the beginning aimed to apply American production methods and his beliefs in those methods as ASEA's salvation. Unger was an old friend from Zurich who took over his father's business in Arbrå in the province of Hälsingland and planned to manufacture electrical motors of the same kind as at ASEA. In the letter, Edström warned Unger about getting into the business and told him he would show no mercy in the competition. Unger would waste his money, he was told, as he had no chance of competing with ASEA. Edström gave the reason:

> I have already acquired capable engineers with American and German experiences and at the moment I am about to acquire capable foremen (Swedes from American and German workshops). It is my purpose to increase the manufacture so that I can meet the German

> competition. – As you see, I have got excellent resources, and as I have got more than four years of American workshop practice myself, I think I will be able to get Allmänna Svenska [ASEA] into the forefront.[36]

Edström proved to be right at least according to his own judgement. In a letter to engineer Helge Smedinger from 1942, he referred to his correspondence with Unger and wrote "Things went badly for him, you know".[37] In the letter to Tinnerholm, an old acquaintance from Westinghouse, Edström asked him to come to Västerås and be the superintendent for ASEA's main shops. He wrote: "I like to get this shop running on the American plan, with American time – piece pay principles, etc.".[38] Edström regarded American and German experiences, both his own and the experiences of others, as valuable. He wanted to lower costs by applying American and German methods of mass production.[39] These observations are in line with Elzinga's, Jamison's and Mithander's as well as Runeby's conclusions about engineers and industrialists viewing American industrial research, organisational efficiency, and scientific management as central for the action programmes to lift Swedish industry.[40] In Table 4:2, we can see that the United States and Germany dominated as sources of experience for the returning ASEA-engineers. Taking the hidden statistics of nineteen engineers into consideration, more than one third (36%) of the leading engineer had experiences from the United States and more than every fourth from Germany (26%). If none of the unrecorded cases had been in any of these countries the rates would drop to 31% for the United States and 23% for Germany.

During his time abroad, Edström created a wide net of personal contacts that became important for his recruitments. Emil Lundqvist and Harald Håkanson were among the first engineers employed by ASEA after Edström had taken over as managing director. Edström, Håkanson and Lundqvist studied at Chalmers during the same time. In the mid-1890s, they shared an apartment in Pittsburgh's East End while working for Westinghouse.[41] Another example was the Danish born technical chief from 1907, Jens Lassen la Cour, whom Edström made acquaintance with in Zurich in the late 1890s.[42]

The majority of the engineers who had been in the United States were at General Electric and Westinghouse. Approximately every fifth leading engineer had worked for shorter or longer times at General Electric's plants in Schenectady, Lynn or Pittsfield. That is not surprising considering these two companies' dominance of American electrical engineering and their place in the technological forefront. Two other American companies, the Allis-Chalmers Co. in Milwaukee, Wisconsin and the Otis Elevator Co. in the New York suburb of Yonkers had two of the future ASEA engineers working there otherwise there were only single employees at some companies.

Proportionately, the German influence was not as important as the American. Germany was, however, number two in rank when it came to the experience of engineers in leading positions at ASEA. It seems to be a fact that it was more sensitive to recruit from German electro-technical companies as the country to a large extent was one where the future ASEA engineers had studied at technical universities more than having been employed. Most common among the ASEA-engineers was the technical university in Karlsruhe. Among the companies, Union Elektricitäts-Gesellschaft attracted four engineers, but the pattern was more dispersed than the American one with single employees at several companies. The third most common country for future ASEA-engineers to gain experience was Switzerland. Here, the cohort was totally dominated by the Polytechnical institute in Zurich.

TABLE 4:2: Countries, companies and institutions of experience among leading engineers at ASEA 1890–1940.

COUNTRY/COMPANY/INSTITUTION	N	% of foreign exp. leading engineers (N=81)	% of all leading engineers (N=121)
United States	***44***	***54,3***	***36,4***
General Electric Co, Schenectady, NY; Lynn/Pittsfield, MA	22	27,2	18,2
Westinghouse Electric & Mfg. Co, East Pittsburgh, PA	10	12,3	8,3
Study trip only	*3*	*3,7*	*2,5*
Germany	***32***	***39,5***	***26,4***
Technische Hochschule, Karlsruhe	6	7,4	5,0
Union Elektricitäts-Gesellschaft, Berlin	4	4,9	3,3
Technikum, Mittweida	4	4,9	3,3
Allgemeine Elektricitäts-Gesellschaft, Berlin	3	3,7	2,5
Elektr. AG vorm. W. Lahmeyer & Co, Frankfurt-am-Main	3	3,7	2,5
Study trip only	*4*	*4,9*	*3,3*
Switzerland	***13***	***16,0***	***10,7***
Polytechnikum, Zurich	7	8,6	5,8
Brown, Boveri & Co, Baden	3	3,7	2,5
Study trip only	*3*	*3,7*	*2,5*
Great Britain	***9***	***11,1***	***7,4***

SOURCES: *Svenska Teknologföreningen* I and II; *Chalmers; Porträttgalleri; Malmö Teknologförbund;* ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010; M J Helén 1955; M J Helén 1956.

The pattern of the United States as a country for the employment of future ASEA engineers, whereas Germany and Switzerland were mostly countries where engineers studied, indicates that the American influences were more significant when it came to the technical practices than what the statistics show. Employment at a cutting edge electro-technical company was viewed as offering practical experience, while a university education was a more theoretical one.

In many cases it was important to begin a new activity with an engineer with foreign experience in the lead, whereas it must have been more common that a non-emigrating engineer could take over once the department had been established. In Appendix 4:2, we can see that twenty-eight departments were started with a foreign experienced engineer at the top (67%); eighteen departments were started with a person with experience in the

United States (43%) and ten of them had been at General Electric (24%). Thus every fourth ASEA department was started with engineers who had experiences from the Schenectady based company. Only one department was started with an engineer with experiences from Westinghouse. Eight departments had engineers who had been in Germany (19%), four were started with persons with experience from Switzerland (10%) and two with experience from Britain (5%). Table 4:3 gives departments managed by foreign experienced engineers by time.

TABLE 4:3: ASEA-departments with foreign experienced engineers in the top, 1890–1940.

Experience country	**For N**	**For %**	**USA N**	**USA %**	**GER N**	**GER %**	**SUI N**	**SUI %**	**GBR N**	**GBR %**	**Non N**	**Non %**
All of the time	17	37,0	6	13,0	3	6,5	0	0,0	1	2,2	5	10,9
Most of the time	16	34,8	14	30,4	11	23,9	2	4,3	2	4,3	11	23,9
Not most of the time	8	17,4	14	30,4	13	28,3	10	21,7	5	10,9	13	28,3
TOTAL	***41***	***89,1***	***34***	***73,9***	***27***	***58,7***	***12***	***26,1***	***8***	***17,4***	***29***	***63,0***
Never	5	10,9	12	26,1	19	41,3	34	73,9	38	82,6	17	37,0
Total known cases	**46**	**100,0**	**46**	**100,0**	**46**	**100,0**	**46**	**100,0**	**46**	**100,0**	**46**	**100,0**
Unknown	*2*	*4,2*	*2*	*4,2*	*2*	*4,2*	*2*	*4,2*	*2*	*4,2*	2	4,2
TOTAL	**48**	**100,0**	**48**	**100,0**	**48**	**100,0**	**48**	**100,0**	**48**	**100,0**	**48**	**100,0**

* Including study trips and immigrants.
SOURCES: *Svenska Teknologföreningen* I and II; *Chalmers; Porträttgalleri; Malmö Teknologförbund;* ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010; M J Helén 1955, M J Helén 1956.

A large majority of the departments were at some point in time before 1940 managed by engineers with European as well as American experience and more than half of them also had an engineer with German experience at the top. It can be pointed out that someone with foreign experience all or most of the time managed almost three-fourths of the departments, and that almost half of the departments had engineers with experience from the United States in the top most of the time. Furthermore, half of all the departments had engineers from General Electric involved at some point of time.

Thus, ASEA to some extent justified the English translation of its name. But what ideas came from the company in Schenectady and what came from other places?

4.5. Technical chiefs

As mentioned above, the foreign influence on ASEA was most obvious under Edström's management, although we must not overlook the fact that his predecessor Göran Wenström also had foreign experience. There were also engineers with experience in the United States working for ASEA before Edström. One of them was the technical chief between 1892 and 1903, Ernst Danielson.

Ernst Danielson (1866–1907)

In a lecture held in Ludvika 1927, Professor Arvid Lindström talked about the electro-technical development in Bergslagen and stated that it was after Ernst Danielson's return from the United States in 1892 and his engagement in the three-phase system at ASEA, the development got new speed. Sweden was able to catch up with the foreign competitors and retake a front rank position in the development.[43]

When Göran Wenström managed to convince Ernst Danielson to return to Sweden and ASEA it was clearly an important repatriation for the country and its electro-technical development. Danielson worked as Wenström's assistant in the late 1880s and Wenström probably realised his capability already then. In the summer of 1890 Danielson went to the United States and worked a short time for the Wenstrom Consolidated Dynamo and Motor Co. in Baltimore, Maryland and for the Thomson-Houston Electric Co. in Lynn to 1892. Thomson-Houston was one of the predecessors of the General Electric Co.[44] Danielson held positions as draftsman, as head of an electro-technical laboratory, and as calculator of machines.[45] In Lynn, Danielson became acquainted with American technology, and especially with the production of dynamos. In a purely technical way this technology was not superior to the one used in Sweden at the time but the quantities produced were much larger in the United States. He also learned a lot about American workshop organization and American work intensity.[46] In a letter written by engineer Victor Ståhle to the secretary of the "Electrical Club" in Västerås in 1946, he referred to a lecture about Danielson. Ståhle told the story about Danielson's first visit at the Swedish Technical Association after his return from the United States. Danielson's friends and colleagues were gathered around him for a kind of interview and one of their first questions concerned how Danielson was able to pick up so much during such a short time in the United States. His response was: "Well, it was so simple, everywhere, where it said 'forbidden entrance', I sneaked in and avoided as long as possible to come across someone".[47]

This kind of "espionage" probably had its background in an aim to return to Sweden and a begin a career back home. According to his own statement, Danielson suffered from homesickness while in Lynn and that was one of the reasons behind Wenström's successful repatriation in 1892, even if Danielson had to accept a less prominent place.[48] However, he also stated that it was due to his parents. Ernst Danielson's stay in Massachusetts, however, cannot be considered as disadvantageous for the Americans. In 1936, his closest boss in Lynn, Mr. A. L. Rohrer wrote a letter to engineer Ivan Öfwerholm in which he described his feelings of disappointment when Danielson had decided to return to Sweden:

> No one ever left the company whose loss I felt more than Mr. Danielsson's going and I objected strongly to his going but when he explained that it was due to his parents I had to

sympathize with him. In (sic!) not only admired his ability but his personality was such that I came to have much affection for him. [49]

The anonymous writer of a short paper describing Danielson's calculation books assumed that regarding theory and the art of calculation, Danielson probably brought more knowledge to the Americans, than what he learned from them.[50] One indication of that was Rohrer's visit in Sweden in the summer of 1937, when he made a car journey from Stockholm to Danielson's grave in Filipstad to pay his tribute to him and his contributions to electro-technology. During this journey, Rohrer told his Swedish hosts that he had asked Danielson to construct a 500-kilowatt direct-current generator as a test. This was a very difficult task at the time and it demanded very good technical knowledge and practical experience. When Rohrer checked Danielson's work a fortnight later, he found that Danielson had made something that was very unusual at a time when the practice was to begin by making the drawings of the machine and then making changes to them as the work progressed. Danielson had instead calculated the machine by forehand and Rohrer claimed that Ernst Danielson was the one who introduced this practice in the United States.[51]

The earlier mentioned German-born General Electric engineer Charles P. Steinmetz gave further evidence of Ernst Danielson's capabilities in 1894. In an article in an electrical engineering magazine Steinmetz stated that numerous poly-phase induction motors shown at the exhibition in Chicago in 1893 had several defects, with the exception of a few small three-phase motors from General Electric. Danielson in consultation with the engineers Edwin Wilbur Rice, Elihu Thomson and fellow Swede Axel Ekström designed all those without defects.[52] This was the most innovative work of the calculation department and Steinmetz later continued where Danielson stopped.[53]

Undoubtedly Danielson had a lot to teach the Americans, but he also learned a lot himself. The author of the paper about Danielson's calculation books assumed that he became acquainted with many details and mechanical construction of electrical machines and that he later applied this knowledge back in Sweden.[54] Former General Electric engineer and historian of technology Ronald R. Kline wrote a biography of Steinmetz. His most valuable work in his early years in the United States was with the poly-phase alternating-current system. European engineers had built practical three-phase motors and these induction motors had been shown at the exhibition in Frankfurt-am-Main in 1891. The large motors operated at the end of the most spectacular transmission line at the time, the 175-kilometer three-phase from Lauffen-am-Neckar to Frankfurt-am-Main.[55]

The European development made the American companies get into business with the poly-phase work and when Rice retuned to Lynn from the exhibition, he started his preparation to introduce a similar system in the United States. During the winter of 1891 and 1892, the engineers in Lynn built their first three-phase motor. Danielson handled the electrical parts of the construction.

Danielson was also appreciated in Lynn. Indeed, Thomson-Houston wanted him to remain with the company. But in 1892, he returned to Sweden. Danielsson was offered a position as head of the workshops and chief electrician at ASEA's new plants in Västerås after his return.[56] In the lecture from 1946, Danielson was described as being in his best shape during his first years after the return from the United States.[57] There was an ongoing kind of competition between inventors in different countries about who would be the first to develop the three-phase system and one of the competitors was Göran Wenström's brother Jonas Wenström. At a late stage Jonas Wenström realised that he was about to lose the competition and the proof of it was the Frankfurt-Lauffen system. The men behind it were Oskar von Miller and Michael Dolivo-Doborwolsky in Germany and Charles Brown in Switzerland. The patent was awarded in 1890 and Jonas Wenström's Swedish patent came in 1891. His patent gave ASEA numerous incomes and made the company a leading manufacturer in the field. [58]

However, the first tests of Jonas Wenström's three-phase machines in 1891 were not as successful as they had hoped.[59] The motor was not constructed in an appropriate way. When Danielson returned the following year he took on the problem and managed to solve it in a short time. This made possible the three-phase transmission of electricity between Hellsjön and Grängesberg in 1893, a mark in the history of Swedish electrification. The next year, the rolling mill at the iron works in Hofors was electrified and this was probably the world's first electrified iron works. ASEA had managed to create a name for themselves in the three-phase technology and this became important in order to meet the competitions of German and Swiss companies.[60] Development in electricity was one of the prime movers when Sweden witnessed the second industrial breakthrough from the 1890s and in to the positive economic climate the country had until the mid-twentieth century.

Thus it was Ernst Danielsson who developed the systems and adjusted them to suit both motor and high-tension engineering. His experience from the United States was important for this. One of his associates there, Edwin Wilbur Rice, was one of the world's leading electrical engineers who furthered the growth of long distance transmissions and of electrical energy and another collegue, Elihu Thomson, was a prominent inventor of arc lighting and alternating current systems.[61] Danielson worked together with them in Lynn and with this kind of technology after his return. In 1897, for instance, he constructed ASEA's alternating-current generator for doctor de Laval's electro-metallurgic experiments in Trollhättan.[62] Danielson's net of contacts was fruitful for his work after his return. He borrowed from the prominent electro-technicians he had met in the United States and his time in Lynn was important for his work in Sweden in the 1890s and 1900s.

Danielson was an example of American influence before Edström, but they became more obvious after his appointment. ASEA had found it difficult to compete with the foreign companies when it came to prices.[63] The standardisation of ASEA products was insufficient to lower prices and a re-organisation was necessary in order to make ASEA profitable again. One of Edström's first actions was to recruit Danielson's successor. The choice was his friend from Chalmers and Pittsburgh, Emil Lundqvist.

Emil Lundqvist (1870–1942)

Lundqvist's main field of interest was electrical engineering and during his time at Chalmers, he also had Wijkander as his professor. In 1893, Lundqvist went to the United States and started to work for Westinghouse. In an article in *Teknisk Tidskrift* in December 1904, the big electrical industry in the United States was described and Westinghouse was used as the example. According to the authors it was obvious that Westinghouse's systematic installations and rational organisation of the way of working was important to reach a result corresponding to use of a work force containing 9.000 workers. One striking thing about the Westinghouse workshop was the concentrated production.[64]

The authors of the Westinghouse article were also describing the manufacturing in the company's tramway department. The tramway framework was manufactured in one place and transported on railway cars to a department where drilling took place. It was then transported again, this time to the assembly department to be finished. [65] Lundqvist and Edström spent several years in this environment and got acquainted to American methods of mass production and workshop organisation.[66]

In 1896, Lundqvist started to work for the German electrician Siegmund Bergmann in New York. Bergmann decided to return to Berlin two years later and Lundqvist followed him to become the leader for Bergmann's newly founded firm's technical bureau. Two years later, Lundqvist went to South Africa to try to sell Bergmann's electrical machines. He stayed three years and was employed, first as electrician and later as a works engineer in the diamond mines of Kimberley. During his time in New York, Berlin and South Africa, Lundqvist kept in regular contact with Edström.[67] Edström recruited him because he hoped that Lundqvist was the right man to introduce the American production methods. Edström knew him as an independent organiser and thought that he was the one to organise the workshops and the office.[68] In a letter dated June 11, 1903, Edström wrote to Wallenberg that he was considering Lundqvist as technical chief for the workshops. Wallenberg responded to Edström's letter the day after and wrote that he did not know Lundqvist's capacity, but that he completely shared Edström's opinion that the managing director, as much as possible, should not involve himself in the running tasks, but concentrate on one task that needed intensive work at a certain point of time. The board trusted Edström's judgement and Lundqvist was given power to organise the workshops the way he wanted.[69]

According to several people who knew him, Lundqvist had extraordinary qualities as an organiser, economist and technician and he gained a reputation as one of the most prominent industrialists of his time. In some circuits he became known as the "company doctor". Often, he succeeded in transforming losing concerns into profitable ones in short time by rationalising methods. His status was high, and Edström was aware of his capability in an early stage, as he knew Lundqvist, both from their mutual time as students in Gothenburg as well as their time in Pittsburgh. In a letter of April 1903, Edström tried to convince Lundqvist to come to ASEA:

> Yes! and then it was thus my offer. – Yes! dear friend, Sweden has changed or it is at least on its way to. – A rightly handled business is nowadays the main thing, systems in everything – construction, production, sale. – And work grounded in this basis must come forward. You see, there is now a delightful big workshop up there in Vesterås. It works heavy and hard, expensive in the old routines. Come home and help me put life into it. You will take over the lead of the whole workshop and your wage is going to be 8000 crowns a year and tantieme, which guaranteed will be at least 2000 crowns. – If you think that I am asking you to come home to be idle, then you are much mistaken. I have never worked as hard as I am doing now. – But here, it pays too. It is of course totally granted that this is also the case in a country, where until now so much has been idle. -.Regarding your ambitions, I am convinced

> that you still are so old Swedish, that you would be proud to put life into the electrical industry at home. And this place ought not to be your place until your dying day. Here there is much to do and a lot of place upwards for the one who wants and can work. In this place you have also got (and… later perhaps is extended, also the one…what concerns the wage) an opportunity to come home, a staircase, that may never again be offered. – You can of course, chose to wait, until you get rich and live on the interests of your capital. – But then it will be difficult for you to live, cause then your best years were gone and I think you have got so much good to give Sweden that it is a pity if you dig yourself down in Kimberley. Here you have got my offer and my outreached hand. If you want to come, then come soon because early help is double help. [70]

Although Edström wrote that he was convinced that Lundqvist still was "Swedish" in mind, the quote indicates that Lundqvist cared less about where his working place was geographically located, as long as the industry functioned according to what he believed was the best principles. Edström described Lundqvist as the one that laid the base for ASEA's workshop system, still applied as late as in the 1950s. He stated however that he thought it was a shortcoming that Lundqvist so often wanted to change place.[71]

In order to satisfy Lundqvist's restless soul, Edström often sent him on long expeditions abroad, for instance to Britain, the United States and Mexico. But Lundqvist only stayed for three years in Västerås, never got himself a house or an apartment, but stayed in a hotel all the time. Lundqvist rarely joined any societies and the work was his only interest.[72] Glete mentioned that Lundqvist was notoriously reluctant to express himself in written words and that this was one of the reasons why there were few documents that can tell us about his time at ASEA.[73]

When Lundqvist came to ASEA he got his first great mission and started to work frenetically in order to solve it. Sometimes he even slept in a corner of the workshop. It was not that easy because specialised mass production was still uncommon in Sweden at that time. However, Lundqvist succeeded with his mission and, already in 1904, the company had turned its losses into profits.[74]

The aim of introducing the American mass production methods at ASEA was to get production cheaper through standardisation, mechanisation, more control of labour management and a deliberate attempt towards constructing the products in a way that made the work in the workshop as simple and rational as possible. The starting point was that ASEA had to sell its products on the World market and manufacturing costs had to be so low that the sale would be profitable. To reach that goal, the company had to raise their production to a minimum volume in order to get the mass production profitable. ASEA also had to standardise the construction of the products and to concentrate the manufacturing to one workshop.[75] The concentrated production at Westinghouse as described earlier was a possible source of inspiration for Lundqvist's work with the rationalisation.

In *ASEA:s egen tidning* from 1909, the company's mechanical workshop was described. According to the journal, the production was diversified and, therefore, difficult to standardise. However, in 1909 a series of electrical locomotives for different use were produced as were a series of electrical elevators and their parts and the production at the crane department. Parts of the machines were manufactured at lagers and then completed with the motors once ASEA had got an order. The author wrote that it was only in recent years, after some types had been prepared and established, that it had been possible to run the production in such a way.[76] This was probably another inspiration from Westinghouse and its tramway department, where the framework was manufactured in one place, transported to another department for drilling and finally finished in the assembly department.[77]

Lundqvist thus managed to put his distinguishing mark on ASEA's mass production and standardisation before he departed to Estonia in 1907 to organise the production of a company in the same ways as he had done with ASEA.[78]

Carl Silvander (1876)

Carl Silvander, who took over when Lundqvist left the company also made important contributions when it came to standardisation. According to a letter from Edström when Silvander was about to leave ASEA in 1914 he had made a successful work as constructor of electrical machines and their adaptation to standardisation.[79] The Gothenburg native graduated from Chalmers in 1898 and was a student in Zurich one year before he joined Union Electricitäts-Gesellschaft in Berlin as constructor and stayed until 1901. When he came home he worked for one of the smaller electro-technical companies in Sweden as chief engineer. In 1903, Silvander made an agreement with Edström to start work for ASEA in 1904. According to Edström, the news that Silvander was to begin at ASEA was not to be announced before Silvander had returned from the United States.[80] Silvander went there in the middle of 1903 and ASEA paid his journey. In a letter from October that year, Edström urged Silvander to pay attention to all sorts of constructions at General Electric.[81] When Silvander was about to leave Schenectady in order to return to Sweden, Edström instructed him to say that he was going westwards in the United States to look for a new place as he did not want General Electric to know that Silvander was going to come to ASEA.[82] Silvander's stay in Schenectady was surrounded by a lot of secrecy which indicates that the aim was to pick up things during his short stay there. This was how Helén described Carl Silvander:

> With his practical experience from leading German and American electrical companies, Silvander united an exceedingly good constructive eye with organisational capacity and economic judgement and put in considerable work on many new constructions that were under his management, among them could be mentioned the – according to how things were in Sweden then – extraordinary "giant generators" for Svalegfoss and Rjukan in Norway and for Trollhättan and Porjus and so on. Purchasing and also its own manufacturing of modern work machines as well as planning and construction of workshop buildings, among which particularly the new Mimer workshop, built in 1912–1913, could be mentioned, also occurred under Silvander's leadership. [83]

Silvander became head of ASEA's construction department after his return in 1904 and during the period 1904 to 1906 ASEA's direct-current machines were reconstructed.[84] In a letter to Lundqvist from March 26, 1904, Edström described the work with the new motors and told him that Silvander was taking over as draftsman as he was not satisfied with the work of the old one.[85]

In 1903 the General Electric Co delivered the largest capacity generators ever constructed for the Canadian development of the Niagara Falls power station.[86] Silvander was working at General Electric's construction department at that time. The power station in the south western Swedish town of Trollhättan had Niagara Falls as model and Fridlund described the establishment as a way to create an "America in Sweden" and a "Swedish Niagara". It was natural that the creation of large water power stations after the American model also had large American type generators. There were other engineers who actively took part in the transfer of waterpower technology from the United States to Sweden. The chairman of the National Water Power Board Vilhelm Hansen and his assistant Gösta Malm made a study trip where they looked at around twenty American and Canadian water power stations in 1906. When they came back to Sweden they were filled with impressions from the United States and Canada and were enthusiastic to start to practise their new knowledge in Sweden and to construct the power station in Trollhättan. They were also enthusiastic about what they had seen in the Canadian village of Shawinigan Falls, Quebec. It was a kind of Klondike in the middle of the forest and according to Hansson the model for Porjus power station in the far north of Sweden inaugurated in 1915. The first electrical engineer was also a man with experiences both from General Electric in Schenectady and from the power station at Shawinigan Falls.[87]

Edström wrote to Silvander in his 1914 letter of recommendation:

> Especially meritorious has your work within organisational matters been and large savings have through your suggestions been accomplished at large new buildings as well as in the running of the workshops.[88]

ASEA and Edström appreciated Silvander's work a lot and his experiences from abroad must have given him status at ASEA. It was not only the experiences from General Electric that mattered. Silvander's studies at the prestigious technical university in Zurich and employment at Union in Berlin contributed. The German experiences were important in Silvander's work with planning and constructing the Mimer workshops, which we will return to later.

Jens Lassen la Cour (1876–1956)

Silvander thus had experiences from other countries than the United States and even if his American experience was most important in the reconstruction of ASEA, other expertise was also highly valued as some of Edström's letters indicated. Another example was the engagement of Jens Lassen la Cour as chief engineer in 1907. In his letter to la Cour from December 6, 1906, Edström wrote that he felt that his old Danish acquaintance from Zurich was the right man for the job as chief electrician of ASEA as he was a sharp theorist and a leader with the power of initiative.[89] In a letter from February 1907, Edström promised la Cour that he would get an independent work and that this was something few other companies could offer.[90] Edström was anxious to convince la Cour to come to ASEA because he was aware of a need to modernise ASEA's constructions after problems with the isolation in large generators, damages of instruments and the like. ASEA did not just manage the technology and material for the advanced products the company manufactured.[91]

From 1899 to 1904, la Cour worked as the leader of a technical bureau in Karlsruhe and he also held a docentship in the projecting of electrical power stations and tramways at the technical university there. He wrote several books about electro-technology. Between 1904 and 1907, la Cour served as chief engineer at the large Scottish electrical company Bruce, Peebles & Co. in Edinburgh, but he was convinced by his old friend Edström to come to Västerås to work with the problems that Edström thought could occur as ASEA had obtained large orders for power stations.[92]

La Cour rationalised the engineering work, standardised the account, eliminated a lot of the deskwork for the workshop management, and worked for better cooperation between technical departments. Furthermore, he led the re-construction of the machine series and they were made according to the latest technical discoveries. With his knowledge of foreign markets, he was also important for ASEA's increased export. [93]

4.6. Leading engineers in the construction departments

Many of the engineers in the departments had foreign experience, and, as has been mentioned most of them came from the United States and General Electric. The so-called "cost office", whose main task was to calculate production costs for almost all ASEA's manufacture in Västerås on the base of the price for the material, wages and other costs connected to the manufacturing and investigate the prices for manufacturing was one example. It started in 1907 under the management of Hjalmar Norström, who had worked eight years in Schenectady.[94] This engagement was in line with the will to plan, standardise and rationalise production in order to cut costs. This was an all-embracing theme in the recruitment of returning and immigrated engineers to ASEA.

Laboratories and consulting offices

The experimental department suggested around 1902–1903 by Arvid Lindström can be interpreted in such a context as well. The department was to investigate and calculate certain characteristics of electrical machinery in order to get a better and simplified production, give instructions to the construction departments on the basis of these investigations and calculate and experiment with new machines. The department was to be consulted in these matters by the construction departments as well as the testing rooms. The ASEA board agreed on Lindström's suggestion but as it included the prerequisite that he was to be departmental head and he instead began at KTH a year later, the suggestion fell through even though it was not forgotten. [95]

In the years 1905–1912, ASEA conducted experiments with machines for the electrification of railways and, in 1913, the company began experimenting with isolation material. The early experiments with machines for the electrification of railways were led by Ragnar Wikander and Julius Körner. Both of them had been in the United States and also spent time on the continent. Wikander was at Westinghouse and Körner at General Electric. One mutual thing was that both of them had been either working or visiting Thomson-Houston's French workshops in Paris.

Gothenburg native Ragnar Wikander spent twelve years abroad before he came to ASEA in 1905. In January that year Wikander's brother, who was chief engineer for the electricity works in Düsseldorf and a friend of Edström from Chalmers, wrote a letter recommending Edström to employ Wikander and guaranteed that the close family relation did not matter.[96] It was the brother's impression that Wikander's long time abroad made him comparable to most engineers in leading positions in Swedish industry.[97] Edström responded that it was good if Wikander studied details on electrical locomotives and Westinghouse's system for motors to run these locomotives. If so, wrote Edström, it was possible for him to come to ASEA within a year. [98]

One year earlier, in February 1904, Wikander wrote a letter to Edström, telling him about the electro-pneumatic signal and switch system developed at Union Switch & Signal Co. in Swisswale, Pennsylvania. It was used at Boston Southern Station and was now built for New York Central Station and the tunnel under Hudson River to New Jersey. Direct current was used for the locomotives, whereas alternating current was used in the running of signal and switch apparatus. According to Wikander, the system could be favourable for large railway stations in Scandinavia. The capacity of a railway station generally increased with 100% to 200% if this fast and reliable signalling was introduced. Wikander recommended Edström and ASEA to get in contact with a firm working with the system because it would be a "business of the future".[99] In a letter from March 1904, Wikander told Edström that he had found out that one of the most prominent firms manufacturing the system was Taylor Signal Co. in Buffalo, New York. Wikander said less about his own work at Westinghouse but stated that he had gotten very interesting work constructing multiple-controllers.[100] In October, Wikander stated that he still was in the constructing office but was waiting to come to the engineering bureau. This was something he apparently managed to do according to his brother's letter. In the October letter, Wikander also told Edström that he liked to get practice in the field of electrical railways before he returned to Sweden. He asked Edström for advice with regard to how he could best use the time.[101]

In the beginning of February 1905, Edström wrote to Wikander and urged him to be patient about coming to ASEA. In the meantime he was to study the airbrakes and other details used on Westinghouse's electrical locomotives.[102] One month later, Edström wrote to Wikander and offered him employment as assistant to Ernst Danielson in order to speed up the work on the construction of alternating current railways.[103] In May, Edström and Wikander obviously had agreed on Wikander's engagement with ASEA. He was to begin in the autumn. Edström urged him to study constructions of single-phase alternating current motors that also could be useful for direct current as well as systems of controlling them. Furthermore, Wikander was to study electro-pneumatic brakes for tramway and railway cars as well as electro-pneumatic arrangements to handle vaults and other live arrangements for such cars. He also stated that ASEA's experimental department had been mothballed and that Danielson was longing for someone with power and energy to deal with these ideas.[104]

Wikander was employed in the experimental department of ASEA on October 1, 1905. In December the same year, he wrote a report of his activity up to that date. One thing he had worked with was the development of an electro-pneumatic brake system for railways

– the same thing Edström urged him to study in his May letter. In his five-page account from early November, Wikander unfortunately did not mention anything about Westinghouse.[105] He had also written an application for a patent of an arrangement changing the regulation of speed at multiple-connected electrical locomotives.[106] In a few pages, Wikander described the Westinghouse patents and their importance for the development of alternating current serial motors. He thought that it would not be risky for ASEA to start to manufacture without considering Westinghouse's basic patent! He assumed that it probably was legally impossible to decide what the conditions that were to be fulfilled in the Westinghouse patent were.[107] Thus ASEA could start to manufacture similar types of motors without considering the American patent.

This work occurred immediately after Wikander had returned from Westinghouse. The fact that he was engaged in working with the similar matters at ASEA as at Westinghouse and his immediate application for patents indicate clearly a lot of influences from the company in East Pittsburgh.

The evidence of the real laboratories points more in the direction of Schenectady. General Electric's laboratories inspired the build-up of them around 1915. The person responsible, Karl-Erik Eriksson, was a man who was laboratory engineer in Schenectady between 1912 and 1914. His task was to establish a material testing laboratory and one for the testing of high tensions. The laboratory was separated from the daily running and directed more towards technical issues in a longer perspective. It also included equipment for chemical analysis, a machine laboratory, and an experiment workshop. The laboratory received resources and research was done on welding, rectifiers, high-tension direct current, electrical furnaces, etc. The ASEA laboratory became the company's first industrial research centre.[108] In this context, it is reasonable that Eriksson took a lot of influence from the Schenectady laboratory created by Willis R. Whitney as the first industrial laboratory in the United States entirely devoted to scientific research.[109]

In addition to the starting of the laboratory ASEA began manufacture their own electrical isolation material. The background was the company's increasing dependence on imports. The inspiration came from General Electric's plants in Schenectady, where the man responsible, Axel Bengtsson, was employed at the isolation department between 1913 and 1916. During three years in Schenectady, Bengtsson educated himself to become a specialist of the manufacturing of isolation material.[110] His closest colleague, the master mechanic Johansson had also been educated in the isolation branch in the United States.[111] From some of engineer Oscar Hellman's letters to Edström it is possible to get the impression that General Electric was viewed as prominent in the manufacturing of isolation. Obviously Edström had instructed Hellman to study isolation methods in Schenectady, and Hellman promised Edström to do so in a letter from September 1912.[112] Hellman however, did not mention it in later letters. In an earlier letter, Hellman stated himself that he had been studying the manufacture of asbestos isolated wire in Schenectady and found it excellent. Hellman wrote that the asbestos was coiled around the wire, and later impregnated with lacquer.[113]

Helén's account did not get into ASEA's isolation factory in detail, nor did the article in the ASEA paper from 1921. However, the factory also produced copper wire that was isolated with lacquer, that, according to Helén, was of a high standard. This was perhaps an influence from the manufacture mentioned by Hellman. The company's isolation factory was described as equipped with a laboratory and the most modern machines and was able to manufacture all materials of isolation that were used in electrical technology.[114]

The literary and patent department

General Electric was possibly also important in the forming of ASEA's literary and patent department in 1904. It also had an engineer with experience from Schenectady as its first head. Foreign and primarily American experiences were present among all the heads until the late 1940s. The departmental head from 1904 to 1914, Harald Håkanson, had been eight years abroad: three in the United States and Germany and one in Switzerland and Finland. Håkanson's stay in the United States also included employment at Westinghouse. He shared an apartment with Edström and Lundqvist in Pittsburgh. He also worked for Union in Berlin and as their representative in Helsinki and had also studied at the Polytechnical Institute in Zurich. His successors were the earlier mentioned Karl Erik Eriksson and Birger Nordfeldt, who both had shorter stays in the United States.

During Håkanson's time in charge, the office was called the literary and patent department. Håkanson described this department in ASEA's paper from July 1909. It was formed in order to systematically take care of the preparations of ASEA's information publications; adverts, circulars, price lists and brochures.[115] Håkanson was in Schenectady between 1894 and 1896 and General Electric's Publicity Bureau was established in 1897. The Publication Bureau had functions that were similar to ASEA's literary department. One thing Håkanson probably realized was the importance of using illustrations for instance in preparing estimates of costs and as replacement for detailed technical descriptions. The photographic department at General Electric was established already at its founding in 1892. The company's use of photography was according to David E. Nye important during its "growth to maturity"[116] and also an "essential tool the company used to convince audiences and capture markets".[117] The same year as the literary department was formed and Håkanson was employed as its head, ASEA started to photograph new machines, apparatus and orchestrates in their workshops on a systematic basis.[118]

The construction offices

These offices were responsible for the electrical as well as the mechanical calculations and the drawing work that were necessary for the manufacturing of machines and apparatus. The calculation sections were from the beginning directly under the technical chief but later they became sorted under a special calculation office. The drawing sections were generally laid under a head of drawing, especially when it came to machine constructions and details.[119]

The first head of the construction offices, Kaleb Hedin, lacked foreign experience. In 1904, the earlier mentioned Silvander replaced him. Daniel Björk replaced Silvander in 1914. He worked in Schenectady as well as at the British Thomson-Houston branch in Rugby, east of Birmingham. Axel Hansson, who had been abroad for twenty-one years, ten in France, nine in Germany and two in the United States, replaced Björk in 1921.

Hansson had a deep knowledge of machine construction and was valuable for ASEA's new construction of standardised machines and for machinery for power stations and railways. Hansson stayed in the position until 1944.[120]

When Hansson came to ASEA, seventeen years had elapsed since he was employed at Westinghouse in East Pittsburgh and he had worked the last ten years in France. It was therefore questionable how much Hansson's American experiences mattered in his work at ASEA in the 1920s and 1930s. The long-time interval indicates that it was rather his experiences from the European continent that were most important. The Schneider Company was developed into France's largest combined steel and engineering company around the turn of the century and became known as an early manufacturer of modern canons.[121] Hansson had also worked for Lahmeyers, where some of the constructions were similar to Westinghouse's.[122] It suggest that he brought a lot of knowledge with regard to standardisation.

The standardisation office

The year after Lundqvist's departure, ASEA founded the standardisation office *(normaliekontoret)* which became a part of the construction offices. The reason was that the construction work at ASEA grew in the early years of the twentieth century. The company's management felt that it was necessary to create a special department that worked with the standardisation of lager dimensions of different raw materials to construct simplified details such as for instance screws and screw nuts and different kind of semi-manufactured articles for the production of machines and apparatus. The office also demanded that standard details and material was specified in construction drawings, made up tables about standard material and handled the distribution of drawing copies and so on. [123]

Returning engineers were in charge from 1908. The standardisation of products was to a large extent an American practise[124] and it is therefore not surprising that they mostly had experiences from North America. Emil Billing, in position from 1908 worked in Schenectady as well as for Allis Chalmers Bullock Ltd. in Montreal, Quebec in the years 1905–1907. The Norwegian engineer Hjalmar Schreiner, who replaced Billing in 1911, had ten years of experience in Germany, as a student in Mittweida and Berlin as well as an engineer at Siemens & Halske in the same city and at Lahmeyer in Frankfurt-am-Main. Daniel Björk replaced Schreiner in 1915 and had, as mentioned, experience from Thomson-Houston's British branch in Rugby as well as from General Electric.[125]

Before Billing went to North America in 1905, he had five years of employment with ASEA. In August 1907, Billing wrote to Edström that he had been studying Allis Chalmers Bullock's manufacturing and construction at the same time and that he almost could guarantee that he was able to bring down ASEA's manufacturing costs by using special tools and simplified construction. Billing also wrote that he was studying how different parts were manufactured in the cheapest possible way at a smaller company where the conditions were more like the ones back in Sweden. He had also seen different kinds of construction in Schenectady.[126] Billing indicated, however, that his practice at Allis Chalmers Bullock was more valuable than the one at General Electric for a future career in

Sweden. He thought he could use what he had learned about constructions and “study how the different parts should be manufactured economically; and this at a smaller company where the conditions are more similar to the Swedish ones”. [127]

In 1908 Billing was back at ASEA again.[128] In a lecture held at “the Master Mechanic’s club” in Västerås in February 1910, Billing talked about standardisation and mass production, something he thought was necessary in order to meet the sharp competition in the industry. His aim was to produce every part of a machine in such large quantities that the cheapest possible price for the production was reached. The way of achieving standardisation went through labour-saving machines.[129] Billing had relatively new experiences from North America and these probably guided him in his work in the department.

Direct and alternating current machines, transformers and turbine generators

In the early years of the twentieth century, standardisation and mass production also became important when it came to ASEA’s direct current machines. The new machines were more uniform and were constructed according to techniques favouring standardisation and adapted for mass production.[130] The person in charge was Axel Widström, a returnee who had been draftsman at General Electric between 1899 and 1901 and who obtained the position directly after his return. In a correspondence between Edström and Danielson in 1906, Edström wrote that Widström was about to leave – something Danielson regretted.[131] Widström’s experiences fit well in the picture. Before 1940, three out of four leading calculation engineers of direct current machines had foreign experience but Widström was the only one with experiences from the United States.[132]

American experience seem to have been most important in the early phase of the wide-scale introduction of standardisation and mass production when it came to direct current machines. As for alternating current machines, the pattern was reversed. The first calculation engineers lacked foreign experience and among eight engineers, only two had been working abroad. Helén wrote that the standardisation of for example the number of cycles was insignificant around the turn of the century but that the question became increasingly emphasised as the alternating current arrangements grew both in sizes and numbers.[133] In an article in *ASEAs egen tidning* in 1923, Arvid Lindström placed the definitive solution of the problem around the year 1913. Possibly it happened with the help of the foreign experienced engineers. The first one was the German engineer Camillo Wiegand who had long-time experience in Germany and Switzerland. He was employed in 1914 as calculation engineer of synchronous machines but as he passed away in World War I the year after his time to make an impact was limited. It is more reasonable that John Wennerberg who was in Schenectady between 1912 and 1913 and became leading calculation engineer in 1915 contributed as he stayed in the position until 1943.[134]

The calculation of transformers was an area where there were indications that other experiences than American were more important. Apart from 1914 to 1917, when the Dane Albert Krogh Aubeck, who had studied in Zurich and worked for the Swiss Brown Boveri Company, was in charge, the leading engineers had not worked abroad.[135] In an article in *ASEAs egen tidning* from 1923, Karl-Erik Eriksson and John Lundgren described the development of ASEA's transformers. Before 1914, ASEA's smaller transformers had become uneconomic and insufficient when it came standardisation. In the years 1914 to 1916 these transformers were radically re-constructed in order to suit demands. The new series also became a model for other Swedish manufacturers of transformers.[136] Switzerland was a leading country in transformer technology and la Cour also recruited the Swiss engineer Nitanz to the lead the manufacturing of them.[137] Aubeck's experience from Brown Boveri were probably important when the transformers were reconstructed.

From 1915 until the early 1940s the leading calculation engineers of turbine generators were returning emigrants from the United States. John Wennerberg was in charge from 1915 to 1928 when C. Richard Söderberg replaced him and stayed in the position until 1930. Sven Gynt was in charge until 1944 and made a long North American study trip in the beginning of the 1930s to learn more about the constructions of turbo generators. [138] The CTI-graduate and naval architect Söderberg came directly from a nine-year stay in the United States which included one year of studies at the Massachusetts Institute of Technology in Cambridge close to Boston, employment at the New York Shipbuilding Company in the Philadelphia suburb of Camden, New Jersey as well as long time employment as a mechanical-electrical engineer at Westinghouse. Söderberg contributed much to the development of ASEA's turbo generators. Westinghouse had achieved world records when it came to the size of turbine generators and Söderberg's comparably lengthy period of working for the company was important when ASEA called upon him to lead the construction of large turbo generators. He helped the company construct a turbine generator of 50.000 kilowatts for Västerås town power station and also a large turbo generator for the company's works in Ludvika. After his return to the United States in 1930 Söderberg remained as consulting engineer for ASEA's subsidiary company *Svenska Turbinfabriks AB Ljungström* (STAL) in Finspång, and functioned as technical advisor in the process of them developing the double rotating turbine. Söderberg had this connection with STAL until the 1970s. [139]

Commuting motors, rail apparatus, mining and relays

When it came to the turbine generators, the United States was certainly important. It is more doubtful whether American impulses were important when it came to commuting motors. Around 1903–1904, the French engineer Marius Latour patented a compensated repulsion motor, which had some advantages over the compensated serial motor that earlier had been patented by the Westinghouse engineer B G Lamme. In Sweden, ASEA bought the rights to Latour's patents. Some experiments were done by Ernst Danielson, which led to the emergence of a combined motor that took the best from the serial as well as the repulsion motor. It was however not useful as a rail motor, which was the main purpose of the experiments, but for the running of elevators, spinning machines, etc.[140]

The first leading calculation engineer was the above mentioned Julius Körner who remained in position from 1909 to 1912 when the Dutch engineer Hidde Schrage replaced him. As mentioned, Körner worked for General Electric, but Schrage was educated in the Netherlands and Germany and had worked as a testing engineer at AEG in Berlin. After

Schrage, only one of the leading engineers had foreign experience. Uno Lysén who began in 1928 had been in Berlin and on a short study trip in the United States, but long before he began at ASEA.[141]

A possible continental influence was the invention made by Schrage in 1915. This was the so-called Schrage motor where the speed was regulated through shifting of the brushes. The motor was used in several areas and became an import export product for ASEA during the 1910s especially in Western Europe. AEG in Berlin, where Schrage had worked before he came to ASEA, patented it in Germany.[142]

It was possibly continental influences that mattered most. Körner wrote to Edström in October 1906 that he had been told to study two things; turbine generators and one-phase commuting motors. With regard to the latter, he was not impressed with what he observed:

> ..I must absolutely confess that America in this respect hardly lives up to the expectations one could have had the right to entertain with reference to the companies' flaming bulletins. Typical is General Electric's bulletin II 4439 regarding the motor GE A-605-A, where it says: 'Since that date [August 1904] the GE Cy has designed a complete line of single-phase railway motors —— a large number of these motors have been manufactured and those already put in service have given excellent satisfaction'. In reality 'the complete line' consists of more or less successful experimental machines and as far as I know no bigger nor smaller amount of machines have been put into running and even less have given the excellent result. The fact is, however, that GE at present has received some orders of single-phase equipments, thanks to their advertising, and that they are working under high pressure to get a suitable motor out, especially since Westinghouse, thanks to New York – New Haven again has got an advantage in the fight.[143]

Körner continued by stating that he had got hold of the latest experimental motors but he was not impressed. He stated that Ernst Alexanderson had gone into the field and that General Electric expected him to be the man who had the solution of the problem. Körner continued:

> During his [Alexanderson's] visit in Europe last summer, he probably tried to get knowledge about the German machines. At Westinghouse, they are considered to having achieved a little more, but it ought to be an indisputable fact that Europe in this field is ahead, at least at present date.[144]

In a letter a month later, Edström responded to Körner and urged him to spend half or a whole year in East Pittsburgh as ASEA actually regarded Westinghouse's single-phase commuting motors as world leading. Edström continued by telling Körner that he was welcome back to ASEA when his education was completed.[145] Körner responded in mid-December almost apologising that he had expressed himself less positively about the Westinghouse machines than he had meant to. He was, however, not going to East Pittsburgh as he wanted to be closer to Sweden for family reasons. Instead, he aimed to go to Germany but was willing to compensate by spending longer time there.[146]

In a letter from January 4, 1907, Edström stated that he thought one year of practice in Germany or Switzerland could be useful for Körner's future career but also that he was willing to engage him at ASEA almost immediately as the company needed him.[147] On his way back to Sweden, Körner visited some places on the European continent, such as power stations in Switzerland, Lahmeyer's works in Frankfurt-am-Main, Thomson-Houston's workshops in Paris and the electricity works in Düsseldorf. Körner mainly wrote about turbine generators in the letters from the continent.[148] At Lahmeyer's, however, he noted that their constructions largely were similar to Westinghouse's.[149]

After Körner had returned, he began experimenting with commuting motors for railways and constructed the first series of motors for stationary running.[150] It seems obvious that his experiences from working and studying in Europe and the United States mattered in this process. In an account Körner wrote in 1910 about the ASEA experiments with commuting motors, he described the ones ASEA constructed for experimental locomotives in the electrification of Swedish railways in 1908. The Westinghouse system was tested as well as motors from Siemens and General Electric.[151] Körner's experience of these systems probably made him able to decide what worked best and how ASEA was to construct their own motors. Later, Körner became responsible for the electrification of *Riksgränsbanan* between 1912 and 1915. The project was carried out in cooperation with Siemens.[152] In the account from 1910, Körner claimed that plans for cooperation with the German company was unnecessary for purely technical reasons, and that it was to be underlined if the plans of cooperation with Siemens were directed by politics. ASEA could execute one-phase railways independently and with good results.[153] Later, Siemens and General Electric's constructions were used in combination on the locomotives on *Riksgränsbanan,* but Siemens began using a type of motor originally from Oerlikon.[154] In all, the development of commuting motors and railway electrification seems to have been a mix of influences, where Germany obviously was an important source.

This held true also when it came to ASEA's construction of rail apparatus, connected to railway electrification and the commuting motors. In 1908, ASEA employed the earlier mentioned Norwegian engineer with German experience, Hjalmar Schreiner – who was later also involved in the electrification of the railway in northern Lapland – first and foremost to work with the development of the electrical equipment for the company's first alternating current locomotive.[155]

The construction of rail apparatus seemingly used a lot of influences from Germany. Schreiner had been at Siemens & Halske and Lahmeyer. Siemens was one of the world's most renowned electrical companies.[156] It was also Werner von Siemens who built the first electrical rail in the 1870s. Germany and Switzerland were the leading nations in this field and it is therefore not surprising that experience from Germany was highly valued, even if Gunnar Seligman, with experience from General Electric was in charge of the department between 1917 and 1919 when it was located in Ludvika. The German expert Paul Friebel replaced him in 1919 and stayed in position until 1945. He was a very important person in the breakthrough of railway electrification in Sweden.[157]

Germany was more important than the United States among engineers working with rail apparatus. Alfred Bjarme, the man in the mining office, established in 1936 to construct electrical driven mine hoists and other mechanical machines used for mining, also had experience from Germany, but so many years before he came to the department that there are reasons to call into question the importance of these experiences.[158]

The same was true for the relay office established in 1918 under Wilhelm Petersén, an engineer with experience in Britain much earlier.[159] The main activity was the construction of different types of relays, but also tension regulators and small motor cupboards, etc. In 1939, a non-emigrant took over and it is reasonable to assume that foreign experience was of minor importance.

Apparatus

A similar "mix" can hardly be noted for the construction of apparatus. There were five leading engineers in the apparatus departments in Västerås and in Ludvika (from 1919) from 1900 to the early 1940s. All were returned engineers; four had been in the United States and all at General Electric.[160] It seems clear that General Electric was an important source for impulses.

Ivan Öfwerholm was employed at ASEA from 1896 to 1899 but nothing in his paper from 1945 describing his employment indicated that he was on a mission from the company when he was in the United States 1899–1900. Öfwerholm wanted to study the manufacturing of electrical regulation apparatus and electrical railways abroad and made a failed attempt to get employment at the tramways in Berlin. He returned to Sweden and contacted Ernst Danielson who gave him a letter of recommendation to Mr. Rohrer at General Electric. Öfwerholm travelled to the United States and got a place at General Electric's construction department, in the sub-department for power and mining. He stated that the year at General Electric was very valuable for him and he was occupied with the construction of electrical locomotives and other details to be used in mining. He did not intend to leave the United States after only one year, but was forced to because of poor health. Before he returned he made a study trip through the eastern states and visited Pittsburgh, Buffalo and Niagara Falls. On his way home, he took the way through Paris and the World Exhibition.[161]

Öfwerholm contacted Danielson about possible employment and called attention to the fact that ASEA more or less lacked manufacturing of electrical apparatus. He thought that he was suitable to take care of it. Danielson's first response was negative but he promised to take the matter into consideration. Öfwerholm met disappointments both in Västerås and in Ludvika, but received letters with offers of employment at both places a few days later. He began at another department, but Danielson soon changed his mind and gave Öfwerholm the task to organise manufacturing of electrical apparatus and an apparatus department.[162]

The first series of non-automatic oil breakers was constructed in 1901-1902 and it is reasonable to assume that General Electric's constructions were models as they produced the first oil circuit breaker in the field in every stage of high transmission potentials.[163] According to Helén, Öfwerholm should have the honour of introducing uniformity and planned construction of apparatus that began at ASEA in the early years of the new century. Öfverholm used the experiences from General Electric and started to build up a special bureau of construction to modernise ASEA's earlier apparatus. Öfverholm also started to construct a series of oil-safety devices for higher tensions and started a movement towards standardisation of the constructions. This became valuable for ASEA's apparatus in the long run, even if standardised constructions of apparatus could not be realised fully as early as in 1901.[164]

Öfwerholm's successor, Sven Norberg, had worked in Britain but lacked experiences from the United States. When Edwin Johnson came to the department in 1908 ASEA had gained an experienced leading constructor of apparatus with twelve years of service in Schenectady. Fridlund has earlier described him and his work at ASEA and Johnson has also written an account of his life in the 1940s. He did not reveal whether he aimed to return or not when he emigrated in the late 1880s. After some time in the United States he most probably did not plan to go back. He applied for American citizenship and he stated that he had not thought of taking employment in Sweden.[165] Johnson's advancement at General Electric after he had been employed in 1895 was fast. It was due to good contacts with Swedish engineers, a correspondence course in drawing, mathematics and electricity, and his American citizenship.[166] It was during the courses and during his time at General Electric he got well acquainted with American technology and, therefore, he became an interesting name to recruit to ASEA in 1908.

In 1904, when the old engineer quit, Johnson became General Electric's leading constructor of apparatus. By 1907, he had taken several patents and he was considered to be one of the future stars. But the knowledge of his competence had also reached Västerås. One summer day in 1907, he received a letter from Carl Silvander, who he knew from Schenectady four years earlier. He asked Johnson whether he was interested in returning to Sweden. Johnson responded that he had not thought about taking employment back home, but if he was given the same benefits he could always give it a thought. Johnson was asked to make a visit to the ASEA-engineer Albert Elfström, who was staying at a hotel in Schenectady later the same year. Elfström offered Johnson employment as engineer and constructor of electrical apparatus. Johnson hesitated. As he had no diploma from KTH or CTI, he thought that he could not take such a place. Elfström explained that ASEA already had KTH and Chalmers trained engineers and that the company could get as many as they wanted of them. He continued to say that they wanted Johnson to do the same thing for ASEA and Sweden as he was doing for General Electric and the United States. Johnson was an American citizen and he had not seen his country of birth in almost twenty years. Nevertheless, Elfström's description of him having a national Swedish mission to fulfil at ASEA spoke to him. Despite his American citizenship, he probably still felt Swedish and one indication of this is his participation in the activities of the Scandinavian club in Schenectady.[167] Johnson did not sleep much the night after the meeting. He was a rising star at General Electric but he had been denied a wage increase he thought he deserved and found it tempting to cancel the contract, as he "was after all Swedish, and now when Sweden needed my experiences".[168] This was at least Johnson's reason in his written memories.

Johnson decided to take ASEA's offer the next day. He received $250 to cover his expenses for the journey. However, he found that the amount was not enough and that he would lose money on the return. He wrote to ASEA and asked them to cancel the contract. But Edström obviously rated Johnson's competence very highly and responded immediately and promised Johnson a first class ticket and to cover all expenses for him and his family. Edström also urged Johnson to hasten his arrival to Västerås. In the beginning of 1908, Johnson left Schenectady and went through New York, Liverpool and Hull to Sweden.[169] He described his last morning on board, when the steamer approached Gothenburg:

> I got up early, because I thought that it would be interesting to see the Swedish native soil, as it was 19 years since I last saw it, rise on the horizon. And then the big moment came; a black fringe glimpsed in the morning haze and it was Sweden. [170]

Johnson continued to describe how he recognised and remembered the lighthouses and the archipelago bordering the sea-approach to his city of birth, a place he was to return to nine years later.[171]

In February 1908, Johnson started his work in Västerås and became the company's leading constructor of oil circuit breakers. Johnson stated that he had to reconstruct all of ASEA's breakers since they were not on the same level as the advanced ones he had worked with in the United States.[172] Johnson had valuable experience. General Electric was as mentioned a renowned company in the field.[173] Access to oil circuit breaker technology, and the knowledge of how to execute it, stemmed from his thirteen years of service there. In *ASEAs egen tidning* 3/1909, Norberg described ASEA's development in the production of oil circuit breakers. The automatic oil circuit breakers were used at high-voltage power stations in order to disengage a circuit in a fast and safe way in case of overcharging or short circuit. This was necessary in order to prevent the dispersion of the disrupter to other parts of the net. ASEA had constructed oil circuit breakers for power stations with an effect of 10.000 to 15.000 kilowatts, but according to Norberg, the company had started to manufacture oil circuit breakers with an effect of 30.000 kilowatts or more. It was possible to assemble, adjust and test the new breakers in the workshop making fully ready to be used when they came to the power station. Because of this, further costs could be avoided. At the time of the issue, March 1909, ASEA had received orders of the new oil circuit breakers from the power station in Trollhättan and from the electricity works in Stockholm.[174]

According to Edvin Johnson, much had to be done when he started his work in Västerås and ASEA had not much of the modern technology that existed in the United States.[175] Although Norberg did not mention Johnson by name in his article, March 1909 was almost exactly one year after Johnson had been employed and it is quite clear that Johnson was the man behind the high-effect oil circuit breakers. There are reasons to assume that Johnson worked with oil circuit-breakers adjusted to higher effects at General Electric and that he carried the technology with him when he returned to Sweden and ASEA.

Edström's decision to recruit Johnson to ASEA shows how anxious he was to get the man and Johnson's long period at General Electric ensured him a good position at ASEA. He was granted about ten technicians and draftsmen who worked under him.[176] From this position Johnson could realise his ideas of manufacturing circuit breakers adjusted for power station with higher effects. He did so until 1917.[177]

That year was also Norberg's last, and the department was taken over by David Danielsson, who stayed in position for twenty-five years. During his time in charge of the department, the standard apparatus underwent a major development and David Danielsson showed skills in solving problems that had to do with apparatus for large machines manufactured for the heavy industry, such as rolling mills, paper machines, printing presses and mine hoists.[178] Whether these skills were due to his time at General Electric may be called into question as his duty in ASEA's apparatus department occurred so long after he had been in the United States. It was however a "tradition" continued by engineers with experience from Schenectady as leading constructors of apparatus.

The crane office and workshop

The same cannot be stated about the crane office and the workshop but it was certainly influenced by the United States. The main activity of this office was to construct the mechanics for different types of electrical driven cranes, such as traverses, side-board cranes, bridge cranes, harbour cranes, and cranes to move locomotives, cars, etc.[179] Three out of four leading engineers from 1898 to 1944 had foreign experience; two from the United States and one from Germany. It was only between 1899 and 1905, that the office had a non-emigrant in the top. The first head, David Lindqvist, had been chief engineer at the Otis Elevator Company, whereas Hjalmar Janson was in charge between 1905–1918, and had worked as a draftsman in crane workshops in the United States. In 1918, Joel Björklund with five years of experiences in Germany took over.[180]

The first task the department got after Janson's return was the construction of the bridge cranes for the harbour in Gävle. According to a document issued by some of Janson's closest friends on his sixty-fifth birthday in 1943, the delivery was of unusual dimensions for the time being. Another task was the cranes for the iron works in Domnarvet, which ended up in a delivery of three trestle cranes in 1907. The cranes were to be used for very special work and the construction had to be adjusted for it. It demanded a lot of preparation work and studies of other arrangements where trestle cranes were used.[181] In this context there are reasons to believe that Janson's American experiences mattered, although it was not possible to read it from the papers.

Janson initiated a production of a type of trestle cranes used for transport of wood from the storage to the sulphite factory. In 1909, he made a study trip to the sawmills at Ortviken close to Sundsvall and came with his suggestions for the trestle cranes. They were further developed in the delivery to the sulphite factory in Gästrike-Hammarby in 1912 when the area over which the crane could work had been extended and there was a demand for a bridge as long as one hundred meters. The Storvik sulphite company who were the owners of the factory wrote a letter to ASEA in 1924 where they stated their satisfaction with the crane and the minimum costs they had for repairing of it.[182] The crane in Gästrike-Hammarby received an unusual amount of attention at the time because of its size and capacity.[183] Later several companies in the sawmill industry came with orders of cranes adjusted to an increasing mechanisation.[184]

4.7. Leading engineers in the production departments

The same engineers managed both the construction and the production of the cranes. These engineers stood with one foot in the construction departments and the other in production. In 1903, production was divided into the following departments in Västerås; the main workshops where smaller and middle size machines, transformers and apparatus were manufactured, the iron and metal foundries, the Emaus workshop where ASEA made larger machines and the mechanical workshop where cranes, traverses, tramways, etc. were made. The company also had subsidiaries. In Gothenburg, *Boye & Thoresens Elektriska AB* made smaller machines and apparatus, and in London, The Fuller Wenström Electrical Mfg. Co. had the same type of production. [185]

In 1949, the organisation looked different. The Västerås part of the production department included the foundries – iron foundries for smaller as well as larger quantities – metal foundries and magnetic foundries and the workshops. In the *Mimer* workshop direct current as well as alternating current machines of certain sizes were manufactured together with rail motors, special machines, control apparatus, etc. In the *Emaus* workshop, the largest machines for direct and alternating current were manufactured, and the Örjan workshop made the smallest and some middle sized alternating current machines, distribution plants, shrews and smaller products. The workshops also consisted of the isolation and electrode factories as well as the Sigurd workshop where cranes, traverses, metal sheet works, electrical industrial furnaces, etc. were manufactured. ASEA also produced transformers, circuit breakers, high tensions apparatus and so on at their works in Ludvika and the works in Stockholm made gear drives and gear drive motors, telphers and tool machines. In Härnösand, worm gears and worm gear motors, as well as trucks, elevators, etc. were produced. The largest works was the one in Västerås with about 4.000 workers. Ludvika had around 2.000 workers, Stockholm 400 and Härnösand roughly 350. Furthermore, ASEA had subsidiaries both in Sweden and abroad, for instance in Norway, Britain, France, South Africa and Australia.[186]

The workshops in Västerås

In 1949, there were six different workshops in Västerås. They were given their names after the areas in the town where they were located, thus Mimer, Emaus, Örjan and Sigurd were different parts of Västerås. This examination will mainly focus on the works[187] in Västerås and begin with the chief engineers over all the workshops there.

They were managed by five engineers from 1895 to the 1940s and three of them were returnees or immigrants; Carl Hedin, Fredrick Vickers and Oscar Hellman, all with experience at General Electric. Vickers had also been at Westinghouse and at Allis-Chalmers in Milwaukee. Hellman had been at Westinghouse as well.[188] Also in the single workshops, Mimer, Emaus and Sigurd, there were several returning and immigrant engineers in charge. From 1898 to the 1940s, six engineers managed the Mimer workshop and among them it was only the first who had no foreign experience. It is possible to say that the workshop was "German" from around 1905 until the mid-1910s and later "American" until the 1940s. Ludvig Schumacher was a German immigrant who had been working at Union and the Norwegian engineer John Laerum was a student at the technical university in Dresden.

From the mid-1910s, engineers with experiences from the United States took over as well as one with experience from General Electric's and Westinghouse's subsidiaries in Britain. This experience to some extent must have been similar to employment at these companies in the United States. In the testing rooms, however, there was only one engineer with foreign experience and it was from General Electric.[189]

The Emaus workshop was continuously managed by returning or immigrant engineers from 1899 to 1917 with the possible exception of the years 1912–1913. From 1907 to 1912, the above-mentioned Schumacher headed both Mimer and Emaus. Hellman, in charge between 1914 and 1917, was the only engineer with experiences from the United States. During this period Emaus became known for its "giant-generators" possibly modelled after General Electric's. Hellman was employed in Schenectady between 1912 and 1913. After 1918 non-emigrant engineers managed the workshop until the 1940s. In the testing rooms, there were also some engineers with foreign experience; Finnish-born Carl von Pfaler had been studying in Zurich and was responsible between 1909 and 1911. Harald Klingberg took over and stayed until 1914. He had been at General Electric. In the early 1920s, Arle Ytterberg, with experience from studies and employment in Germany in the mid-1910s headed it.[190]

The Sigurd workshop had four chief engineers from 1898 to the 1940s. Three had foreign experience; two in Switzerland and one in the United States. The above mentioned Hjalmar Janson took over in 1918 and stayed until 1943. Some of the engineers responsible for different productions also had foreign experience, primarily when it came to elevators. Edward Andersson, in charge of the elevator office from 1908 to 1921, had been employed as constructor at Otis Elevator Company for six years before his arrival. That company produced the first ever elevator and was a world leader in its area.[191] Also among the engineers working with elevators in Stockholm was one with experiences from the United States. Per Deurell was employed there between 1901 and 1902; as a draftsman at American Fire Engine Co. in Seneca Falls, New York, at an unknown company in Brooklyn and at the National Meter Co. in New York.[192]

In 1906, Edström corresponded with Hedin, employed at ASEA in 1898,[193] but who went to the United States in 1905, probably on a mission from the company. In a letter to Edström in January, Hedin described General Electric's workshops in Pittsfield which he claimed were run in an exemplary manner. Hedin was working with fan-drawings and as he was doing the same at ASEA before he went to the United States, he was doing fine in Pittsfield. However, he stated that he was about to leave Massachusetts in about eight to ten weeks in order to look for a place in a workshop in Chicago, Milwaukee or somewhere nearby.[194] In response, Edström urged Hedin to study, apart from workshop methods and organisation, special machines used for electrical manufacturing.[195] Hedin replied and stated that he would follow Edström's advice regarding observations in the United States and that he usually walked around in some part of the Pittsfield workshops every day in order to study the work and the machines.[196] In the middle of April, Hedin wrote to Edström from Niagara Falls on his way westwards. He stopped by in Schenectady where he got to see the giant workshops of General Electric.[197] In late May he was back in Schenectady after having met a disappointment with Wagner Electric Co. in St. Louis. He wrote to Edström: "the works were small and located in the middle of the city and housed in a seven floor house with a small base and everything was run on a small scale". Hedin's aim was to leave the United States in late July and to seek employment at some electrical firm in Germany or Switzerland and then return to Sweden during the autumn.[198] Edström responded in the middle of June telling Hedin that he had asked Lundqvist to write to him and tell him what ASEA wished him to study. Edström wrote it was especially important for Hedin to study the workshop machines for certain fabrications but unfortunately did not provide any further specifications. Edström also urged Hedin to spend some time at Westinghouse as it would be a pity if he left the United States without getting acquainted to the company in East Pittsburgh.[199] Hedin replied two weeks later, writing that he thought it would be pleasant to visit Pittsburgh, because it was such an interesting city from a technical point of view.[200]

In September Hedin was back in Västerås and became the head of ASEA's workshops. He quit in August 1908.[201] During Hedin's time in the workshop, a uniform piecework system was introduced and Hedin also took part in the introduction of mass production led by Lundqvist. [202] There are a lot of indications that Hedin picked these ideas up especially in Pittsfield. His disappointment with the company in St. Louis also gives us a picture of his fascination with mass production.

The way of organising a workshop was probably what inspired Edström most about the American industry. Engineer Anders Landberg was in the United States in 1907. He wanted to study high-voltage engineering and wrote to Edström for advice. This was how Edström responded.

> To organise and run a workshop cheaply is a far more important problem today, than to be able to build and run high-tension stations. The one who can run a workshop cheaply also gets money out of it and can claim a corresponding wage. As America is the best place in the world to learn this, I do not want to omit pointing out the big opportunity that is open for you here. [203]

The quote indicates that Edström regarded organisational practises as an area where it was most important to look westwards. The appointment of Hedin's successor in 1908 was in line with this as well. His name was Frederick Vickers and he was born in England. Vickers had ten years of working experience from the United States behind him, and had worked as organiser both at Westinghouse and Allis Chalmers. He had also served three years as foreman at General Electric and came from one and a half year as manager for Bruce, Peebles & Co. in Edinburgh. There he had became acquainted to la Cour who also was involved in the recruitment of him.[204] Vickers bought many new and modern machines and used an economical planning in his work at ASEA.[205] This was in line with Edström's desires and Vickers's experience as organiser at American and British companies aided him. Westinghouse was largely the inspirational source for Edström's and Lundqvist's re-organisation and Hedin stated that his aim was to go to Milwaukee to continue his study trip in the United States.[206] Alfred D. Chandler stated that Allis Chalmers was at the forefront of rationalising their production in the early years of the century.[207] Two years as organiser in their workshops in Milwaukee certainly contributed to give the Vickers the skills he also needed to do a "good job" in the ASEA workshops. Vickers's General Electric and Westinghouse experience is to be interpreted in a similar manner.

Evidence of Vickers being inspired of how the Americans and British organised their workshops is the report he wrote from the study trip he made in Germany in September 1910. Vickers's journey had two purposes: to study how the Germans could manufacture goods to sell so much cheaper than in Sweden; and to compare the German workshop organisation with the one in Britain and the United States.[208] He ended his report with these words:

> I must say, that I was very disappointed with my journey, I had looked forward to seeing something very much out of the ordinary run of manufacturing, but only in the two exceptions that I have mentioned did I see anything so good as what is usual American Practise.[209]

The two exceptions were Bergmann & Co in Berlin and Reinecker in Chemnitz.[210] Siegmund Bergmann, the German electrical engineer who had been in New York and for whom Lundqvist worked before he came to ASEA ran the former. Otherwise, Vickers stated that the German firms generally were not as specialised as the American ones. Progressive specialisation calling for one highly efficient machine for each operation and groupings of machines for each article manufactured was nowhere to be found except at Bergmann and Reinecker. Transportation costs were not considered, few tools were used for labour saving actions and the machines in the workshop were of universal types and nothing that could excite Vickers. In the work process, Vickers did not note any great energy among the German workers. The example of Siemens-Schukert's workshops in Nuremberg, Vickers stated, was the best illustration of his argument as they

> have a large meter department; these operations were arranged very nicely, each article is divided up very carefully into its operation, each machine is arranged so that when an operation is finished the operator has only to push it forward a little on the bench and it is in reach of the operator on the next machine for the next operation. That is all very nice, now take the Ingersoll Watch Co. practically the same article, and notice the different methods. One man to look after eight machines, (entirely automatic, each making a different article and not only making but counting and packing into boxes ready for the stores. You walk into the machinery hall it is full of machines) all working at very high speeds, very few men, who only have to feed the machines with rods, instead of very small parts. Siemens-Schuckert have a room full of people, each machine a man to attend toit (sic!). Instead of automatic feeds they were fed by hand. [211]

Vickers also stated that the design of large machines were considerably more expensive in Germany than in Sweden and that ASEA had almost nothing to fear from the Germans in these fields. Vickers reached the conclusion that it was not the workshop practices that made the Germans able to manufacture to sell cheaper than ASEA, but the fact that they produced the material themselves – as Lahmeyer for instance – while ASEA had to buy it from elsewhere.[212] Vickers compared the workshop practices between the United States and Germany and wrote that he would also compare them with Britain but these methods were not mentioned in his paper at all. It is more or less understated that the methods in Britain were similar to those in the United States, and this was possibly something Vickers had contributed to himself during his time as assistant manager in Edinburgh.

The German “irrational” workshops were thus something that offered no inspiration for Vickers, while rationally organised workshops such as Allis Chalmers, Westinghouse and General Electric were sources of inspiration. According to Helén, Vickers was an extraordinary good workshop engineer who actively acquired new and modern work machines and was able to plan the running of the Västerås workshops in an economical way for ASEA.[213] It was without any doubts that his previous experience gave him both the status to get a position at ASEA, and the knowledge of how to organise a workshop in a manner that was favourable for the company.

Vickers stayed in his position until 1913, and after an interlude of three years with a non-returnee in charge of the Västerås workshops, Oscar Hellman took over in 1917. Hellman was born in the countryside close to Västerås in 1881 and graduated from the technical upper secondary school in Norrköping in 1905. In the same year, Hellman was accepted as an apprentice engineer at ASEA, and in 1907 he was employed as assembly engineer. Between 1910 and 1911, Hellman was employed in Canada, by Westinghouse at the building of the power station in Niagara Falls, managed by the Hydro Electric Power Commission of Ontario. After a short interval back in Västerås, Hellman returned to North America in 1912, worked for General Electric and stayed until the following year. When he returned in 1913 he became one of the chief engineers for the Emaus workshop and stayed in that position until he took over the after Vickers as head of all workshops in Västerås four years later.[214]

Helén wrote that Hellman’s thirty years of leadership over the production in Västerås meant a development that led to the workshops becoming the top ranked ones in Sweden. The working methods improved and one thing characterising Hellman’s leadership was his belief in the education of apprentices.[215] Hellman was one the engineers who had the most intense correspondence with Edström while he was in North America. It is clear that Hellman was on a mission from ASEA and had the purpose to return. In a letter to Edström from Niagara Falls Centre in Ontario in March 1910, Hellman wrote that he had left his place at Hound Chute as it turned out that he could not be of any use, either to ASEA or to himself.[216] During 1910, Hellman worked at power stations and reported his observations to Edström.[217] In November, he was at a power station called McCall’s Ferry in Pennsylvania and wrote that he was going to Sweden over Christmas and wanted to stay after New Year. Hellman also told Edström that he had been walking around in General Electric’s workshops in Schenectady and Pittsfield for two weeks and studied work methods and everything he came over. Hellman thought that he had seen more of the company than those who were working a year as draftsmen.[218] In a note in a letter from Edström to Hellman in Brooklyn while he was on his way home, Hellman was told that he could return to ASEA beginning in January.[219]

He did so, but in 1912, he was travelling to the North America again. He wrote his first letter to Edström from Schenectady in the beginning of May and told him about the generators General Electric was constructing for the power station in the Mississippi River at Keokuk, Iowa. Hellman wrote that General Electric probably used false plates on the generators stating that they were 15.000 kilowatts. His assumption was that they really were 9.000 kilowatts, but he continued to state that the dimensions were enormous.[220] As mentioned, the Emaus workshop – managed by Hellman between 1914 and 1917 –

became known for their constructions of ASEA's giant generators.[221] In the letters to Edström in 1912, Hellman made notes on the new workshop in Schenectady, the production of standardised motors and the use of scientific management principles. The latter was something he interestingly enough claimed he could not find at General Electric and also, from reading Taylor's works, he had doubts whether it was something for ASEA.[222] Edström obviously trusted Hellman's judgement, since he responded that it seemed to be the case that the principles of scientific management had not much value for ASEA.[223] Hellman also described the production of asbestos isolated wire and that General Electric was seeking to introduce as many good-working tool machines as possible in every operation of the production. The machines were automatic and demanded a minimum of skill.[224] Large production made it possible to standardise much more than in Sweden and one example of this was the production of three-phase motors, which according to Hellman was so standardised that it should not be possible to bring about a more ideal production.[225]

Writing to Hellman in October 1912, Edström let it be known he was thinking of letting him take over either the apparatus department or the Emaus workshop. Edström wrote: "If you are to take over the Emaus workshop you should of course study the manufacture of large machines and ways of winding either in Schenectady, Pittsburg or Berlin".[226] Hellman had been a great deal in Schenectady and this probably was important when he took over the Emaus-workshop after his return. In his last letter to Edström before he returned, Hellman was at General Electric's workshops in Lynn. He thought that their system of writing out the work operations in booklets was practical as the instructions were given in order and inspected when the work was done. Each operation was inspected independently, something Hellman claimed made it easier to avoid bad workmanship.[227] All these studies were possibly important when Hellman developed ASEA's workshops to a number one position in Sweden.

What Vickers noted about the German workshops was to some extent contradictory to Brunnström's conclusion about the inspiration from the German architect Peter Behrens in the construction of the Mimer workshop. However, Vickers' comments were mostly connected to manufacturing and he also revealed that he was impressed with some of the German companies when it came to their design with regard to rational production and working environment.[228] We shall also remember that AEG to a large extent was inspired by American workshops. One engineer that was important for the planning and construction of the Mimer workshop was also the former mentioned Carl Silvander. He was not mentioned in Brunnström's account but she stated that the plans for a new, large and rational workshop for the manufacturing of small and middle-sized electrical motors grew out of Edström's inspiration from the American industry. Work, time and motion studies, calculation of prime cost, was all cast in a Taylorist spirit. His note about scientific management in the letter to Hellman quoted earlier speaks to some extent against Brunnström's conclusions but it is reasonable to say that Edström was inspired by the spirit, though perhaps not every piece of Taylor's system. The inspirational sources for the building were to a large extent German, at least in a direct sense. Brunnström claimed that Edström found the inspiration at AEG in Berlin when it came to the design of the new workshop building and the Västerås town architect's studies in Germany and involvement in it are clear evidences as well as the Mimer architecture's close relation to Behrens. There were many similarities to AEG's workshop for small motors as well as the company's factory for railway cars and other materials that were both in Berlin. AEG's leader Emil Rathenau was inspired by the same American principles as Edström.[229] Therefore, it is perhaps possible to speak about an indirect American influence as well.

Helén's stated that Silvander was important in the building of the Mimer workshop, and in a general way, his foreign experiences probably were as well.[230] It is not reasonable to assume that Silvander was directly inspired by Behrens's ideas as his stay in Berlin occurred in 1899-1901 and Behrens was engaged by AEG in 1907.[231] Brunnström did not connect Hahr's architecture to his study trips in Germany, which actually occurred many years before Silvander worked in Berlin.[232] However, Silvander probably followed the development and also contributed with his experience.

Rathenau and another factory owner in Berlin, Ludwig Löewe, were both inspired by ideas about mass production originating from the United States. Löewe was the first factory in Germany that applied these methods and planned the factory after American models. The engineer in charge, Julius Pajeken, had made study trips in the United States.[233] When the rational factory was planned at ASEA it is reasonable that Schumacher also participated. He was employed at Löewe in the 1890s. Furthermore, Schumacher worked for Union, during the same time as Silvander was there. It seems more or less obvious that they became acquainted in Berlin in the late 1890s. Later, both of them worked for the smaller electro-technical company Magnet in Ludvika.[234] In the late 1890s, rational factories were established both by Löewe and AEG. Union and these two factories were located some blocks away from each other in Martinickenfelde in Berlin.[235] It seems reasonable that a curious engineer looked around in the neighbourhood even though it is not possible to establish whether Silvander was allowed to make study visits to AEG and Löewe. However, although they did not experience the factory architecture of Behrens in late nineteenth century Berlin, Silvander and Schumacher probably contributed with ideas and experiences of rational factories originating from there. Silvander possibly also used ideas from his time at General Electric. Harry Zanders, an engineer with experiences from the Newport News Shipbuilding Co. in Virginia as well as the Gisholt Machine Co. in Madison, Wisconsin, also participated in the planning of the Mimer workshop.[236] The inspiration seems to have been something that really could be called a German-American blend.

Tool making

Zanders later became responsible for ASEA's tool making. From the beginning it was under the mechanical workshop. However, in 1913, it received its own construction office. William Willner replaced him in 1916 and stayed until 1919. Willner had worked for Pratt & Whitney in Hartford, Connecticut, and for General Electric. Walter Björklund, who lacked foreign experiences, replaced Willner and stayed until the 1940s.[237] The task of the tool-making department was to construct and manufacture tools that were needed in ASEA's production, such as gigs, stances, fixture, etc. The department also manufactured special machines that could not be bought from elsewhere.[238]

The Pratt & Whitney Company in Hartford, Connecticut, was an important company when it came to tool making.[239] Hellman was instructed by Edström to try and get a good constructor of tools to ASEA. In his letter from Schenectady in September 1912 Hellman wrote that he did not think that there was anyone who met the qualifications required among the Swedish engineers in Schenectady. Hellman had been instructed, probably by Edström, to go to Hartford and see the workshops of Pratt & Whitney and his hope was that he would meet someone who could live up to ASEA's expectations there.[240] Hellman and Edström obviously thought that Pratt & Whitney was a better place for this recruitment than General Electric was. The story does not say whether Hellman ever went to Hartford and whether he had something to do with the recruitment of Willner to ASEA.

The foundries

ASEA began the building of its foundry in August 1905 and it was finished in January the next year. Production started early in 1906 under the lead of the returned engineer Gustaf Blume, who worked one year in Steelton, Pennsylvania and two years in Detroit, and spent four years as consulting engineer. When Edström recruited him, he lived in Toledo, Ohio. In 1910 the non-emigrant Silverstolpe replaced Blume and was chief engineer until 1912. Gösta Drakenberg, a KTH-educated mining engineer with a short study trip in Germany, came after Silverstolpe and was in charge until 1945. [241]

Edström had a lot confidence in Blume's ability to do good work and was anxious to get him to come to Västerås and ASEA. In a letter of April 1905, Edström promised that his American wife would help Blume's young wife to feel at home in Västerås.[242] If his wife was resistant, it must have been more problematic to recruit Blume. Then Edström continued:

> In engaging you I feel certain that the malleable iron business will be good. We have a good large foundry and patternshop (sic!). There is plenty of room for extensions. Having erected the plant, you will have to run it, push the selling of products etc. We shall keep you busy.[243]

Blume was engaged to set up the malleable-iron foundry and to run it. When the company described the foundry in a booklet from 1909, they did not spare words.

> The personnel, of whom practically everyone without exceptions, worked in a malleable-iron foundry for the first time, had by the beginning of the year 1908 got used to the occupation so much, that the work intensity very well could be called worthy of respect and evoked an acknowledgement from one of the United States' largest manufacturers in the field, who paid the foundry a visit about a year and a half ago. [244]

In the foundry, there was an automatic forming machine manufactured by the Berkshire Mfg. Co in Cleveland, Ohio. Around 1908/1909, ASEA was about to install more modern forming machines, combined presses and lifting arrangements manufactured by the same company.[245] There are unfortunately no direct evidences that Blume ever sat his foot in this company but presumably he did. As he lived in Toledo, a city located only about one hundred-eighty kilometres west of Cleveland it seems reasonable. Blume at least was present in the area, and as he was a consulting engineer in the foundry business, he presumably acquainted himself with manufacturing companies.

In the brochure about the malleable-iron foundry from 1909, ASEA wrote that some of the methods used partly for smelting and partly for forming were new for Sweden and that the manufacture of malleable-iron probably was unknown to many people. Therefore it was necessary to get the readers of the brochure acquainted with the methods and the process as a whole. ASEA stated that they were using open furnaces, similar to flame furnaces, instead of dome-shaped ones and that this was a practice that had been widely diffused in the United States. According to the company's brochure, the advantage to do smelting in open flame furnaces compared to dome-shaped ones was that they could keep control of the process and change the composition when it was needed at any time. Another advantage had to do with the possibility to foam the "iron bath" in order to get rid of slag and dross and thereby get a cleaner iron with a higher quality.[246]

This probably also held true about the malleable process, where the brochure stated that there were two systems of manufacture of malleable iron; the *Reaumur* system and the *American* system. Both systems were used in Västerås. The American system gave malleable iron greater malleability, flexibility and tensile strength than the other system, whereas the Reaumur system was better suited for iron that was to be worked in machines before it was used.[247]

ASEA's malleable iron foundry was developed under Blume to a foundry that was almost totally devoted to mass production. The model workshop was one of the most major departments at the foundry. Metallic models were made there. They were used when a large delivery of malleable iron after the same models came. This created a need to manufacture many models of the same kind. Mass production in the foundry also required a rational system to store the models. The practice was to photograph the model as soon as it came to the foundry and write the name of the purchaser, the designation of the models and where the models were kept in the storeroom. The system helped the foundry to find a model easily and it also facilitated the expedition to the customers. [248] These systems of mass production introduced by Blume clearly had an American touch. When he quit in 1910 to become consulting engineer in Stockholm his successors Silverstolpe and Drakenberg had a few foreign experiences but not from the United States. It was presumably the case that Blume and his American experience was mostly needed in an early stage of the foundry's development and organisation.

4.8. Concluding discussion

The larger context of industrialisation and development nationalism inspired by American and German models, and the information about the interesting development within electrical engineering in primarily the United States and Germany, spurred an interest among electrical engineers and other engineers interested in electro-technology to emigrate. Abroad they learned more and acquired the access and the knowledge of current developments in the electrical industry. In this way the engineers had the information, interest, access and knowledge of the latest developments within electro-technology. It was rewarding for electrical engineers to go abroad and learn more about cheap planning and organisation of an electrical workshop. The knowledge worked as a symbolic capital in what we in line with Bourdieu may call the sub-field of electrical engineering and gave the returned engineers the crucial power to become carriers of technology. The support the returned and immigrant engineers received from boards and managers was considerable. The belief in them was a crucial factor for technology transfer to occur but also a factor contributing to the success of it.

Workshop organisation was the area in which ASEA was most influenced by the conditions in the United States, and where it was more important than other countries. American impulses came mostly from General Electric and to a smaller extent from Westinghouse and minor influence can also be noted from elsewhere in the United States. Ideas of mass production were introduced and the standardisation of machines and apparatus became increasingly important. Other impulses were the development of the three-phase system and the adjustment of it to higher tensions in the 1890s. This was important for the breakthrough of electro-technology, which was one of the major forces behind the second industrial breakthrough. The construction of generators for larger sizes, the establishment of an industrial laboratory emphasising scientific research, the construction of apparatus for larger sizes and higher effects, elevators, modern forming machines and other methods used in the foundries as well as the use of photography were other influences.

It would be an exaggeration to state that these practices were all American. La Cour also contributed with ideas of standardisation. It may be difficult to geographically place technical influences. What can be concluded is that the United States was most important and that Germany and Switzerland were the other major sources of influence. Areas in which there are indications that the latter countries were more important than the United States were railway electrification, transformers, commuting motors and rail apparatus. The shaping of the Mimer workshop seems to have been a blend of ideas where the direct influences came from the rational factories in Berlin in the 1890s, which in turn were inspired by American factories.

The core of the American ideas of standardisation, mass production and the adjustment of different constructions to it were implemented over time in many places of the company. This indicates a considerable impact. In a smaller unit such as a company, such an impact must have been larger compared to a country as a whole. A huge majority of the ASEA departments had a chief engineer with experiences from the United States at some point. Almost half of the departments had it for all or most of the time of their existence until 1940. If other foreign experience are added, the pattern of foreign influence becomes even more significant. Engineers who lacked foreign experience played a minor role in leading positions. The continuous process of employing engineers with foreign experience in leading positions indicates that the strategy was successful and that engineers with this kind of experience were a source of technical development for ASEA.

The surrounding context probably facilitated a successful implementation of these technical practices at ASEA on a wider scale. Sweden had a high level of technical education. Furthermore, many of the engineers at ASEA were educated at renowned technical institutes on the European continent such as the ones in Zurich, Berlin or Karlsruhe. In the English language brochure *What We Can Do* from 1905, ASEA wrote that they “had a thoroughly trained staff of electrical and mechanical engineers”. [249] Despite the exaggerations that may be present in an advertising brochure, it seems obvious that the company had the technical expertise required in order for the reception to be successful. The question concerning the general technical level in the donor country and whether the technology exported to ASEA was too advanced compared to the general technical level in primarily the United States and Germany is more difficult to answer. Technology and other ideas brought from abroad came from leading companies in the countries and would indicate that it was more advanced than the general level. However, the large domination of a few companies in at least the United States may indicate that the practices were common standards within the American electrical industry as a whole.

The availability of natural resources was probably important for the successful adaptation of the technological implementations. Sweden's geography enabled ASEA to develop high competence in the transmission of electrical power over long distances. Sweden was a country well equipped for the establishment of an electrical industry on a larger-scale from the beginning. In "What We Can Do", ASEA wrote:

> The location of our works at Westerås is excellent, in the close proximity to the best swedish (sic!) steel, iron and copper works, possessing good railway and steamship communications and cheap electric power from our own waterfalls. [250]

The geographical closeness to the natural resources in the Swedish steel and iron district of Bergslagen facilitated the transition to mass production as the large quantities of steel and iron required could easily be transported to Västerås and Ludvika at a comparably cheap price. Cheap electricity possibly contributed to make the production more economic. Even if there could be reasons for rationalisation due to production that was too expensive, the cheapness of electricity and natural resources probably allowed a company such as ASEA to compete on the international market. Geographical factors also contributed to the cost-effectiveness of rationalisation in the environment, something that further facilitated its implementation.

In the existing Swedish view of technical development as the source of a new great power era for the nation, and with the electro-technology as one of the prime movers, these technologies and ideas were easily adapted. Moreover, as most of the engineers in responsible positions were returning Swedes and many of them also had been employed at ASEA before they had emigrated, the integration in the social order of ASEA and Västerås went smoothly. Presumably many of these engineers were "mentally" prepared to work for ASEA, as it was Sweden's largest electro-technical company. Furthermore, the immigrants that were recruited could easily adjust to Swedish conditions. In all, this created a foundation for a successful implementation as well as adaptation of technology brought by returning and immigrant engineers to the early twentieth century Swedish electrical industry. In the next chapter, we will look into the same process in the major Swedish steel and iron industry.

Notes

1 For several years, Edström was a prominent person in the Swedish as well as the international sports movement. He was vice chairman in the organising committee for the Olympic Games in Stockholm 1912 and initiator to the International Amateur Athletics Federation (IAAF) and its first president from 1913 to 1946. During the years 1920-1952 he was also a member of the International Olympic Committee and president from 1946 to 1952.

2 Edström J. Sigfrid, "Radio-speech to the United States held by J. Sigfrid Edström, April 29, 1932". Unpublished paper, 1932 JSE, RA, volume 46.

3 M Fridlund, 49; J Glete 1983, 18.

4 H Lindblad 1995, 199.

5 *J. Sigfrid Edström. Inför hundraårsdagen av hans födelse den 21 november 1870* (Västerås, 1970), 5. Swedish original: "en modern tekniker och affärsman av amerikanskt snitt".

6 J Glete 1983, 17.

7 *Svensk Uppslagsbok2*. Search word: "Allmänna svenska elektriska ab" (Malmö 1960), 666-667; *Nationalencyklopedin 2*. Search word: ASEA. Band 2, (Höganäs, 1990), 4.

8 http://www.abb.com, available on Internet 16/5-2003.

9 *Allmänna Svenska Elektriska Aktiebolaget, Wästerås, 1883-1908* (Stockholm, 1908); Johan Åkerman, *Ett elektriskt halvsekel. Översikt över ASEAs utveckling 1883-1933* (Västerås, 1933).

10 M J Helén 1955; Martin J Helén, *ASEA:s historia 1883-1948. Andra Bandet. Försäljning, avd. för installationsmaterial, social verksamhet, föreningsverksamhet, biografier, diagram* (Västerås, 1956); Martin J Helén, *ASEA:s historia 1883-1948. Tredje Bandet. Den tekniska utvecklingen* (Västerås, 1957); J Glete 1983.

11 J Glete 1983, 11.

12 M J Helén 1956, 319.

13 J Glete 1983, 18, 36, 45, 50, 52.

14 K A Bratt 1950; Karl Axel Bratt, *J. Sigfrid Edström. En levnadsteckning. Senare delen* (Stockholm, 1953).

15 M Fridlund, 35-36, 50-53, 64-67, 73-76.

16 L Brunnström, 77, 167-177.

17 K A Bratt 1950, 32-33, 36; M-L Bowallius, 22-25.

18 K A Bratt 1950, 38-40.

19 K A Bratt 1950, 76.

20 K A Bratt 1950, 75-76.

21 O Gasslander, 152; J Glete 1983, 45.

22 R Torstendahl, 13-14.

23 K A Bratt 1950, 76-77.

24 J Glete 1983, 47-48.

25 *J. Sigfrid Edström inför hundraårsdagen*, 5.

26 M Fridlund, 48.

27 *Svensk-Amerikanska Sällskapet i Stockholm. Förteckning av ledamöter. Maj 1909* (Stockholm, 1909), 7, JSE, RA, volume 53.

28 "Förslag till stadgar för Svensk-Amerikanska sällskapet i Stockholm 1907", JSE, RA, volume 53.

29 In 1948, Edström also became honorary member of the Swedish Engineers' Society of Chicago, see Albin G. Witting, *A History of the Swedish Engineers' Society of Chicago* (Chicago, IL, 1948).

30 Edström to August Herlenius, 10/9-1926, JSE, RA, volume 45. Swedish original: ”Betydelsen av att stiftelsen kan sätta ett 20-tal eller mer unga svenska män och kvinnor, med de bästa kvalifikationer för uppgiften, i tillfälle att förvärva ökad kunskap och erfarenhet, var och en på sitt speciella område, i det stora framtids- och nutidslandet Amerika med dess sjudande utveckling på snart sagt alla områden är i ögonen fallande. Och det är svensk vetenskap, svensk handel och industri, svensk bankverksamhet, som i sista hand tillgodogör sig detta Stiftelsens arbete”.

31 Edström to Herlenius.

32 M Fridlund, 50.

33 Monte A. Calvert, *The Mechanical Engineer in America 1830-1910. Professional Cultures in Conflict* (Baltimore, MD, 1967), 217.

34 K O Bjork, 45.

35 M J Helén 1955, 308.

36 Edström to Unger 8/6-1903. Swedish original: ”Jag har redan anskaffat dugliga ingenjörer med amerikansk och tysk erfarenhet samt håller f.n. på att skaffa mig dugliga förmän (svenskar från amerikanska och tyska verkstäder). Det är min mening att uppdrifva fabrikationen, så att jag kan bjuda den tyska konkurrensen spetsen. - Som Du ser har jag utmärkta resurser, och då jag själf ligger inne med öfver 4 år amerikansk verkstadspraktik, tror jag mig vara i stånd få fram Allmänna Svenska”.

37 Edström to Helge Smedinger, 4/3-1942, ENDA, volume H: Ö2-05-022. Swedish original: “Det gick ju galet för honom, som Du vet”.

38 Edström to August Tinnerholm, 22/5-1903, JSE, RA, volume 85.

39 J Glete 1983, 50.

40 N Runeby 1978, 23.

41 K A Bratt I, 40.

42 Edström to Jens Lassen la Cour, 6/12-1906, JSE, RA, volume 93.

43 Arvid Lindström, ”Några elektriska anläggningar i Bergslagen under elektro-teknikens barndom”, lecture in Ludvika, Sweden, 3/9-1927. Unpublished paper 1927, ENDA, volume H:Ö2-13-009.

44 M J Helén 1956, 273-274; *Svenska Teknologföreningen* I, 305.

45 Martin J. Helén, ”Jonas Wenström och Ernst Danielson. Några förut ej publicerade brev och berättelser från två märkesmäns levnad”. Lecture held at Elektriska Klubbens 40th year meeting, Västerås, Sweden, 17/10-1946. Unpublished paper 1946, ENDA, volume H:N 16-01-010.

46 Arvid Lindström, ”PM (ang. Ernst Danielsson) för uppsats i svenskt Biografiskt Lexikon”, Unpublished paper, 1930, ENDA, volume H:N 16-01-9A.

47 Victor Ståhle to J. Eric Carlsson, 14/12-1946, ENDA, volume H:N 016-01-10. Swedish original: “Jo, det var så enkelt, överallt, där det stod ”förbjuden ingång”, smög jag mig in och undvek i det längsta att råka ut för någon”.

48 A Lindström, 2.

49 A. L. Rohrer to Ivan Öfwerholm, 26/4-1936, ENDA, volume H:Ö2-008-5.

50 ”Ernst Danielsons räkneböcker”, Unpublished paper not dated, ENDA, volume HÖ:2-08-05, 1. If one compares the handwriting in it with other documents, the conclusion is that the author probably was Arvid Lindström.

51 M J Helén 1956, 274-275.

52 “Some events in the early days of the polyphase induction motor”, Unpublished paper, 1930, GEHA.

53 R. R. Kline 1992, 72-74, 99.

54 “Ernst Danielsons räkneböcker”, 1.

55 “Some events in the early days of the polyphase induction motor”.

56 M J Helén 1956, 274.

57 M J Helén, 1946.

58 Åke T. Wrethem, "Jonas Wenström och trefassystemet" in *Teknik i ASEA 1883-1983* (Västerås, 1983), 8-11.

59 M J Helén 1955, 51.

60 J Glete 1983, 36.

61 R R Kline; "A personal sketch of Edwin Wilbur Rice, Jr.," in *Schenectady Works News,* 21/7-1922, GEHA.

62 M J Helén 1955, 33.

63 Emil Lundqvist, "Begynnande massfabrikation", Unpublished paper, around 1923, ENDA, volume H:N 16-01-018, 1.

64 Jos. Swartz & A. Norstrand, "Westinghouse-kompaniets elektriska verkstäder i Pittsburg", *Teknisk Tidskrift. Mekanik och elektroteknik* 1904, 151.

65 J Swartz & A. Norstrand, 151.

66 Stig Jonsson, "Krisen vid sekelskiftet" in *Från Wenström till Amtrak. Profiler och händelser ur ASEAs historia* (Västerås, 1983), 24.

67 Sven Rydberg, "Lundqvist, Karl Emil" in *Svenskt Biografiskt Lexikon 24 (Stockholm 1984), 366-368*.

68 K A Bratt 1950, 82.

69 K A Bratt 1950, 80-82.

70 Edström to Emil Lundqvist, 21/4-1903, JSE, RA, volume 85, Swedish original: "Ja! Och så var det då mitt erbjudande. – Ja! Käre vän, Sverige har ändrat sig eller är åtminstone på väg dertill. – En rätt skött affär är numera huvudsaken, system i allt – konstruktion, fabrikation, försäljning. – Och arbete grundat på denna basis måste fram. – Ser du, det ligger nu en härlig stor verkstad deruppe i Vesterås. Den arbetar tungt och hårdt, dyrt i den gamla slentrianen. Kom hem och hjelp mig rycka upp den. Du skall få öfvertaga ledningen af hela verkstaden och din lön blir 8000 kronor om året samt tantieme, som garanteras uppgå till minst 2000 kr. – Om du tror att jag beder dig komma hem för att lägga dig på latsidan, så misstar du dig mycket. Jag har aldrig arbetat så hårdt, som jag gör nu – Men här betalar det sig ock. Det är ju alldeles gifvet att så ock skall blifva fallet i ett land, der man hittills legat så mycket på latsidan. - Hvad din äregirighet beträffar, så är jag övertygad om att du ännu är så gammal svensk, att du skulle känne dig stolt öfver att få rycka upp den elektriska industrien här hemma. Och ej bör denna plats vara din plats till döde dagar.. Her finnes mycket att göra och mycket plats upptill för den som vill och kan arbeta. Äfven har du i denna plats (och….senare kanske utvidgas äfven den..hvad lönen beträffar, blott affären går igen) ett tillfälle att komma hemma, ett trappsteg, som kanske aldrig mer erbjuder sig. – Du kan ju välja att vänta, tills du blir rik och kan lefva af räntor. – Men då är det svårt för dig att lefva, ty då är dina bästa år borta och jag tror att du har så mycket godt att gifva Sverige att det skulle vara skada, om du gräfde ner dig i Kimberley. Godt her har du mitt erbjudande och min utsträckta hand. Vill du komma så kom snart ty snar hjelp är dubbel hjelp".

71 K A Bratt 1950, 82.

72 K A Bratt 1950, 117.

73 J Glete, 50, n. 13.

74 E Lundqvist, 3.

75 E Lundqvist, 1-2; J Glete 1983, 50.

76 "Mekaniska verkstaden", *ASEA:s egen tidning* 6/1909, 47-48.

77 J Svartz & A Norstrand, 151.

78 K A Bratt 1950, 40; J Glete 1983, 50; S Rydberg 1984, 366.

79 Edström to Carl Silvander, 18/8-1914, JSE, RA, volume 122.

80 Edström to Marcus Wallenberg, 6/5-1903, JSE, RA, volume 85.

81 Edström to Silvander, 11/10-1903, JSE, RA, volume 85.

82 Edström to Silvander, 30/10-1903, JSE, RA, volume 85.

83 M J Helén 1955, 272-273. Swedish original: ”Med sin praktiska erfarenhet från tyska och amerikanska elektriska företag förenade Silvander synnerligen god konstruktiv blick med organisationsförmåga och nedlade ett förtjänstfullt arbete på den mångfald nykonstruktioner som utarbetades under hans ledning, bland vilka kunna nämnas de för dåtida svenska förhållanden anmärkningsvärda ”jättegeneratorerna” för Svaelgfoss och Rjukan i Norge samt för Trollhättan och Porjus m. fl. Inköp och även egen tillverkning av moderna arbetsmaskiner, ävensom planering och konstruktion av verkstadsbyggnader, bland vilka särskilt den nya Mimerverkstaden, uppförd 1912-13, kan nämnas skedde likaledes under Silvanders ledning”.

84 M J Helén 1957, 20.

85 Edström to Lundqvist, 26/3-1904, JSE, RA, volume 89.

86 ”Some important events in the history of the General Electric Company” in *Schenectady Works News,* 6/4-1923, GEHA.

87 M Fridlund 63-67; S Hansson, 174-182; “Världens största elektriska maskin. Konstruerad och byggd af Allmänna Svenska i Västerås Ett den svenska ingeniörkonstens mästerverk” in *Stockholms Dagblad*, 20/11-1910; “Jättegeneratorerna till Trollhättans kraftstation. De största hittills byggda i Europa” in *Svenska Dagbladet* 18/1-1908; Edström to Albert Elfström, 31/10-1907, JSE, RA, volume 97. In this letter, Edström stated that the chief engineer in Trollhättan was planning the power station in a similar way as the Ontario Power station on the Canadian side of Niagara Falls.

88 Edström to Silvander, 18/8-1914. Swedish original: “Synnerligen förtjänstfullt har Edert arbete varit i organisationsfrågor och stora besparingar ha genom Edra förslag åstadkommits vid såväl nybyggnader som drift af verkstäderna”.

89 Edström to la Cour, 6/12-1906; M J Helén 1955, 273.

90 Edström to la Cour, 17/2-1907, JSE, RA, volume 97.

91 J Glete 1983, 52 and n.22.

92 “Jens Lassen la Cour”, Unpublished paper, not dated, ENDA, volume H:N-016-013; J Glete 1983, 52; M Fridlund, 51-52.

93 M J Helén 1955, 273-274.

94 M J Helén 1955, 277-278; ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

95 M J Helén 1955, 278-279.

96 *Svenska Teknologföreningen* I, 420.

97 Einar Wikander to Edström, 19/1-1905, JSE, RA, volume 85.

98 Edström to E Wikander, 30/1-1905, JSE, RA, volume 93.

99 Ragnar Wikander to Edström, 13/2-1904, JSE, RA, volume 90.

100 R Wikander to Edström, 13/3-1904, JSE, RA, volume 90.

101 R Wikander to Edström, 10/10-1904, JSE, RA, volume 90; E Wikander to Edström, 19/1-1905, JSE, RA, volume 91.

102 Edström to R Wikander, 30/2-1905, JSE, RA, volume 93.

103 Edström to R Wikander, 3/3-1905, JSE, RA, volume 93.

104 Edström to R Wikander, 17/5-1905, JSE, RA, volume 93.

105 Ragnar Wikander, ”Elketropneumatiskt bromssystem för järnvägar”, unpublished paper, 1905, ENDA, volume H: Ö2-13-009, Appendix 8.

106 Ragnar Wikander, ”Rapport öfver försöksafdelningens verksamhet från den 1 oktober 1905 till dato”, Unpublished paper, 20 december 1905. Professor Arvid Lindströms efterlämnade handlingar, ENDA, volume H: Ö2-13-009, 1.

107 Ragnar Wikander, ”Rapport öfver Westinghouse patentens betydelse för utvecklingen af vexelströmsseriemotorerna”, ENDA, volume H: Ö2-13-009, Appendix 13, 1, 5.

108 M Fridlund, 89-90; J Glete 1983, 162.

109 Leonard S. Reich, *The Making of American Industrial Research. Science and Business at GE and Bell, 1876-1926* (Cambridge, 1985), 71; George Wise, *Willis R. Whitney, General Electric, and the Origins of U. S. Industrial Research* (New York, NY & Guildford, 1985).

110 *Chalmers,* 22; M J Helén 1955, 357-359; M J Helén 1956, 314.

111 M J Helén 1955, 358-359.

112 Hellman to Edström, 25/9-1912, JSE, RA, volume 113.

113 Hellman to Edström, 5/5-1912, JSE, RA, volume 113.

114 ”Aseas isolationsfabrik”, *ASEA:s egen tidning,* number 11/12, 1921, 92.

115 Harald Håkanson, ”Litterära afdelningen”, *ASEAs egen tidning,* 7/1909, 53.

116 David E Nye, *Image Worlds: corporate Identities at General Electric, 1890-1930* (Cambridge, MA, 1985) 15.

117 D E Nye, 36.

118 H Håkanson, 56-57.

119 M J Helen 1956, 285.

120 M J Helén 1955, 286, 292; *Malmö Teknologförbund,* 162; *Svenska Teknologföreningen* I, 431, 517, 585.

121 ”Schneider”, *Nationalencylopedin. Ett uppslagsverk på vetenskaplig grund utarbetat på initiativ av statens kulturråd. Sextonde bandet* (Höganäs, 1995), 307.

122 Julius Körner to Edström, 18/4-1907, JSE, RA, volume 99.

123 M J Helén 1955, 284.

124 See for instance Boel Berner, “Konstruktionsarbete under 100 år” in *I teknikens backspegel. Antologi i teknikhistoria,* ed. Bosse Sundin (Stockholm, 1987), 267-268; David A. Hounshell, *From the American System to Mass Production 1800-1932. The Development of Manufacturing Technology in the United States* (Baltimore, MD, 1984), 151.

125 *Svenska Teknologföreningen* I, 517, 578, *Tekniska föreningen i Örebro,* 299, ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

126 Emil Billing to Edström, 8/8-1907, JSE, RA, volume 97.

127 Billing to Edström, 8/8-1907. Swedish original: “studera hur de olika delarna skola tillverkas ekonomiskt; och detta vid ett bolag där förhållandena mer öfverensstämmer med de svenska”.

128 *Svenska Teknologföreningen* I, 578.

129 G. E. Billing, ”Standardisering och massproduktion”, *ASEAs egen tidning,* 1/1911, 4-5.

130 M J Helén 1957, 20-21; E. J. Westman, ”Likströmsmaskinens utveckling vid ASEA” in *ASEAs egen tidning,* 1/1914, 5.

131 Edström to Ernst Danielson, 27/11-1906, JSE, RA, volume 93; Danielsson to Edström, 1/12-1906, JSE, RA, volume 93.

132 M J Helén 1955, 289; M J Helén 1957, 20; *Chalmers,* 215, 288; *Svenska Teknologföreningen,* I and II, 463, 574, 596, 902.

133 M J Helén 1957, 30.

134 M J Helén 1955, 290-292; M J Helén 1956, 150; *Chalmers,* 135, 178; *Svenska Teknologföreningen,* I and II, 390, 485, 819, 1060; *Chalmerska Ingenjörsföreningen*, 1930-1937; ASEA personnel files, ENDS; volume H:F1 20 001-010; *ASEA:s egen tidning,* 5/1915, 82.

135 M J Helén 1955, 291, 384; *Svenska Teknologföreningen,* II, 981; ASEA personell files, ENDA, volume H:F1 29 001-010.

136 Karl E. Eriksson & John Lundgren, ”Tranformatorer” in *ASEAs egen tidning,* 4-9/1923, 121.

137 M Fridlund, 52.

138 M J Helén 1955, 292; *Chalmers,* 263; *Svenska Teknologföreningen* II, 1047, 1165.

139 *Chalmers,* 263; J Glete 1983, 203; M J Helén 1955, 287-288; ”Turbine Generators Makes World Record” in *Westinghouse Electric News,* volume 6, no. 8, August 1920, 4 and 9, W, HSWP.

140 M J Helén 1957, 68-69.

141 M J Helén 1955, 292, *Chalmers,* 179, *Svenska Teknologföreningen* I and II, 626, 726, 1432, Chalmerska Ingenjörsföreningen, 1928; Körner to Edström, 31/3-1907, 18/4-1907, JSE, RA, volume 99.

142 J Glete 1983, 182.

143 Körner to Edström, 2/10-1906, JSE, RA, volume 95. Swedish original: ”måste jag verkligen erkänna att Amerika i detta avseende näppeligen motsvarar de förväntningar man kunde ha rätt att hysa med ledning af bolagens braskande bulletiner. Typisk är General Electrics bulletin II 4439 angående motorn GE A-605-A, där det heter: ‘Since that date [August 1904] the GE Cy has designed a complete line of single-phase railway motors —— a large number of these motors have been manufactured and those already put in service have given excellent satisfaction’ I själfva verket utgöres ’the complete line’ af mer eller mest mindre lyckade försöksmaskiner och så vidt jag vet har intet hvarken större eller mindre antal motorer satts i drift, än mindre gifvit utmärkta resultat. Faktum är emellertid att G. E. för närvarande fått en del betsällningar å single-phase equipments, tack vare sina reklamer, och att det nu arbetas under högtryck för att få ut en passande motor, helst som Westinghouse, tack vare New York – New Haven ånyo fått ett övertag i kampen”.

144 Julius Körner to Edström, 2/10-1906. Swedish original: ”Under sitt besök i Europa i somras torde han sökt taga reda på de tyska maskinerna. Hos Westinghouse anses man ha hunnit något längre, men det torde vara obestridligt att Europa på detta område står före, ännu så länge åtminstone”.

145 Edström to Körner, 6/11-1906, JSE, RA, volume 95.

146 Körner to Edström, 16/12-1906, JSE, RA, volume 95.

147 Edström to Körner, 4/1-1907, JSE, RA, volume 99.

148 Körner to Edström, 31/3-1907 and 18/4-1907, JSE, RA, volume 99.

149 Körner to Edström, 18/4-1907, JSE, RA, volume 99.

150 ”Ingeniör Julius Körner” in *ASEAs egen tidning,* 4/1916, 62.

151 Julius Körner, ”Kort redogörelse för försök med kommutatormotorer vid ASEA”, Unpublished paper, 1910, in ENDA, volume H:N16 04-007, 10-11.

152 J Glete 1983, 89.

153 J Körner 1910, 12-13.

154 Julius Körner, ”Kommutatormotorer. I. Enfasmotorer”, unpublished paper, not dated, ENDA, volume H: N 016-01: 17, 8.

155 M J Helén 1955, 296.

156 M J Helén 1955, 296, J Glete 1983, 53.

157 J Glete 1983, 53; M J Helén 1955, 296; Georg Siemens, *History of the House of Siemens* (Munich, 1957); *Svenska Teknologföreningen* I, 600; ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

158 M J Helén 1955, 297; *Svenska Teknologföreningen* II, 797.

159 M J Helén 1955, 297; *Svenska Teknologföreningen* I, 752.

160 M J Helén 1955, 293-294, 384; M Fridlund, 74; Edwin Johnson, ”Ingenjör Edwins Johnsons 1870-1942 anteckningar om sitt märkliga liv”, Unpublished paper. held by the author, a gift from Dr. Mats Fridlund, 13; *Svenska Teknologföreningen I,* 438, 464, 495, 725; *Teknologföreningen i Borås 1862-1912. Minnesskrift utgifven vid teknologföreningens femtioårs-jubileum af dess ombudsnämnd,* ed. Sigurd Köhler (Borås, 1912), 73.

161 Ivan Öfwerholm, “PM angående Ivan Öfwerholms anställning vid Asea”, Unpublished paper, 1945, ENDA, volume H:N016-01-010.

162 I Öfwerholm, 3-4.

163 M J Helén 1957, 133; “Circuit breakers”, Unpublished paper, not dated, JWH, GEHA, volume L 1829.

164 M J Helén 1955, 123-124; Sven Norberg: “Ur apparattillverkningens historia”. Unpublished paper, not dated. ENDA, Volume H:N16-01-18, 10.

165 E Johnson, 13-14.

166 M Fridlund, 74.

167 E Johnson, 11, 14; M Fridlund, 74.

168 E Johnson, 14; M Fridlund, 75. Swedish orginial: ”så var jag ju svensk, och när nu Sverige behövde mina erfarenheter.”

169 E Johnson, 14-15; M Fridlund, 75.

170 E Johnson, 18; M Fridlund, 75. Swedish original: ”gick jag upp tidigt, för jag tyckte det skulle bli intressant att se den svenska fosterjorden, som det var 19 år sedan jag sist såg den, stiga upp vid horisonten. Och så kom det stora ögonblicket, en svart rand skymtades i morgondiset och det var Sverige”.

171 E Johnson, 18.

172 E Johnson, 31; M Fridlund, 75.

173 “Circuit breakers”.

174 Sven Norberg, ”Oljeströmbrytare”, *ASEA:s egen tidning,* 3/1909, 22.

175 E Johnson, 31.

176 M Fridlund, 75.

177 E Johnson, 36-45.

178 M J Helén 1955, 294.

179 M J Helén 1955, 298

180 M J Helén 1955, 298, *Svenska Teknologföreningen* I and II, 464, 937, 1392 *Teknologföreningen i Borås,* 73.

181 Joel Björklund et al. ”Till Ingenjören HJALMAR JANSON på 65-årsdagen den 11 oktober 1943 från vännerna och arbetskamraterna Joel Björklund, Joseph Dolk, Karl Olsson, Oscar Ericson, K J Nordström, Nils Rosén efter ett mer än 25-årigt samarbete”, Unpublished paper 1943, ENDA, volume H:N 016-01-010.

182 J Björklund et al, 4.

183 M J Helén 1957, 163.

184 J Björklund et al, 5.

185 M J Helén 1955, 302.

186 M J Helén 1955, 302-304.

187 The Örjan workshop is however left out as it did not open until 1945/1946, M J Helén 1955, 339.

188 M Fridlund, 52; M J Helén 1955, 304-305; *Svenska Teknologföreningen* I, 339, 657, 671; ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

189 M J Helén 1955, 334, 336-337; M J Helén 1956, 323; *Svenska Teknologföreningen* I, 491-492.

190 M J Helén 1955, 345, 347-348, M J Helén 1956, 321, 331, *Chalmers,* 209, 301, *Svenska Teknologföreningen* I, 394, 646, ASEA Personel files, ENDA, volume H:F1 29 001-010.

191 Alfred D. Chandler, *Scale and Scope. The Dynamics of Industrial Capitalism* (Cambrigde, MA, 1990), 68, 198.

192 Per Deurell to J. & C. G. Bolinders Mekaniska Verkstads AB, 18/12-1903, BMVA, FSF. Deurell was later employed by Bolinders, another of the case study companies in this study.

193 ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

194 Carl Hedin to Edström, 24/1-1906, JSE, RA, volume 95.

195 Edström to Hedin, 9/2-1906, JSE, RA, volume 95.

196 Hedin to Edström, 26/2-1906, JSE, RA, volume 95.

197 Hedin to Edström, 16/4-1906, JSE, RA, volume 95.

198 Hedin to Edström, 26/5-1906, JSE, RA, volume 95. Swedish original: "Verket var gammalt och låg midt i staden inrymdt i ett 7-våningshus med liten basyta och drefs allting i liten skala".

199 Edström to Hedin, 13/6-1906, JSE, RA, volume 95.

200 Hedin to Edström, 16/4-1906.

201 ASEA Personnel cards before 1935, ENDA, volume H:F29-001-010, ASEA phone books 1907 and 1908, ENDA, volume H:B7–01-001.

202 M J Helén 1955, 305.

203 Edström to Anders Landberg, 7/1-1907, JSE, RA, volume 99, Swedish original: "Att billigt organisera och drifva en verkstad är idag ett långt viktigare problem än att kunna bygga och drifva högspänningsanläggningar. Då Amerika är den bästa platsen i världen att lära detta har jag ej velat underlåta påpeka det stora fält som här ligger öppet för Eder.

204 M Fridlund, 52; ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

205 M J Helén 1955, 305.

206 Hedin to Edström, 24/1-1906, JSE, RA, volume 95. Hedin never got employment in Milwaukee and took the position in St. Louis described earlier.

207 A D Chandler, 198.

208 Frederick Vickers, "Report of my trip in Germany, September 1910", ENDA, volume H: N8-01-003, 1.

209 F Vickers, 9.

210 F Vickers, 1.

211 F Vickers, 3-4.

212 F Vickers, 4.

213 M J Helén 1955, 305.

214 *Svenska Teknologföreningen* I, 657; M J Helén 1956, 319.

215 M J Helén 1955, 305-306.

216 Hellman to Edström, 31/3-1910, JSE, RA, volume 107.

217 Hellman to Edström, 31/3-1910; 7/7-1910; 1/9-1910; 21/9-1910; 6/11-1910, JSE, RA, volume 107.

218 Hellman to Edström, 6/11-1910.

219 Edström to Hellman, 19/11-1910, JSE, RA, volume 107.

220 Hellman to Edström, 5/5-1912, JSE, RA, volume 113.

221 M J Helén 1955, 342.

222 Hellman to Edström, 5/5-1912.

223 Edström to Hellman, 23/5-1912, JSE, RA, volume 113.

224 Hellman to Edström, 5/5-1912; 2/7-1912, JSE, RA, volume 113.

225 Hellman to Edström, 2/7-1912.

226 Edström to Hellman, 10/10-1912, JSE, RA, volume 113, Swedish original: "Om Ni skall öfvertaga Emausverkstaden, bör Ni naturligtvis studera stora maskiners fabrication och lindningssätt i antingen Schenectady, Pittsburg eller Berlin".

227 Hellman to Edström, 25/11-1912, JSE, RA, volume 113.

228 F Vickers, 4-5, 7-9.

229 L Brunnström, 167-176.

230 M J Helén 1955, 327.

231 L Brunnström, 74.

232 *Svenska Teknologföreningen* I, 350.

233 L Brunnström, 77; Miron Mislin, ”Anfänge der Industriearchitektur in Berlin 1850-1910. Eine Ausstellung des Fachbereichs Architektur der Technischen Universität Berlin für das Fachgebiet Bau- und Stadtgeschichte, im Rahmen der Übung Industriegeschichte I und II, SS 1998 und WS 1998/99, vom 11. bis 22. Januar 1999 im Fachbereichsforum des Architekturgebäudes, Ernst-Reuter-Platz, Berlin“, http://www.a.tu-berlin.de/institute/0833/Mislin/AusstPr/Mislin.pdf, available on Internet, 15/7-2003.

234 *Svenska Teknologföreningen* I, 508; ASEA Personnel cards before 1935, ENDA, volume H F:29-001-010.

235 M Mislin, 4.

236 L Brunnström, 228 n 6; ASEA Personnel cards before 1935.

237 M J Helén 1955, 326; M J Helén 1956, 314, 330-331; ASEA Personnel cards before 1935.

238 M J Helén 1955, 326.

239 D A Hounshell, 50.

240 Hellman to Edström, 25/9-1912, JSE, RA, volume 113

241 Gustaf A. Blume, “Aduceringsgjuteriet vid A.S.E.A” in *ASEA:s egen tidning,* 1/1909, 19; M J Helén 1955, 316; M J Helén 1956, 316; *Svenska Teknologföreningen* I, 493, 614; http://www.ellisisland.org/search/shipManifest.asp?MID=06833889580064259584&FNM=GUSTAF&LNM=BLUME&PLNM=BLUME&CGD=M&RF=1&pID=101807060105&lookup=101807060105&show=G%3A%5CT715%2D1124%5CT715%2D11241105%2ETIF&origFN=G%3A%5CT715%2D1124%5CT715%2D11241106%2ETIF, available on Internet, 24/3, 2003; Edström to Gustave A. Blume, 4/4-1905 and 19/4-1905, JSE, RA, volume 91.

242 Edström to Blume, 19/4-1905. Blume’s wife Hanna Maria Teresia Nylén was born in Stockholm 1886 (*Svenska Teknologföreningen* I, 493), but Edström’s reference to Ruth Miriam Randall’s American origin may indicate that she had grown up in the United States.

243 Edström to Blume, 19/4-1905.

244 G A Blume, 19-20. Swedish original: “Personalen, af hvilken alla, så godt som utan undantag, för första gången arbetade uti ett aduceringsgjuteri, hade vid 1908 års ingång så inarbetat sig i yrket, att arbetsintensiteten godt kunde sägas vara aktningsvärd och framkallade hjärtligt erkännande från en af Förenta Staternas största tillverkare inom området, som för c:a halfannat år sedan gjorde gjuteriet ett besök”.

245 *Aduceringsgjuteriet* (Västerås, 1909), 4-6.

246 “Aduceringsgjuteriet”, 5.

247 “Aduceringsgjuteriet”, 8.

248 “Aduceringsgjuteriet”, 12-14.

249 *What we can do* (Stockholm, 1905), 6, ENDA, volume H: BS 08-001.

250 *What we can do,* 5-6.

5. STEEL AND IRON INDUSTRY: Sandvikens Järnverks AB

> An important contribution to the group's development was also made by the colleagues who had returned to Sweden after having been forced to emigrate to the USA in the early 20s and so to speak had "gone through the mill" there. They had started out on the workshop floor and received a thorough training in what I would like to call practical iron industry. …… has without doubt been important back home – even in a purely pedagogical way, especially during the 30s, in the practical handling of problems with humans, furnaces, machines and steel.[1]

Nils Elfström recalled his long career as an engineer at the Fagersta ironworks in central Sweden.[2] The early 1920s were characterised by crisis in the Swedish steel- and iron industry and therefore, it was natural that many people, engineers as well as workers, were driven to North America. This was a general phenomenon and the last peak in the era of transatlantic mass emigration from Sweden occurred in 1923 when more than 26.000 persons went to Canada or the United States.[3]

It was natural that engineers from the Swedish iron and steel regions would be among the crisis-driven migrations of the 1920s and that many of them would make their way over the Atlantic. When they returned they could bring knowledge to the Swedish steel and iron industry, as Elfström suggested. The emigration and return of engineers from the United States to this industry did however begin earlier than in the 1920s.

As for most Swedish industries, early technical influences came to the largest extent from Britain especially before the mid-nineteenth century.[4] Several Swedish technicians went on study trips and worked there and, as in many other European countries, British workers were engaged in Sweden.[5] In the latter half of the nineteenth century, American impulses became increasingly important for the Swedish steel and iron industry.[6] In quantitative terms, the iron works that employed most engineers with experience from the United States was the one in Sandviken.[7] Let us now consider the emergence and history of this important iron and steel production centre.

5.1. The history of the iron works in Sandviken

The community of Sandviken grew up around the iron works founded in 1862. The reason for the foundation of the iron works in the province of Gästrikland was to make use of the Bessemer method, a patent the founder Göran Fredrik Göransson (1819–1900) had bought during a business trip in England during 1857. From the 1860s and onwards, the community arose around it and by the turn of the century, Sandviken had a larger population than many towns although it was not given a town charter until 1942. An early speciality of the Sandviken iron works was the production of wrought steel rings for railway cars. Already from the beginning the iron works had a strong emphasis on the export market and it developed into one of the world's leading manufacturers of quality steel. The hollowed drill steel gave the company the most dominant position in the world in the 1920s. During the mid-twentieth century, Sandvikens Järnverks AB moved more into tool production and cemented carbide and that is mainly what the company, whose name was changed to Sandvik AB in 1972, is known for today.[8]

5.2. Previous research about the iron works in Sandviken

One of the earliest writings about the iron works is the commemorative book *Ett svenskt jernverk* (A Swedish iron works) issued on its seventy-fifth anniversary in 1937. It includes articles on the earliest history, technical development, economic development, social development in the community and statistics of the Sandviken workers.[9] It is an overall history written mostly by people standing close to the development of the iron works. This perspective has both advantages and disadvantages. There were reasons to assume that these persons had a deeper insight into the development, than if outsiders had written the book. However, the different authors also had such close ties with the company that this possibly made them take a more positive viewpoint towards its development. The commemorative book has been used mostly in order to identify leading engineers and processes at the iron works. The early history of the iron works has also been discussed briefly in former Sandviken engineer Olle Hedebrandt's *Omvandlingen* (The Transformation) and local historian Gillis Andersson's *Gästrikland och järnet* (Gästrikland and the iron). Both books emphasised a more modern time period than is the focus of this thesis even if Andersson's study also was a thorough survey of Gästrikland as a major district of iron trade from the Viking ages.

Another book of major importance for this study has been geographer Gösta Carlestam's *Samhällsbyggarna vid Storsjön* (Society builders by Storsjön [The Great Lake]). Carlestam's main conclusion was that the Swedish model of cooperation and mutual understanding between employers and labour unions had its roots in the iron works culture. The book has mainly been used as a reference to the concept of welfarism advocated by Sandviken's managing director Karl Fredrik Göransson in the 1920s. Carlestam also discussed this with reference to Karl Fredrik Göransson's time in the United States.[10] After this short survey, it is time to get acquainted more closely with him and his predecessors.

5.3. Managing directors

Göran Fredrik Göransson founded Sandvikens Järnverk and his family was closely connected to the management of the iron works into the 1940s. The founder came from a merchant family and was born in 1819. He studied in Britain, France and the United States before he joined a merchant firm in the town of Gävle, about twenty kilometres east of what was to become Sandviken. The firm bought the works in Högbo in 1857 and this became the beginning of the iron works in Sandviken.[11] In 1868, the founder's son Henrik Göransson (1843–1910), took over the position and stayed until his death in 1910. As we can see in Appendix 5:1, the managing directors until the 1940s, Henrik Göransson, Tord Magnusson (1851–1929) and Karl Fredrik Göransson (1879–1960) all had foreign experience – from primarily Switzerland and the United States - although Tord Magnusson's consisted of a short study trip to the Chicago exhibition in 1893. On this level American experience became most prominent when Karl Fredrik Göransson took over as managing director in 1920. In the beginning, however, it was primarily the British experience that mattered in the newly established iron works.

Early British influences

The foreign experience of the founder and his son contributed to the early international orientation of the iron works. Already at the foundation in 1862, the international influence was present. The development of the Bessemer technology in Gästrikland was spread to producers of steel all over the world. Thomas J. Misa and Jeanne McHugh have acknowledged his importance for the development of steel making in the United States.[12]

Technical director Lars Yngström described the technical development of the iron works from the beginning in the commemorative book from 1937. He gave another example of the technical influence from Britain during the earliest period of the iron works. When Sandviken was to start forging in 1862, the fifteen-ton steam hammer was bought from Kirkstall Forge Co. in Leeds. The same year, a forging foreman by the name of Proctor came over to help Sandviken start to use the steam hammer.[13] There were also a few other British professionals in Sandviken at that time.

This influence was in line with the general development of the Swedish industry during the mid-nineteenth century. Swedish industries often called on British engineers and foremen to come over and become masters of technical development. Sweden also had long trading relations with Britain and especially the exchange of Swedish iron and wood for British machinery had a long history. But the exchange also took other forms. Swedish entrepreneurs went to Britain in order to bring home already tested methods of manufacturing and Swedish technicians learned how to build machines and manage companies in a more rational way than was previously the case in Sweden.[14] The adaptation of the Bessemer process as well as the buying of the steam hammer from Leeds and the recruitment of Proctor must be interpreted in the light of this general development.

The American experience noted among the managing directors before Karl Fredrik Göransson took over was Tord Magnusson's short Chicago-visit. He took over the position seventeen years later, indicating that at least that visit did not matter much in his work. Karl Fredrik Göransson's move into the position as managing director also occurred after a long interval from his year as a student at Columbia University in New York. However, he made several study trips to the United States after his time in New York[15] and it was clear that, in addition to technical expertise, he also brought home ideas about welfarism from the United States.

Karl Fredrik Göransson's welfarism

The son of Henrik Göransson graduated from the primary school in Gävle in 1897. He followed in his father's footsteps. The years 1897–1898 he studied in Lausanne and the two years, he made study trips in Britain and Germany. In 1900 he went to the United States and studied at Columbia University in New York where he took a Master of Arts a year later. The same year he returned to Sweden. After his return, Sandvikens Järnverk employed him as head of the calculation department. From 1908 to 1915, he was also in charge of bookkeeping and the secretariat of the board and the social departments. From 1916 to 1920 he headed the sales department before he took over as managing director in 1920. Karl Fredrik Göransson stayed in that position until 1948. In 1929, he also became chairman of the iron works' board, a position he kept until 1959 the year before his death.[16]

Karl Fredrik Göransson's experiences, inspirations and actions

Sixty years earlier, in New York, Karl Fredrik Göransson studied economics, electrodynamics and metallurgy.[17] According to a letter he wrote to his father, he began a course in what he called "socialistic theories" within the economics programme in the spring of 1901. He wrote that he had hoped to begin the course in the autumn when it dealt with worker and wage issues, but he was still satisfied with the course as it was dealing with the trusts. These issues obviously interested him. During his stay in New York he also made journeys to see industries in Pennsylvania, to the electrical and locomotive works in Schenectady and Lynn, the iron industries in Worcester as well as to Washington. In a letter of September 1900, he described his admiration for Carnegie Steel's works in Homestead, Pennsylvania, which had a rolling mill that was almost run without any people. Karl Fredrik Göransson was impressed with Carnegie's labour-saving machines. On his way back to New York he wrote a letter while travelling by train telling his father that he had seen many iron works. Among them was the largest steel-mill in the world with an output equalling Sandviken's yearly production in four days.[18]

As managing director in the 1920s Karl Fredrik Göransson aimed to create a new rationalism built on the co-operation between management and workers seeking productivity goals. The concept was called *sandviksandan* (the Sandviken spirit). Some of these thoughts he developed in his 1927 booklet *Hur man sköter sitt folk* (How to handle one's people) and the 1928-successor *Samförstånd mellan företagare och arbetare* (Cooperation between entrepreneurs and workers).[19] Gösta Carlestam claimed that his sources of inspiration were the modern American philosophy of how to manage a company built on the ideology of Henry Ford (1863–1947) and the idea of scientific management, launched by Fredrik Winslow Taylor (1856–1915).[20] Ford was a core company when it came to these ideas in early twentieth-century United States.[21] It was not clear whether Karl Fredrik Göransson ever visited Ford's factories in Detroit during his time as student or at one of the several study trips he made over the Atlantic later in his life.

His comment on the course in socialistic theories indicates his early interest in the social relations between the employers and workers and he remained interested in this later in his life. In late 1923 he was on a study trip in the United States and wrote from New York to his mother that he was going to make a journey in order to visit the iron works in Middleton close to Cincinnati. He regarded Middleton as the United States' most developed iron works when it came to social relations between employers and employees.[22]

Social relations were closely connected to welfarism or welfare capitalism whose roots were to be found in the United States. In the end of the nineteenth century the United States witnessed violent strikes and union militancy and the idea of welfarism grew out of these experiences as a strategy for American politicians to deal with problems related to labour market conflicts.[23] In 1906, a course in welfare practices was given at the Chicago Institute of Social Science and many leaders in American industry contributed to the diffusion of the idea. Among them were John D. Rockefeller (1839–1937), Charles M. Schwab (1862–1939) at Bethlehem Steel and Gerard Swope (1872) at General Electric.[24]

Welfarist ideas acknowledged the fact that there were opposing interests between capital and labour. However, it also claimed that mutual interests were persistent when it came to increasing productivity and success of the company. The way to go was to emphasise the mutual interests and try to put the struggle over how to distribute the surplus from production in the background. The labourers received material advantages, were integrated into the company, and were given limited influence over how the company was run. This could turn union activity into an advantage for the company and at the same time it stimulated the labourers to increase their productivity and made them more willing to make sacrifices for the sake of the company. The difference from the paternalism of the nineteenth century was that the goal of welfarism was not to create personal ties between the employer and the employee, but to create an emotional loyalty to the company among the workers, in the form of a company spirit that made them feel like they were belonging to one big family.[25]

The steel workers' unions were powerful in the United States until 1892, when they suffered a severe loss in the Homestead strike at the Carnegie works close to Pittsburgh. Before that defeat, the steel workers had a kind of veto when it came to new technology and new works methods. But after 1892 the steel companies got a free hand to introduce new technology and it was the workers who had to adjust to it, and not the other way around. It led to a wave of new technology all over the American iron and steel industry. This mechanisation led to higher productivity. The United States emerged as an industrial super power. But the workers had to be stimulated to do good work and therefore, methods engineering was introduced in order to create incentive pay systems. The companies also tried to develop a social system for their employees. The United States Steel Corporation created a far-reaching welfare system including a programme for workers to buy stocks, profit-sharing system, pensions, insurance in case of accidents, workers residences, schools, possibilities for recreation and sports, and health care institutions. This was probably the largest system in the United States in the 1910s and early 1920s.[26]

Mass production led to boring jobs and higher pressure on both employers and employees according to Stuart D. Brandes. The companies grew and the relations between the bosses and the workers became increasingly impersonal. It was an environment that potentially could facilitate labour unrest and, therefore, there was a growing need for welfare capitalism, as this system aimed towards the maximising of benefits from factory style production. Welfare capitalists had this in common with the Taylorists. Otherwise, the systems differed from each other and the means to reach high productivity were so different that there was an ongoing antagonism between spokesmen of the two systems. But the difference was mainly due to the fact that the advocats emphasised different labour market policy arenas and there were no principal problems for coexistence between them. This also happened at some companies at an early stage and became increasingly common after World War I. At the same time the tense relations between welfare capitalists and Taylorists decreased.[27] In the 1920s, many economic scholars saw the synthesis as the way to meet the future as efficiency and productivity increased and the companies were able to sell their products on increasingly larger markets. However, what followed in the wake of the 1929 collapse of the Stock Exchange proved them wrong. The first cut the companies made was in the welfare systems. Taylor's thoughts remained, but the American welfarism disappeared.[28]

The real breakthrough of welfarism came during World War I and in 1926, 80% of the American companies had developed welfare programmes. The United States Steel Company spent more than twenty-two million dollars from 1912 to 1924 on the welfare programme. Everything in the workers' life was to happen under the single roof of the company. One basic idea of welfare capitalism was that the employers accepted the existence of unions, not officially, but in their internal strategic calculations and the employees' demands for a decent living standard.[29]

Karl Fredrik Göransson developed several thoughts in line with this. One thing was that the company was to help its personnel with specific matters and this was a replacement for the old paternal system but without its autocratic directions. The company was not to exercise authority, but to offer services such as help with debts, health care, help with the rent of housing and owner-occupied houses. Karl Fredrik Göransson stated this was something that was not only made in the interest of the workers but also in the interest of the company. His idea was that if the company treated workers fairly, it could count on them showing more interest and loyalty. In Carl Björk's account of the labour movement in Sandviken he stated that actions were taken to improve the conditions in the workers' homes and that a place for sport was established in the 1920s. [30]

Karl Fredrik Göransson referred to the American expression "mutual interest department", a word that in Sweden was translated to *intressekontor* (interest office). The interest office was meant to be a place where the employees could come with private matters such as economic and personal problems as well as discuss their plans for the future. The office personnel should be there to help and try to find solutions to the problems. Also in judicial matters the office was to assist the personnel in case they needed it.[31] In Sandviken, an interest office was introduced in 1916 after a suggestion from Karl Fredrik Göransson whose duties were similar to the ones he described in the 1920s booklets.[32] His reference to the American expression in the booklet clearly indicated influences from the other side of the Atlantic.

He also wrote about the importance of health care institutions and stated that the feeling of being taking cared of when they were ill without any increased costs, calmed the workers and strengthened their feelings of affection for the company. Karl Fredrik Göransson stated that if the health care worked fewer workers would be staying at home because of illness and that would cut the costs for the company. Furthermore, households where long illness had made damaged the family economy were more often becoming centres for agitation against the company.[33] He argued from a preventative company approach and reached to the conclusion that there was a need for good health care as it was favourable for the company.

Other ideas connected to welfare capitalism in the United States included profit-sharing systems and part-ownership.[34] Karl Fredrik Göransson developed thoughts about these systems in his book. He stated that the North American industry had managed to turn a feeling of rivalry between employers and workers into a spirit of cooperation through the offering of part-ownership. American unions were less involved in launching strikes and aimed more at finding mutual ways to heighten productivity and thereby also wages and living standards. Karl Fredrik Göransson thought that part-ownership was a step in "the right direction" and that it was a means to merge the interest of the two parts. He feared, however, that the workers could sell their stocks, but thought that this could be solved by giving out a bonus per stock in the same way as U S Steel Corporation did. He also referred to the part ownership system in the United States and stated that it was no direct economic profit for the companies to sell stocks to the employees. It was the long-term goals that were important. If the company could "prove" to the workers that their investments in stocks were a good for them, they became more tied up with the company. It could create a feeling of loyalty.[35]

The most interesting idea in American welfarism was, according to Svensson, the notion of industrial democracy. The employees were able to elect representatives to local company institutions and thereby able to exercise limited influence over how the company was ruled. One major reason for these institutions was to merge the employers and the employees into a unit. Schwab called them a canal for promotion of mutual interests. The socialist unions looked upon these institutions as a means for the employers to regulate the relationship between capital and labour in a way favourable for the companies and called them "company unions".[36] The American institutions were the first advanced venture to give the employees participation in decision-making. The employers initiated it and it spread from company to company despite the opposition from the unions. In 1919, 500.000 American workers were participating in the institutions and ten years later the amount had increased to one and a half million. A huge majority of 80 %, of workers participating were employed in big companies with more than 5.000 employees.[37]

As early as March 1886, a first glimpse may give the impression of a surprisingly positive attitude towards the American workers' right to form unions when Andrew Carnegie wrote in *New York Daily Tribune*. What Carnegie certainly aimed at, however, was a type of "company unions" similar to the ones described above.[38] Charles Schwab had worked close to Carnegie and also took over the leadership of Carnegie's Pennsylvanian steel empire.[39] This type of industrial democracy inspired Carnegie and Schwab. The other advocats of welfarism mentioned earlier, such as Rockefeller and Swope, were also inspired.[40]

So, too, was Karl Fredrik Göransson. He stated that industrial democracy in the United States was based mainly on voluntary agreements between the companies and the workers and that this mainly was due to the fact that the labour unions were not as strong and organised as in Sweden. In Sweden, there was often a resistance to an introduction of welfarist practices from the companies' side, whereas the workers were more positive if the system was connected to the unions. As the unions were stronger and more uniformly organised in Sweden compared to those in the United States, it was practical to build a system adjusted to Swedish conditions. From the managing director's point of view the strong unions in Sweden made it somewhat more difficult to create a spirit of cooperation similar to that found in the United States. This was mainly due to the fact that the unions had been formed as organisations aiming to protect the workers' interests in relation to the companies. This led to distrust on both sides making it difficult to cooperate towards a mutual goal. Karl Fredrik Göransson continued to state that this should not be impossible and that there were Swedish examples where representatives from the union as well as the company had met for conversations even at times when there were no special conflicts evident. According to Karl Fredrik Göransson, these meetings had prevented problems based on misunderstandings or misinterpretations from both sides.[41]

The Wednesday evening meetings, 1923–1930

Beginning in the winter of 1923/1924 the management and the union leaders began gathering in Karl Fredrik Göransson's sister Sigrid Göransson's home on Wednesday evenings for discussions about problems of mutual interest. The discussion club was called *Onsdagsklubben* (The Wednesday Club). Until 1930 the meetings were weekly, lasting until 7.30 in the evening. After this the gatherings were more infrequent.[42] The club had twenty-four members of who seventeen were representatives of the workmen. Almost all the leading men in both the local branch of the Metal Workers Union and the local branch of the Social Democratic Party participated.[43] The initiative came from management, but the iron works personnel paper *Konvertern* (The Converter) from the early 1960s claimed that the initiative had come from the workers. The writer of the article also claimed that the meetings took place on neutral ground.[44] It seems somewhat of an exaggeration to use that expression about the home of the managing director's sister. It is more reasonable to connect it to Carlestam's conclusion that the fear of the establishment of socialist ideas among the Sandviken workers was an underlying reason for the Wednesday meetings. On a national scale, *Järnbruksförbundet* (The Iron Works' Employers Association) and *Landsorganisationen* (The Swedish Trade Union Confederation) were in conflict in 1923 and Karl Fredrik Göransson wanted to break the ice. His ideas about launching a special spirit in Sandviken based on cooperation with the workers must be interpreted against this background. His choice was to apply American ideas. One goal was to raise the workers' level of education and the most important subjects were economics and social science. If the workers were educated in these two sciences they would realise the importance of the capital needed by industry and for their own living standards. In his book he also developed thoughts about industrial democracy, profit-sharing systems and the idea of giving the workers part-ownership through the purchase of stocks.[45] Karl Fredrik Göransson provided his readers with an example from the United States Steel Corporation. Personal administration and a well-functioning health care department were also important parts of his concept. A piecework system was also important and was built on methods engineering. In this context, he also emphasised the education of engineers and foremen. It was important for them not only to get a technical education, but also to make them human beings worthy of the responsibility given to them in their future work.[46]

The Wednesday evening meetings were a means to reach the management's goals of cooperation between management and the workers. It was probably these experiences Karl Fredrik Göransson referred to when he was talking about the prevention of problems based on mutual misunderstandings in his booklet. Carlestam connected the meetings to his ideas about the managing of a company he had brought from the United States.[47] In the booklet the necessity to adjust industrial democracy to Swedish conditions and to build on the institutions persistent was emphasised.[48] The Wednesday evening meetings can be interpreted as an attempt to turn a traditional "Swedish" union into more of a "company union" in the American sense. Andrew Carnegie's 1886 statement in the *New York Daily Tribune* included views that the American workers should have the right to form unions in the same way as the English workers. Carnegie stated:

> My experience has been that trades-unions upon the whole were beneficial both to labor and to capital. They certainly educate the workingmen, and give them a truer conception of the relations of capital and labor than they otherwise could form. The ablest and best workmen eventually come to the front in these organizations; and it may be laid down as a rule that the more intelligent the workmen the fewer the contests with employers.[49]

What Carnegie aimed at was "company unions" and such a system later developed under Carnegie's successor Charles Schwab. During the 1919 strike against U S Steel, Schwab introduced Employee Representation Plans, to which workers could elect delegates to present their opinions to the management. It was a type of "company unions" and Schwab of course wanted the workers to elect representatives who were "intelligent" and had a "truer conception of the relations of labor and capital", to use Carnegie's words some thirty-three years earlier. Schwab feared unions led by outsiders who he preferred to call "walking delegates from Kamchatka".[50] In the same way, Karl Fredrik Göransson feared the socialist ideas that could re-awaken by the ongoing conflict in the Swedish steel and iron industry in the 1920s, but he had to adjust to a country where traditional labour unions were stronger than in the United States. The traditional unions were integrated into the system in the way he claimed was necessary in his booklet.[51] It was in a way an adjustment of the "company union" system to Swedish conditions.

In the article in *Konvertern,* the Wednesday meetings were labelled a "seed to industrial democracy". In the winter of 1959/1960 some members in the discussion club had once again gathered in Sigrid Göransson's home to relive memories from the 1920s. Karl Fredrik Göransson then stated that the meetings in Sandviken were one of many seeds that resulted in the negotiations in the Stockholm suburb of Saltsjöbaden and the 1938 agreement regulating the relations on the Swedish labour market.[52] During the "work peace conference" *(arbetsfredskonferensen)* in 1928, he worked out a document together with the chairman of the Metal Workers Union, Frithiof Ekman, about how cooperation in the companies could be arranged. It included the establishment of a central organisation that was to support and follow up local cooperation between companies and workers and led to the "Work Peace Committee" *(Arbetsfredskommittén).* The work peace conferences were also some of the seeds leading to the Saltsjöbaden agreement even if the early 1930s meant a temporary backlash in the work towards a permanent work peace on the Swedish labour market.[53] According to Karl Fredrik Göransson, the Wednesday evening meetings in Sandviken contributed to the development of industrial democracy in Sweden.[54] It is an exaggeration to state that this spirit had its origin in the Sandviken spirit, which in turn had its origins in the United States. However, the core of the Sandviken spirit was at least evident in the agreement in Saltsjöbaden.[55]

5.4. Engineers in leading positions at Sandviken

Foreign impulses seem not to have been as important for the steel and iron industry as for the electrical industry. In Table 5:1, we can study the leading engineers at Sandvikens Järnverk from the 1890s until 1937.

TABLE 5:1: Emigration experiences of engineers in leading positions at Sandvikens Järnverks AB's management and technical departments from 1890(1) to 1937. By time period and total.

PERIOD	**Returnees**	**Immigrants**	**Only study**	**Foreign experiences**	**%**	**Non-emigrants**	**No information**	**TOTAL**
Bef. 1900	2	0	6	8	66,7	4	*0*	**12**
1901-1910	2	0	0	2	66,7	1	*0*	**3**
1911-1920	3	0	2	5	55,6	4	*2*	**11**
1921-1937	3	0	1	4	33,3	8	*3*	**15**
TOTAL	**10**	**0**	**9**	**19**	**52,8**	**17**	**5**	**41**

(1). Engineers who quit before 1890 were not included.
SOURCES: *Chalmers*; *Matrikel över tjänstemän vid Sveriges Järnverk och järngruvor 1921,* ed. Gunnar Deutgen (Stockholm 1921); *Ett svenskt jernverk; Svenska Teknologföreningen* I and II; Wilhelm Haglund, *Levebröd. Strövtåg i brukshistorien* (Stockholm, 1978); Carl Sebardt, *Sandvikens Jernverk 1938-1957. Sandvikens Kallvalsverk 1930-1940* (Stockholm, 1992); http://www.ellisisland.org/search/passRecord.asp?MID=06833889580064259584&FNM=OSCAR&LNM=PARMENT&PLNM=PARMENT&RF=1&pID=102837180038, available on Internet, 9/3-2003; SCB Summariska Folkmängdsredogörelser Gävleborgs län 1914, 1929, 1930.

The table shows that foreign experience was not as common among the leading engineers at the iron works compared to the electrical industry ASEA. Slightly more than half the cohort of engineers had worked/studied abroad or been on study trips. The latter category was almost as large as the emigrants and this was a sharp contrast to ASEA where they consisted of a minor share. Furthermore, immigrants were seldom among the leading engineers at Sandviken during this time period.

Among technical directors, the first was Eric Esselius who began in 1918 and had twelve years of American experiences mainly from the Carnegie Steel's works around Pittsburgh. Esselius came from a position as head of the rolling mill and forging department and it was in that position he left most marks in Sandviken and this will be discussed later. Esselius successor Lars Yngström was not as experienced and had "only" been on study trips on the European continent, Britain and the United States. Eric Pehrsson, head of production from 1931 onwards, lacked any foreign experiences. Experience seems to have been important in the beginning, but Esselius also acquired his qualifications during his time as head of the rolling mill and forging department. His actions there were, however, based on his American experience and were also useful when he became technical director. In Table 5:2, we can see that "Internationalisation" in this context was largely the same thing as "Americanisation".

TABLE 5:2: Countries, companies and institutions of experience among leading engineers at Sandvikens Järnverks AB, 1890-1940.

COUNTRY/COMPANY/INSTITUTION	N	% of foreign exp. leading engineers (N=19)	% of all leading engineers (N=36)
United States	***13***	***68,4***	***36,1***
Carnegie Steel Co (1)	4	21,1	11,1
*Unknown	2	10,5	5,6
Study trip only	*4*	*21,1*	*11,1*
Germany (all study trips)	***8***	***42,1***	***22,2***
Great Britain (all study trips)	***5***	***26,3***	***13,9***
Switzerland	***4***	***21,1***	***11,1***
Study trip only	*2*	*10,5*	*5,6*
Austria (residence)	***1***	***5,3***	***2,8***
Indonesia (residence)	***1***	***5,3***	***2,8***
France (study trip)	***1***	***5,3***	***2,8***
Netherlands (study trip)	***1***	***5,3***	***2,8***
"Europe" (study trip)	***1***	***5,3***	***2,8***

(1). Duquesne, PA (3); Carrie Furnaces, Rankin, PA; Clairton, PA; Bellaire, OH; Mingo Junction, OH (1)
SOURCES: see table 5:1.

Other countries where the engineers had worked or studied at a university, etc. were Switzerland, Austria and Indonesia. However, a considerable number of the engineers gained experience from study trips in Germany and Great Britain. However, if we assume that those who actually resided in a foreign country had more valuable experience, the American domination was clear.

The Carnegie Steel Company made an impact on Sandviken. As we will see later, this company was one of the most advanced in the world when it came to the use of modern technology and labour-saving actions. It would be an exaggeration to state that Carnegie was for Sandviken what General Electric was for ASEA. A little more than every tenth engineer in leading positions had experienced Andrew Carnegie's steel empire, which was a smaller amount than the ASEA-engineers who had experienced General Electric. Keeping in mind the small numbers and the missing data for two of the engineers, the rest of the Pittsburgh district dominated together with Carnegie. It was an area, which included western Pennsylvania and eastern Ohio including Youngstown. The area was the most important one in American iron and steel making and also one of the most important in the world. In 1900, Pennsylvania produced 60% of the iron and steel in the United States and 54% of Pennsylvania's output was produced in Allegheny county including Pittsburgh and its vicinity. In the 1920s the Pittsburgh district had a total output equalling Germany and France together. Ideals about rationalisation and mass production were not driven as far anywhere in the world as they were in Pennsylvania. [56] In a period when ideas about rationalisation swept over Sweden as means to uplift the country,[57] it was not surprising that Swedish engineers were driven to the Pittsburgh district and that those with experiences from there had good opportunities to get positions as chief engineers, perhaps especially within rolling and cold rolling. We can note that there were employments at two companies in Youngstown; the Republic Iron & Steel Company and Cold Metal Process.

Single engineers also worked for Midvale Steel in Philadelphia, the Willamette Iron & Steel Company in Portland, Oregon and the U. S. Bureau of Standards. In comparison with the electrical industry, steel and iron thus seemed less foreign influenced, but the dominating source of ideas was the United States. This dominance was thus in line with the general spirit in Sweden in the decades around 1900, among technicians, industrialists and several politicians.[58] In an official letter to the Government in 1904, the Swedish Parliament suggested that more investigations and studies of American conditions should be done especially in order to strengthen the domestic industry.[59] Many of the technicians that contributed to the development of the Swedish rolling mills had worked in the United States.[60]

As we have seen, so in Sandviken. In Table 5:3 we can study how many and how long a time departments at Sandviken were managed by returning engineers.

TABLE 5:3: Departments at Sandvikens Järnverks AB with foreign experienced engineers at the top, 1890-1937.

Experience country	For N	For %	USA N	USA %	Other N	Other %
All of the time	7	33,3	5	23,8	2	9,5
Most of the time	3	14,3	4	19,0	1	4,8
Not most of the time	4	19,0	3	14,3	4	19,0
TOTAL	**14**	**66,7**	**12**	**57,1**	**7**	**33,3**
Never	7	33,3	9	42,9	14	66,7
Total known cases	***21***	***100,0***	***21***	***100,0***	***21***	***100,0***
Unknown	*4*	*16,0*	*4*	*16,0*	*4*	*16,0*
TOTAL	**25**	**100,0**	**25**	**100,0**	**25**	**100,0**

SOURCES: see table 5:1.

A majority of the departments were at some point of time managed by an engineer with foreign experience, and almost half of them for most of the time. This was a high percentage but it was not as high as at ASEA. More than half of the departments had an engineer with experience in the United States in the top at any point of time and 43% for all or most of it. Engineers with experiences from other countries were less numerous. In all, it looks like a pattern where many people adopted American models at several places and over time was relevant also for the iron works. Gottfried Lindskog and Henning Sparr in the construction department, Eric Esselius and Teofil Lindblom in the rolling-mill, Ivar Magnusson in the cold-rolling and wire drawing as well as Axel Wahlberg and Torsten Wahlberg in the metallurgical department will be discussed more closely in this chapter. Other returnees or engineers who had been in the United States were Sven von Hofsten, Carl Sebardt, Oscar Parment and Torkel Berglund. Many of these engineers also had experience from other countries. Bertil Åström and Arvid Lundberg were, apart from Henrik Göransson, the only leading engineers who had been abroad but not in the United States. The remaining heads were non-emigrants or persons where no information has been found. Closer information on all these engineers is to be found in Appendix 5:1.

Sandviken was at the forefront when it came to iron works in Sweden that employed engineers with experience from the United States. The future chief engineer and managing director Wilhelm Haglund was employed at the construction department in Sandviken in the summer of 1925. He originated from Laxå in southern central Sweden, which also had an iron works. His father had been foreman in Laxå and Haglund wrote about all the surprises that met him in the technologically advanced iron works. In September 1925 his father replied: "Yes, Sandviken is probably, when it comes to modern works and facilities, Sweden's America".[61] Haglund's father had not seen Sandviken himself. His statement, however, indicated that this was a kind of reputation Sandviken had among men in his profession. What could this reputation have been based on? This examination will begin with the department that employed Haglund in 1925.

5.5. The construction department

Haglund's mentor, Henning Sparr, was one of these returnees. When he began his work in the department in 1914, he came directly from a five year stay in the United States at the Carnegie Steel plant in Clairton, Pennsylvania. Sparr stayed in that position until 1947. Before him, Gottfried Lindskog, with five years of employment at workshops and iron works in the United States, was in charge. Before Lindskog came in 1886, the department had had four heads from 1868: Ernst Göransson, C. J. Tholander, Albert Göransson and Fredrik Forsberg. Neither of the two Göranssons, nor Forsberg had been abroad, whereas there is no information available on Tholander.[62]

Sparr's predecessor Gottfried Lindskog arrived in Sandviken in 1886 after a short interval in Fagersta and was probably the first engineer with experience from the United States who took a position as chief engineer at the iron works. Unfortunately, the directory gave no information with regard to Lindskog's five years in the United States. In Sandviken, Lindskog became head of construction, building, heating and the mechanical workshop, i.e. four departments.[63] Lindskog was responsible for the construction of the band, wire and tube mills and one of the leading people when the iron works built a lot of new buildings in the 1890s.[64] According to the obituary in the local newspaper in Sandviken after Lindskog's death in February 1914, he was a man with a sharp eye and a good judgement, something that often led to the successful completion of works for which he was responsible. The newspaper continued:

> In the close circle of acquaintances who has been in position to learn from his rich experience and who always has had him as a prototype when it comes to unselfish and dutiful work, he will always be kept in the memory as a worthy representative of the generation who carried Sandviken's development during the first half century of its existence. [65]

It was probably a close colleague and friend to Lindskog who wrote the obituary. That notwithstanding, Lindskog was doubtless an important person in Sandviken during the decades around the turn of the century. As head of four departments and as constructor, he had an important role in designing what the iron works should look like.

Yngström described the development of the construction department in a few pages. In 1937, the construction department had become a kind of controlling central office where calculations for new constructions as well as programs for purchasing of material and machines were made and where the costs for building were controlled. In his description of the construction department, Yngström ended by pointing out that the construction department constantly adjusted to the increasing demands, used impulses from the company's own experiences as well as listened to the "voice of modern technology" and had been an excellent instrument for the ongoing modernisation and development in Sandviken.[66] The construction office adjusted to ideas about systematic organisation of construction and drawing work that began to come in to Sweden during the last decades of the nineteenth century. One important principle was that all instructions were to be given by the construction department and the drawing office. On the floor, the employees' only duty was to follow the given instructions and the construction department was to decide what every little detail of the construction should look like, how it should be manufactured and by whom, and when the work was to be finished.[67] Yngström did not place in time the development of the construction department into what he called a controlling central. This practise however had similarities to the systematic work that came over from the United States around the turn of the century.

Berner studied the development of the Swedish construction departments towards the end of the nineteenth century and in the beginning of the twentieth. One thing emphasised was that construction became more and more independent from the activities in the workshops. Already in 1887, the emerging division between planning and construction on the one side and manufacturing on the other was discussed in the industrial magazine, *Industritidningen Norden.* The writer in the magazine saw a new world emerging at the Swedish industries where professionals with a different education from the workers on the shop floor started their invasion in the construction departments. The work of the skilled master mechanics became less and less important.[68] Berner argued, however, that systematic construction work was brought from the United States in the early years of the twentieth century.[69] In a lecture held in September 1902, the returning engineer Robert Ardell suggested a system where the basic principle was that all issues and all instructions came from the construction department. The construction department was to decide how, and by whom, the manufacturing was to be done and when it was to be finished. Ardell concluded that the costs for such a system would increase in the beginning, but the gains would compensate for it in the long run. This had been shown to be the case in the United States.[70] Ardell's suggestion meant a system that clearly indicated the reduction of power among the master mechanics as the construction department was to give information so detailed that it was almost impossible to do things wrong and also decide the matters mentioned above. Around 1910 this new system was established on a wider scale in Sweden. Ernst A. Hedén, deputy managing director for Götaverken and himself a returnee from the United States, wrote in *Teknisk Tidskrift* that the times when the drawings consisted of the ones the foreman drew on a blackboard definitely were over and that the workers were to be given clear instructions from the construction department so that no time was "thrown away".[71]

In Sandviken, the head of the cold rolling mill department, Carl Gustaf Larsson, was responsible for the construction department until 1885 and Larsson can be described exactly as a skilled master mechanic.[72] When Lindskog came, Larsson lost his position in a way reminding of Berner's description and Ardell's suggestions. The one who was to lead the new organisation was a man who had five years of experiences from the country where a lot of these ideas originated.

It was thus probable that systematic construction work in line with the descriptions of Berner, Ardell and Hedén was established in Sandviken at an early stage under Lindskog. Henning Sparr continued the tradition. Haglund described his first meeting with Sparr in 1925. Sparr told him that the iron works wanted constructors who were experienced and knew something and in this context, Sparr referred to his years on the other side of the Atlantic.[73] When *Sandvikens Tidning,* the local newspaper, wrote about Sparr for his sixtieth birthday in August 1944, they stated that he had left many traces in the ironwork's development.[74] That definitely also was the case with the man who took over the rolling mill and forging department from 1906.

5.6. The rolling mill and forging department

The old chief engineer Larsson resigned that year and a man with twelve years of experience from Carnegie Steel took over. His name was Eric Esselius and when he became technical director in 1918, Teofil Lindblom took over the department. Both of them had been at Carnegie's plant in Duquesne, described by contemporary observers as the technologically most modern and advanced iron works in the world. It was really a break with the older and more practical tradition.

Larsson was born 1841 on a manor in Sandviken's neighbouring parish of Valbo, worked his way to the position as head of the rolling mills through jobs as bookkeeper at iron works in Gästrikland and in the neighbouring provinces of Hälsingland and Dalarna.[75] He was not an engineer in the modern sense of the word, a person that had a technical education. In Sandviken, he was commonly known as *"verkmästarn"* ("the master mechanic").[76] The formally educated engineers became more and more important in the late decades of the nineteenth century. However, autodidactic master mechanics still remained technical leaders in several larger Swedish industries in the beginning of the twentieth century.[77] Larsson was one such example. He was important for Sandviken's manufacturing of tubes and in the 1890s Sandviken took several patents in tube making and on all of them Larsson's name stood. In 1889, Sandviken became Sweden's first iron works that started to manufacture seamless and rolled tubes. The production began after Larsson had made the only study trip that can be registered to him, to Britain to study the tube making in 1889.[78]

The method used for tube making in Sandviken became commonly known internationally as *svenskvalsverk* (Swedish-rolling mill) and remained practically unchanged from 1889 to 1906. It was introduced after Larsson's return in 1889 and possibly a borrowed on the method patented by Pilkington in England in 1889.[79] In the early twentieth century there was an increasing trend towards newer methods in several iron works and in 1907 the first hollowing works in Sandviken was introduced.[80] Under Esselius, older methods and practises started to become increasingly called into question.

Eric Esselius (1873–1947)

In his book of 1937, Sandviken's former bookkeeper Bengt Eiserman recalled his meetings with the new man in charge of the rolling mill and forging department:

> But he was Americanised! When one arrived to meet him and he had time, one was always welcome. First, he offered a cigar (he did not tolerate cigarette or pipe smoke in his office), then he sat down comfortably in his chair, put his feet on the writing-table, and then one could sit by him for any length of time, right up til one had carried out one's errand. [81]

Esselius was educated at CTI and had several years in the United States behind him. He can be seen as sharing an ideal of engineer as a manager and person with his sympathies entirely on the side of the company. In the years around 1910 there was a debate in Sweden on what the positions of The Swedish Technical Association as well as KTH were to be. Engineers with a position in the large-scale Swedish industry advocated an education, which was to meet the needs of it in a better way. In this education the economic perspectives should be emphasised and KTH was accused of putting technology and science in front of economy and organisation. The latter perspectives were important if a graduate was to work as chief engineer in some large-scale company. In the social conflict between capital and labour, the so-called modern engineer was to the take side of the employers and companies, whereas the technocratic viewpoint was one of the engineer as a third force, a man with a technical expertise that made him above the conflict.[82] One of the most obvious examples of the modern engineer was the Swedish Taylorist Erik August Forsberg, chief engineer at one of AB Separator's substitute companies. He claimed that it was an engineer's duty to stand on the employers' side and that the engineers, because of their education and their net of contacts stood emotionally closer to the employers than the workers. [83] There were many engineers sharing Forsberg's viewpoint but this ideal was still in a minority position.[84]

As stated in Chapter two, it was a contemporary movement in the United States that wanted to reduce the engineer's role as the employer's representative and claimed that he stood over the labour market conflicts. However, Forsberg's opinion was in line with an article published in *Teknisk Tidskrift* in March 1913, stating that discussions had been going on in the United States how an engineer should act in the relations to others and a document was about to be developed by several engineering organisations. One of the points in the document was that the engineers should view the protection of a client's or an employer's interest as his first obligation and therefore avoid every action that was contrary to this duty.[85] Esselius, who stayed in the rolling mill until 1918 when he was appointed technical director of the whole iron works could be viewed as a prototype of the type of engineer Forsberg advocated.[86] According to an episode told in the book issued to the local branch of the Metal Workers' Union on its thirtieth anniversary in 1936, Esselius gave the order to start the large mills "so that the devils hear it all the way up there in Överbyn [The Upper Village], that it is running down here" during the Great Strike in 1909. [87] The strikers were gathered in Överbyn. One of the organisers and agitators had difficulties to get work elsewhere in Sweden because of Esselius' recommendations to other employers. But the picture of Esselius is not one-sided. Carl Björk stated that he after all was a man to trust, and the real reason that the said worker who had good marks and a reputation of being skilled could not get work elsewhere may well have been that Esselius thought he needed him in Sandviken! This was the answer he got from a foreman when he was looking for employment at the neighbouring iron works in Forsbacka. When he demanded an answer from Esselius of why he had prevented him from getting employment at the other iron works, the meeting actually resulted in him being re-employed at Sandviken. Esselius' first demand on him was that he should not speak with his fellow workers about other matters than ones concerning the actual work. When the worker refused, and demanded to talk to the other workers about whatever he liked and stated that he had all papers ready to go to the United States and look for employment, Esselius first got furious, and then promised the worker employment. To underline the complexity, Björk also stated that Esselius and the worker gradually became personal friends.[88]

In the obituary for Esselius, Ernst Haglund wrote that most leading persons in the Swedish iron works realised that they were in an urgent need of improvement and modernisation at the time of Esselius' return to Sweden. Esselius realised this and thought that his long practice in the United States and knowledge about rolling mills could open possibilities for him in the native country. Haglund assumed that Sandviken's management probably had designed the place as Larsson's successor for Esselius.[89] The expectations of Esselius were certainly high. One piece of proof is the correspondence between the managing director Henrik Göransson and the chairman of the iron works' board, Wilhelm Sebardt (1841–1918) in Stockholm, in September 1905. Henrik Göransson wrote to Sebardt about Esselius' time in the United States and pointed out that it was one of the better certificates he had seen. He was sure that Esselius' would do a good work in Sandviken. In his response, Sebardt wrote that he was satisfied with the choice and that Esselius' experiences gave them reasons to assume that he probably would not use more people than necessary in the production, something Sebardt thought Larsson did not bother much about.[90] Eiserman revealed the encounters between Esselius and Larsson.

> It was told, however, that the fall out was so sharp between the old practitioner and the young modern theorist when it came to practical experience from leading countries' large-scale production, that Esselius at last should have said to the managing director, that it probably was not possible for him to come anywhere because of the strong resistance of the old master mechanic. [91]

Esselius offered the managing director to leave Sandviken, because of Larsson's resistance. According to Eiserman, the managing director wanted to proceed with Esselius' ideas and let him continue after his own plans, while Larsson retired earlier than planned. Eiserman assumed that Larsson "probably could not stand to be forced to 'keep quiet' and only watch the modernisation, that this new man had the management's permission to carry out".[92] The incidents with Larsson showed Esselius' power to introduce the new methods and the management's faith in him and his ideas.

In the beginning Esselius' work was really appreciated by the iron works' management. In 1906, they raised his wages from 5.000 to 7.000 crowns per year and in 1911 they awarded him a further 3.000 crowns for his success in cutting productivity costs during 1910. Another example is the Gävle lawyer Gustaf Sandström's correspondence with Esselius and Henrik Göransson. On his return Esselius was an American citizen but he obviously wanted to become Swedish again after his re-settlement in the native country. The company was anxious that Esselius should not be forced to go into military service and asked Sandström whether it was a good choice by Esselius to retake Swedish citizenship. The lawyer gave the advice not to naturalise if military duty was to be avoided.[93]

Eiserman described Esselius as a very confident man. This judgement was grounded in Eiserman's own experiences of him as well as hearsays that of course need to be taken carefully.[94] One example of this is the petition he made to the ironwork's board in 1914 and was discussed at the board meeting on November 16 and 17 that year. Esselius asked for a wage increase of 3.000 crowns per year, which retroactively was to be due from the beginning of 1913. The reason was an idea of setting up mechanical receivers behind the tube mill. According to his own calculations, Sandviken would save twenty-four workers and thereby 11.400 crowns per year in wages. However, there was an initial cost of 18.000 crowns for the instalment of the receivers and the running expenses were 1.200 crowns per year.

At this stage the board responded negatively. The first receiver came in use in June 1913, the second one in December the same year, and the remaining ten were installed during 1914. The board thought that Esselius' wage demands were not in proportion to the money saved. Furthermore, the board did not like that an already fairly well paid official assumed he was entitled to wage increases when he made improvements or savings. The board added to their statement the conclusion that if Esselius got such a high wage increase there would be no direct savings on the receivers, as it would eat up the money saved by reducing the number of workers. The board stated that they were not opposed to increasing Esselius' wage in the usual way, but not immediately nor retroactively and not based on the arguments used by him. The decision was to award him a bonus of 1.000 crowns for his idea. He was however named technical director for the whole iron works in 1918 but the board was dissatisfied with his work as such, because he seldom came up with any suggestions for technical improvements. Esselius was actually discharged from Sandviken early in 1920. After that decision was taken, Esselius asked for economic support from the board, referring to what he had done for the ironworks. Once again, the board gave a negative response.[95] At this stage, it was obvious that Esselius had lost the confidence that was given to him by Sandviken's board at an earlier stage.

Esselius's inspirational sources

The board's early belief in Esselius was grounded in his long time experience in the United States and especially with the Carnegie Steel Company. He probably also spent time with them already at his arrival in the United States. Henrik Göransson's letter to Sebardt stated that Esselius spent most of his twelve years in the United States with Carnegie.[96] Esselius had experienced the steel and iron works that drove the automation furthest in the world in the decades before 1900. Historian Kenneth Warren stated that Carnegie Steel always showed a readiness to equip their mills with state-of-the-art plant and equipment.[97] Joel Sabadasz, historian of steel making in the Monongahela Valley where most of Carnegie's works were located wrote that the company's strategy was to install automatic steel making equipment. These installations together with new methods to test the products undermined the power of the steel making unions at Carnegie's works and it was also one of the reasons behind the Homestead strike in 1892.[98] One result was that the American steel making unions no longer could stop new technology and new methods. The technological wave was described by the contemporary observer Herbert N. Casson as a victory for the machines in the battle against labour and the beginning of the "Machine era".[99] Esselius arrived in the United States the year after the Homestead strike and had the opportunity to watch this technological shift on the spot.

The British economic historian H. J. Habakkuk stated that when the Bessemer plant came to the United States the Americans developed labour-saving equipment and measures designed to speed up the work and at the same time increase the output per unit.[100] In an Appendix to *Jernkontorets Annaler* 1902 the development in the American steel and iron industry during the last years was described. The article was a translation from the German journal *Stahl und Eisen* and dealt with the development during the years before 1902. The article compared the American steel industry with the German and found that in the United States technology was used to its full capacity and that the results were the best due to the fact that specialisation of the manufacturing process was driven from the very beginning of it.[101] This was especially characterising the Carnegie Steel Company which developed the so-called Carnegie system. Casson and Warren stated that Carnegie Steel introduced "department store principles" into steel making and that large-scale production and quantities were the keywords.[102]

One of the most advanced works in the Monongahela Valley when it came to labour saving actions was the one in Duquesne.[103] There was no evidence that Esselius actually was working in the plant but it was reasonable to assume that he did so during the years 1893-1899 when his stay in the United States was unrecorded. The letter from Henrik Göransson to Sebardt also indicated that Esselius at least spent most of these years with the Carnegie Steel Company. What we do know is that Esselius spent the years 1899 to 1901 in Duquesne's immediate neighbourhood when he was at the Carrie furnaces in Rankin. Robert Hessen stated that "Carnegie was determined to concentrate his energy and his empire in Pittsburgh and its immediate vicinity; he wanted the entire area to be his monument".[104] And the plants were very concentrated. Braddock, where the Edgar Thomson works was located, Homestead, Duquesne, and Rankin were almost within walking distance from each other. For engineers willing to learn as much as possible about the practises in the Carnegie works, it must have been natural to try and get into as many of them as possible if only for a study visit.

Contemporary writings about the Carnegie Steel Company were often more or less documents of hero worship and James Howard Bridge did not spare his words about the company's excellence in his inside history of it from 1903. It is almost an understatement to say that the book was written from the company's perspective. The manager of the Carrie furnaces, Alva C. Dinkey, was called a "young genius" and Bridge often stated how many world records Carnegie Steel set in different areas.[105] It is, however, clear that the Carrie Furnaces was one of the most advanced blast furnaces in the world. The Swedish engineer Torsten An. Tesch reported home to the Ironmasters Association about the world record in the production of pig iron set by the Carrie furnaces in 1901.[106] The Carrie furnaces, as well as the other works in the Monongahela valley were, to a large extent, the places to be if an engineer wanted to learn about American practices in the steel and iron business.

The iron works in Mingo Junction and Bellaire were described only briefly in William T. Hogan's economic history of the American iron and steel industry, and cannot be viewed as unique from other plants.[107] Esselius learned Carnegie's practises in general from the work at several of the company's plants in Pennsylvania and Ohio but his position as chief engineer at these two works provided valuable experience to bring in the luggage home.

Esselius's actions

Esselius was one of the most obvious examples of influences from Carnegie Steel on the iron works in Sandviken. He came to the United States in 1893, the year after the Homestead strike, and witnessed the technological changes on the spot. It is clear that he was inspired by them when he began his work in Sandviken. Esselius's major idea was to increase production and at the same time decrease the number of workers, which he successfully did. The knowledge and inspiration of how to do this was borrowed from Pennsylvania. In William Sisson's article on mass production in Pennsylvania between 1867 and 1901, he concluded that engineers helped improve the productivity of Pennsylvania's workers between 1880 and 1900 and that the Pennsylvanian plants were significantly more efficient than the American mills as a whole.[108]

When Esselius arrived in 1905 the rolling-mill department had close to 900 workers and produced about 20.000 tons per year. In 1913, the workforce had been reduced to 700 while production had increased to 31.500 tons per annum. If we compare these two years, we find that the production was 22.5 tons per worker in 1905. Production in 1913 was 43.5 tons, i.e. an increase of 93% per worker.[109] "This, one must say, was well marched!"[110] wrote Eiserman. It is questionable whether those who were forced to leave the department because of Esselius's actions agreed.

One of Esselius's ideas was to install mechanical receivers behind the tube mill and thereby replace twenty-five workers. In 1910, Esselius made an investigation and wrote a suggestion for improvements of the rolling mills. In the wire works, he suggested that there should be a transport track from the furnace to the rolls and an automatic reel. This would save one man on each shift. He concluded that his suggestion would eventually increase the production capacity of the wire works by 50%. "Automatic" seems to have been a keyword for Eric Esselius. He wanted automatic receivers, reels and weighing-machines, transport tracks, electrical elevators, turntables and so on.[111] This was most certainly something he had picked up during his practice at Carnegie's different steel works. To some extent Esselius's arrival at the iron works marked a victory for the machines against labour in Sandviken in a similar way as has been outlined for Carnegie Steel.

The impact of Esselius' ideas was certainly different for different groups of people. From the company's perspective, Esselius's ideas had a good impact on productivity and costs, as production increased while costs were cut. For some of the workers in Sandviken's rolling mill, however, Esselius' arrival probably had other consequences. As stated above the picture of him was complex. Björk stated that Esselius interfered a lot in the working process in the rolling mill and made himself unpopular among the workers. In 1906, for instance, the boys in the tube mills supported by the adult workers went out in strike in order to get rid of Esselius and his American ideas.[112]

Teofil Lindblom (1884)

Thus Esselius left the rolling mill in 1918, but the "returnee management" of the department continued. Teofil Lindblom became Esselius' successor in the rolling mill in 1918 and he was still there in 1937. Lindblom had not worked in the United States as long as Esselius had but he had also spent some time with Carnegie Steel in Duquesne. The practise of rationalisation, mechanisation and mass production was thus familiar to Lindblom. Although there are no records stating it, one may suspect that Esselius had some influence in the hiring of Lindblom as his assistant in Sandviken in 1912.

In 1926, Lindblom made an investigation of modernising the tube works, partly to lower the production cost and partly to meet increasing demands from the market of tubes with larger dimensions and higher quality. He made the investigation together with Sparr who also had worked for the Carnegie Steel Company and the board approved their suggestions.[113] This was also in line with the development in the American industry and the tradition continued in Sandviken.

5.7. The cold rolling and wiredrawing department

Wire drawing in Sandviken began in 1876 when the board discussed the possibility of extending the activities of the iron works due to the recession. At the end of that year, Albert Göransson travelled to Germany and Britain in search for a skilled wiredrawer, and in the autumn of 1877 a German by the name of Friedrich Schmidt arrived. Schmidt had experience from some of the larger wire drawings in Germany, but was to some extent a disappointment in Sandviken. Henrik Göransson wrote to the agent in Düsseldorf who had engaged Schmidt that the Swedish drawers often made nicer fine-wire than Schmidt and that he was used for the drawing of coarse-wire. During a visit in Britain, Henrik Göransson saw the manufacturing of paragon-wire, that was common in England and Germany before 1876. He engaged an engineer Falding who stayed in Sandviken between the autumn of 1878 and the spring of 1880 and started up the manufacturing of paragon according to English methods.[114]

Cold rolling seems to have begun in 1883, when a rolling mill bought from France started but with serious problems. In 1886 new attempts at cold rolling began. They were once again problematic and some experts from Switzerland were engaged to get production in order.[115] Sandviken was the first iron works in Sweden to introduce this method. [116]

There were some foreign experts on the spot but the first head of the department was Tord Magnusson who lacked foreign experience.[117] In 1876, Fredrik Forsberg, who also lacked them, took charge of it.[118] Between 1916 and 1936 the returnee Ivar Magnusson managed the department and another returnee Carl Sebardt took responsibility for cold rolling after the department was split in 1937. It has unfortunately not been possible to establish whether two of the four heads (Erik. H Petersson and Olof Backman) that took over when the department was split into one for manufacture, wire-drawing, cold rolling and hardening in the 1930s were abroad. The possibility that Gösta Svensson, head of wire drawing, was abroad some time between 1925 and 1932 is quite high, as he was a graduate of KTH who was not included in Indebetou's and Hylander's directory. This means that Svensson for some reason had chosen not to be a member of *Svenska Teknologföreningen,* a membership that was automatic for graduates from KTH. One reason may be that Svensson had the intention to settle abroad, but these thoughts are highly speculative. So what we do know was that two heads of cold rolling were abroad. This examination concerns managing director Tord Magnusson's son Ivar Magnusson, who came to the department in 1910.

Ivar Magnusson (1880–1936)

When Ivar Magnusson was in the United States between 1904 and 1910, his father was head of offices, purchases and mines and one of the persons who stood closest to managing director Henrik Göransson. As stated, Tord Magnusson took over the position in 1910.[119]

His son graduated from CTI and arrived in the United States in 1904 after two years of studies at the Bergsakademie in the Austrian town of Leoben. He began working for Midvale Steel in Philadelphia and apart from a one-month interval with the Seamless Tube Company in Monessen close to Pittsburgh in 1905 he remained with Midvale until 1907[120] In his correspondence with the family in Sandviken, Ivar Magnusson wrote that he was learning a great deal, especially about the manufacturing of rolled wheel rings and he hoped this these experience would be valuable in Sandviken.[121] He was disappointed – but not surprised – when he got his father's letter of November 14, 1906, in which Tord Magnusson wrote that the board had decided that Sandviken would not go into such a production.[122] In the same letter, however, Tord Magnusson also stated that the cold rolling and wire drawing department probably would be split up in some years and that Forsberg was soon to retire. Tord Magnusson had talked the matter over with Henrik Göransson, and both of them thought that it was a good alternative to get Ivar Magnusson into the cold rolling department. His father had also talked about the possibilities with Esselius who said that it was possible to get a place for Ivar Magnusson at Jones & Laughlin in Pittsburgh, Cambria Steel Company in Johnstown, Pennsylvania or at the cold rolling mills in Worcester, Massachusetts or Waukegan, Illinois. Tord Magnusson wrote to his son stating that it was valuable if he had some experience of cold rolling, even if it was not an absolute demand that it should be of the same type as in Sandviken.[123]

His son responded that his father's advice meant a total re-orientation for him both with regard to his personal as well as occupational plans. Ivar Magnusson probably wanted to stay with Midvale perhaps because it would have facilitated his plans to get married. The latter was something his father had serious doubts about, both with regard to the planning of the marriage and because it might have affected his son's future career. Tord Magnusson also had his doubts about his son's choice of future spouse, Elma Krey, daughter of a wholesale dealer from Gävle. She was still in Sweden during Ivar Magnusson's first years in the United States and Tord Magnusson and his wife found her to be very reserved when she had visited them in Sandviken. Both parents were also afraid that the marriage was going to make Ivar Magnusson and Elma Krey settle in the United States for good.[124] In an undated and unsigned letter to Elma Krey, which was received on February 18, 1907,[125] Elisabeth Magnusson commented upon a letter from Ivar Magnusson to her husband. Ivar Magnusson had shown his gratefulness to his father for his financial support in case he was to change place from the works at Midvale to a construction department. This was a wish from his father's side so that his son would learn something that could be valuable for a future career at Sandviken, which was the original purpose of Ivar Magnusson's journey to the United States. Elisabeth Magnusson wrote:

> A study trip, but not an emigration, was what he [Tord Magnusson] thought of when he gave Ivar resources for this journey and therefore he hopes that Ivar more shall seek to get an employment which gives him knowledge, with which he can benefit his country (even if

at a more unpretentious place) than one bringing big incomes for the moment and promises of future places in America.[126]

The cold rolling and wire drawing department stood open for Ivar Magnusson in the long run but it was more difficult than both Tord Magnusson and Esselius thought getting him into a cold rolling mill in the United States would be. In December 1906, Per Torsten Berg who at the time was the United States Steel Corporation's technical representative in Europe visited Sandviken and talked to Tord Magnusson in his office. As their representative in Europe, Berg had contacts with the iron and steel industries around Pittsburgh and had also served twenty-three years as engineer and chief engineer, first at the Edgar Thomson works and later at Homestead. He made a suggestion to Tord Magnusson that his son should try to get into the Duquesne works and said that he could use the contacts he had with Mr. Ahlin, a Swedish engineer there. Berg thought that a place at the big and technically advanced works in Duquesne could be valuable for a future career in Sweden if Ivar Magnusson followed the building of furnaces, rolling mills and other facilities. There was however no cold rolling in Duquesne and Berg thought that it was impossible for him to arrange a place for Ivar Magnusson. Berg obviously convinced Tord Magnusson of the advantages that his son could obtain from taking employment at Duquesne. From there, it was easier for him to look around in Pittsburgh and perhaps get another place later.[127]

In the beginning of April 1907, Ivar Magnusson arrived at Duquesne, and in a letter from late April the same year he stated that he was very satisfied with his work at the plant, and that he was independent and got experience from a little of everything, unfortunately without any further information of what "a little of everything" may have been.[128] The Duquesne steel works was undergoing major new construction and Ivar Magnusson stated that they were in a big hurry with everything they were doing and, therefore, there were long working hours every day and not even the Sundays were free.[129] In some other letters, he wrote that times were bad and that several draftsmen had been discharged from Duquesne, but that the works was still running.[130] Unfortunately, Ivar Magnusson's time in Duquesne is very sparsely recorded. There was a gap in his letter collection from early December 1907 to mid-May 1909 which makes us know little about it.[131]

We do not know if Ivar Magnusson did not write letters at this time, or if they have simply disappeared but such evidence does not exist. There are, however, some letters written around the turn of the year 1906/1907, which indicate some tensions between Ivar Magnusson and his parents, partly because the latter were worried that their son would stay in the United States forever. He was working at places that Tord Magnusson believed did not offer as much as he would like for a career at Sandviken or at least in Sweden. The parents thought that their son's marriage came in between his "education" and forced him to take places where there was more to earn, but less to learn. At the same time they were not one-sidedly positive to his choice of Elma Krey as life companion.[132] In May 1909, however, Ivar Magnusson was about to leave Duquesne. He preferred to go to Germany before he returned to Sweden.[133] The next letter was written in late June, and Ivar Magnusson stated that he returned from New York the day before and that it would probably be difficult for him to get a place in Germany. He had however made an interesting study visit on his way back from New York. In Roebling and Trenton, New Jersey, Roebling's had works with huge wire drawings and cold rolling mills, that, according to Ivar Magnusson, were probably Sandviken's biggest competitor in that field in the United States. The works made wire for cables and had four martin furnaces with a capacity of thirty tons. It was modern and built only four years earlier. The superintendent was a Finn who was a friend to one of Ivar Magnusson's closest friends and he promised Ivar Magnusson to try to get him a place there probably as worker in the production as Roebling's had no construction department. The Finnish superintendent also offered Ivar Magnusson a chance to look around. He was very impressed with what he saw and wrote to his father:

> If I could get some place there, is it Father's opinion that I should take it rather than seeking to come to Sweden or Germany from Duquesne? Wouldn't such a place be a merit for Sandviken?[134]

Tord Magnusson thought so. His son's wage in Roebling would have been lower than in Duquesne, and in a letter from July 31, Ivar Magnusson told his father that he had moved from Duquesne and showed his gratefulness for the offer to financially cover the difference in wage. However, Ivar Magnusson's letter was not written from New Jersey, but from Youngstown, Ohio. He decided to take an offer from Republic Iron & Steel Company in that town instead of the one from Roebling, partly because he was offered a higher wage than in Duquesne. Ivar Magnusson thought that Elma Krey had to suffer too much if the couple was to continue to live on the same amount of money every month. Another reason for his departure from Duquesne was that he had little work as the construction of the new rolling mills had been postponed and would probably not begin during 1909. He stated that Carnegie also had a works in Youngstown and discussed the possibilities to seek employment there but continued:

> Republic is however about to do large new constructions – the present were to a large extent very out of date – and therefore I can learn a lot here. They do not have as large resources as the Steel Corporation, and must look over the costs a bit, which makes Republic very much like a European works.[135]

At the time of the writing, Republic was planning a new works close to Youngstown and Ivar Magnusson was making suggestions for the blast furnaces, something he had also done in Duquesne. He had hoped to be able to take part in the construction of rolling mills and got an answer that it probably would happen in due course.[136] Ivar Magnusson was at the construction department and did not consider to get much out of the works.[137] In the end of March 1910 he still worked with the constructions of blast furnaces and stated in his letter that he wanted to come back into rolling mill construction.[138] There was no information if he did go into the rolling mill business during his last months at Republic. As head of the persons who worked with the blast furnaces at Republic, Ivar Magnusson probably got a position to see constructions of rolling mills as well. In July 1910, he wrote what probably was his last letter from the United States in which he stated that he had telegraphed his acceptance of the job his father had offered him in Sandviken and that he was hoping to depart for Sweden in the middle of August. The wage was not high, but Ivar Magnusson hoped that Sandviken would pay the housing costs for him and his family and wrote: "I am willing to dare the attempt to work myself up in Sandviken, as many other opportunities to come home to Sweden will not be offered".[139] It was a thoroughly and solidly educated engineer who came back to Sandviken after two years in Austria and six years in the United States.[140]

The job Ivar Magnusson was referring to in his last letter from the United States was as assistant engineer to Forsberg in the cold rolling and wire-drawing department. His first main duty was to take care of the hardening. In a letter to Wilhelm Sebardt from late July 1910 Karl Fredrik Göransson wrote that Ivar Magnusson had been offered the place and continued:

> His grounding ought to be suitable for this place, as he studied both metallurgy (and thereby especially the condition of steel at heat-treatments) and mechanics, that is served as draftsman in America[141]

Ivar Magnusson's experience in the United States was important for him when he got his position. In another letter to Sebardt, written the day before, Tord Magnusson was also telling him that his son had been offered the place. Both Karl Fredrik Göransson and Tord Magnusson stated that it was a good opportunity for Ivar Magnusson to return and try his skills at Sandviken.[142] Tord Magnusson also told Sebardt that Forsberg had accepted his son as his assistant, but that he also claimed that he did not do it because of the family ties.[143] This may very well have been false, but Sebardt must have had the possibility to ask Forsberg directly if he wanted to hear his real opinion. In Yngström's description of Sandviken's technical development he did not mention that anything particular happened in the field of hardening between the years 1910 to 1916, and neither did Ivar Magnusson himself in the lecture he held on the cold rolling development in Sandviken in December 1933.[144]

It took six years after his return before Ivar Magnusson took over the position as departmental head of the cold rolling and wire-drawing department. There are reasons to wonder whether he got this position primarily because he was the son of the managing director. The family ties probably contributed. Karl Fredrik Göransson's letter to Sebardt about Ivar Magunsson's suitable American background points in a direction where it was important with his experience to get a position as Forsberg's assistant in 1910. Ivar Magnusson's time as assistant gave him an opportunity to accumulate more experience and knowledge which was valuable to him when he took over the department. All in all, it was a combination of family ties, experiences and knowledge from abroad and merits he had got in Sandviken.

Ivar Magnusson began to modernise the cold rolling and wire-drawing department in 1916. The work force was increased by 10%, the foremen by 50% and the office personnel with 75% whereas the number of engineers doubled. He also introduced a card system and time clocks.[145] It was not stated in his letters whether he had studied such systems in the United States but presumably he had. In Wyman's account of reasons to return to Europe he revealed how many immigrant labourers were inclined to leave the United States and return to Europe where the work was still hard but where there at least were no clocks or bosses watching over the workers.[146] A possible "Americanism" in a similar way probably developed under Ivar Magnusson's management. It is reasonable to assume that he applied some ideas from the United States although it is difficult to ascertain. He stated, however, in several letters that Midvale Steel Company was as modern – if not even more modern than any works of U S Steel.[147] It is possible that he reached this conclusion since Midvale was Taylor's early laboratory. Even if Taylor was not there at the same time as Ivar Magnusson, his ideas were still present and probably influenced the engineer from Sandviken. The views of Ivar Magnusson as departmental head of the cold rolling and wiredrawing department in Sandviken diverged. In the obituary from August 12, 1936, *Sandvikens Tidning* celebrated him and wrote that his leadership was characterised by broad-mindedness and humanity. He was according to the local newspaper appreciated by his subordinates and free from every kind of artificiality.[148]

Eiserman also wrote about the friendship he felt with Ivar Magnusson, "everyone's friend Ivar", as he preferred to call him.[149] From the workers' side however, there was also criticism against their departmental head. In the beginning of the 1920s, bad times struck the department and the workers' wages were cut to half of what they had been. One worker wrote a letter to another local newspaper, *Arbetarbladet* [The Workers' Paper] in Gävle, which also was read in Sandviken. The worker stated that they had tried to get more work. Ivar Magnusson had responded that the department was trying to arrange more work, but that it was not possible to do so to the extent the workers wished since there was not enough money. At the same time, the squad of foremen, office personnel and engineers were kept intact. This really annoyed the writer who saw it as strange in the economically bad times and suspected that the reason for it was that they were to be used as strike-breakers in case a strike occurred in the department. The writer's judgement of Ivar Magnusson was harsh:

> The already mentioned departmental head generally seems to enjoy seeing his workers suffer, as he sees fit to ignore all their accounts and mostly keeps away so that he can not be found, and his subordinates were the ones who must take the first blow, and they have no right whatsoever to give answers, and it is always said that: we can not do anything, we see that it is difficult, but we are not allowed to do anything, we shall ask the head.[150]

In his 1933 lecture, Ivar Magnusson talked about the history of cold rolling in Sandviken and he was telling his audience about the so-called "cluster mill" Sandviken bought from the United States in 1927. He had himself gone to the United States in order to arrange the affair. The "cluster mill" was placed in one of the buildings at the iron works and used for rolling of bands that were 120 millimetres or thinner. In his lecture, Ivar Magnusson stated that the use of the "cluster mill" in the rolling had saved fifty-four men per day in comparison to the "old" mill.[151] Labour-saving machines and actions were thus important for him.

He also described the development of cold rolling in Sandviken in his lecture. During his time as chief engineer, the cold rolling mill was developed and modernized and four new buildings were set up with modern machines and equipment.[152] New methods for using mills were developed in the early 1920s and Ivar Magnusson stated that there were not many iron works that had modernized the cold rolling mills to such an extent as Sandviken.[153] Lars Yngström stated in the obituary for Ivar Magnusson that production capacity more than doubled in the department between 1916 and 1936, and that the number of employees did so as well.[154] In 1917, there were a total of twelve engineers and office personnel at the department and in 1937 there were forty-three. The number of workers was in 1937 1566 in the four departments that earlier was the department managed by Ivar Magnusson.[155] Unfortunately, the statistics did not give the number of workers in 1917. Modernisation seemingly gave increasing possibilities for engineers and clerks to come into the department, but there were no available statistics showing that the workers had to pay the price. One indication is however the letter to *Arbetarbladet* in 1922, but it is difficult to state whether it was something typical for Ivar Magnusson and the department he managed. It is difficult to state how the workers were influenced by Ivar Magnusson's actions, but the Sandviken iron works certainly gained from his actions as the statement of productivity increase above shows.

Ivar Magnusson was a skilled technician and the experiences from the United States were important for him to get his place at Sandviken. This is how Yngström described him in Sancte Örjens Gille's obituary from 1937:

> Within cold rolling technology and hardening of steel it is a question of being master over a whole lot of details and to come with ingenious suggestions and constructions. At the shaping of some big cold rolling mills that were built by Krupp, Ivar Magnusson contributed with very important skills and without his contributions they would probably not be as perfect as they are.[156]

The question is whether Ivar Magnusson transferred any of the knowledge he gained in the United States over to Sweden and the Sandviken iron works? As for Eric Esselius and Teofil Lindblom, the answer of is probably yes. Karl Fredrik Göransson's letter to Sebardt shows that Ivar Magnusson had the right background for his position as responsible for hardening. During his time at Midvale Steel Company in Philadelphia he primarily got experiences of a kind of production that Sandviken later decided not to get into, but possibly also about Taylorist methods. Duquesne was also one of the world's most advanced iron works when it came to labour-saving methods and it is probable that he picked up things from there which he used in his work in Sandviken. As an employee in the construction department in Duquesne, he probably got into a position to see labour-saving methods and other technological improvements in the rolling-mills. The one and a half year gap in the letter collection unfortunately leaves a big question mark with regard to what Ivar Magnusson learned in Duquesne. His time in Youngstown was rather short even if he stated that he probably was able to learn a lot from the new construction that the Republic Iron & Steel Company was about to carry out. The modernisation and the new construction he carried out in Sandviken, i.e. the four new buildings and all the details in the constructions, point in the direction that his six years in the United including two with a place called one of the most advanced iron works plants in the world must have been important.

It seems to have been in the construction department as well as in rolling and cold rolling the American experiences mattered most apart from in the management from the 1920s. These departments were for a long time managed by returned engineers. However, there were also some indications that impulses from the United States were important in other departments for instance in the metallurgical one.

5.8. The Metallurgical department

The metallurgical department was formed in 1868 for the purpose of manufacturing pig iron and steel.[157] Before 1882, it had the same heads as the building department, the mechanical workshop, the heating department and the construction department. They were Albert Göransson, C J Tholander, and Ernst Göransson. Foreign experience was not as persistent as in the earlier mentioned departments and the only engineer with a longer foreign stay behind him was Torsten Wahlberg who had spent two years on Sumatra and six years in the United States before he came to Sandviken in 1929 in order to lead the setting up of the electrical steel works.[158]

There was however a Wahlberg before him in this department. Axel Wahlberg managed it between 1893 and 1896. In 1892, he was on a study trip in the United States, sent out by Sandviken. He first spent time in the eastern parts of the United States, but after an advice from Henrik Göransson he made his way to the charcoal works in the Midwest. The only one he was impressed by was the Hinkle Furnaces in Ashland, Wisconsin. The superintendent Mr. Hunt had more than twenty-five years of experience in charcoal works and was according to Axel Wahlberg the United States' most skilled man in the field. In the letters he wrote to Henrik Göransson, he suggested that Sandviken should apply the system that Hunt used in Ashland to weigh coal before it was used in the blast furnace. It would increase production and save fuel.[159] It is not clear if Sandviken began using the system, so the impact of the Hinkle Furnaces in Sandviken cannot be ascertained. The American influence is more evident when we turn to the other Wahlberg.

In a discussion held at the Ironmaster's Association *(Jernkontoret)* after engineer Lennart von Friesen held his lecture on the development of electrical steel making in the United States in 1923, the managing director of the iron works in Nyhammar,[160] Gerard De Geer, stated that it was surprising that electrical steel making had not been given a higher priority in the Swedish iron and steel industry, but that it probably was only a matter of time before it would happen. De Geer continued

> When it comes to going into electrical steel in Sweden's iron trade, we can to a large extent build on experiences from America. We ought to scoop up from the large source of experience that the Americans have collected in the field. I am hereby aiming at their experiences of constructions and constructive details. In this field, the Americans have put down enormous costs and have also been succeeding in working out types of furnaces, that hardly leave anything else to wish when it comes to running them. We cannot afford to experiment with new types of furnaces, something that is still going on to quite a large extent. Our field of work, our place for new initiatives, lies in the use of the furnaces in the metallurgical field. There, the Swedish iron trade has great opportunities to reach further, much further, than the Americans have reached.[161]

In the United States, the electric furnaces were the most advanced. Misa stated that they were "the last major production technology that American steelmakers adopted in advance of external competitive pressures"[162] In von Friesen's report, he stated that the United States witnessed a boom in the steel- and iron industry thanks to an increasing need of iron and steel during World War I. The boom was especially persistent in the quality steel works and most striking was the development in the electrical steel industry.[163]

Torsten Wahlberg, with six years of experience in the American industry. Sandviken could make use of his knowledge. After he had finished his mission in Sandviken to set up the works, he also became its chief engineer.[164] Yngström stated that in 1929 and 1930, the second and third steps in the electrical steel making in Sandviken were taken. The third electrical furnace in Sandviken was the biggest in Europe and built in connection with the crucible steel works, something that von Friesen noted in the electrical steel industry in the United States during his study trip in 1922. It was also regarded as a substitute for crucible steel and the electrical furnaces had all the advantages of a crucible furnace, but not the disadvantages.[165] It must have been a considerable knowledge of how to handle the electrical furnaces that Torsten Wahlberg brought to Sandviken.

In 1934 Sandviken's fourth electrical steel furnace came into use and it was the first the kind in Sweden, because of its far-reaching mechanisation. Yngström's description of it has similarities with von Friesen's observations from Naval Ordnance Plant in South Charleston, West Virginia. In both places there was an arrangement that could be uplifted when the tapping was about to begin.[166] Unfortunately, there is no account of where Torsten Wahlberg was in the United States but the processes used in West Virginia described by von Friesen were also applied elsewhere in the United States.

5.9. Concluding discussion

We have seen that primarily American experience mattered in both a quantitative and qualitative ways at an iron works in Sweden around the turn of the last century. Like other engineers in Sweden, those aiming at employment in the steel and iron industry were attracted to learn more about the development in the American steel and iron industry, particularly in the area around Pittsburgh where the most advanced iron works were located. They had an interest to work with rolling mills after they had returned to Sweden, and the interest spurred them to get over and acquire knowledge of it. This later could function as a symbolical capital in Bourdieu's sense. It is reasonable to assume that steel and iron engineers as did electrical engineers became informed of about the technology there through articles in technical journals as well as lectures, letters and other channels.

The knowledge of the methods used in steel and iron plants in the United States were important when the engineers were looking for jobs in the Swedish steel and iron industry. It was a valuable symbolical capital. The correspondence between Henrik Göransson and Wilhelm Sebardt about Esselius's experiences at the Carnegie Steel Company was one example of how leading individuals in the industry valued the knowledge of methods used in the United States. The conflict with Larsson, where Henrik Göransson took Esselius's side, shows that his knowledge of the methods used in rolling mills in the United States worked as symbolic capital that gave him power, even if social capital such as family ties probably mattered more in this context than in the electrical industry. However, the general spirit in Swedish industry was to use American examples and returning Swedish-Americans were important for a major Swedish steel and iron works. The power constituted by the returning engineers led to technical change in Sandviken. This backing from the management probably also contributed to make the introductions successful at least from the company's perspective. Most of the methods used were in a Taylorist spirit and consisted of systematic organisation of the construction department, rationalisation of the production in order to increase it and at the same time a reduction in the number of workers. This was achieved through the use of automatic machines and other labour-saving actions. Especially in the 1920s, Taylorism became to a large extent combined with welfarism. Other possible areas of influence concerned blast furnaces practises and electrical steel furnaces.

More than half of the Sandviken department were at some point in time managed by an engineer with experience in the United States, and more than 40% for most of the departments' existence. The two major departments of the rolling-mill and cold-rolling mill were ruled by returnees from the United States for longer periods. During a longer time, the returnees from the United States could shape the technical development of Sandviken and Americanise the iron works. Proportionally, the iron works was not as much foreign influenced as the electrical company, but the influences that came were more one-sidedly American. Other countries contributed only in a minor way, often through study trips and Henrik Göransson was the only person that had actually been living in another foreign country than the United States.

As mentioned, the level of technical education in Sweden was comparably high. Furthermore, iron and steel was a deeply rooted industry in the country and especially in the area around Bergslagen. Sandviken was in the forefront among the Swedish iron works and the transfer of technology and ideas was probably in line with Svante Lindqvist's crucial factors facilitated by this fact. There was an available expertise present, and as time went by more and more engineers in the iron works came to have experience from American steel and iron works. This facilitated the introduction of practises from them.

Especially in the Carnegie works, rationalisation and technological changes began in the 1890s. When the returning engineers began establishing the changes in Sandviken, the rationalisation methods were to a large extent common in American steel and industry. The American welfare practises that were a model for Karl Fredrik Göransson's introductions in the 1920s also had their roots many years earlier and were not uncommon in the American industry at the time. The success of the system was probably also facilitated by the fact that it was adjusted to Swedish conditions where the unions became integrated in it and because the harsh anti-unionism, at least when it came to "traditional" unions, that characterised the American system was not transferred.

Esselius's example proves that his rationalisation was cost-effective and this was certainly a merit in the board's eye that also facilitated the implementation of them. The cluster-mills worked well and were manufactured by Sandviken itself. The electrical steel furnaces were described as very functional. [167] From the company's perspective the technical changes were profitable. The very fact that Karl Fredrik Göransson later became one of the driving forces in the work peace conferences of the late 1920s and the negotiations in Saltsjöbaden 1938 clearly indicates that his strategy to apply welfarism and cooperation between management and workers was successful from his own point of view.

However, these strategies also had their roots to some extent in the elderly patriarchal structure of the Swedish iron works. Sandviken was an iron works where the consul Göran Fredrik Göransson already from the beginning aimed to create a kind of model community.[168] Karl Fredrik Göransson returned in 1901 and contributed to the development. Possibly, this "spirit" had become deeply rooted already when the returned engineers came with their suggestions. Even if there were technological changes they were integrated in the social order and the traditions possibly had a calming effect.

The returning engineers were also often rooted in the traditions, as they were all Swedes and many of them originated from the province of Gästrikland. Among the ten returnees, five were born there. Furthermore, some of them came from the families that were connected to the ownership of the company. Most of them were mining engineers and it seems clear that they had planned to spend most of their life in a Swedish iron works environment. The integration of the returnees in the community hardly provided any problems in the technology transfer.

Notes

1 Nils Elfström, *Medmänniskor och situationer: statistik och reflektioner. Fagersta-minnen.* (Fagersta, 1976), 42-43. Swedish original: En betydande insats i koncernens utveckling gjorde också de medarbetare som återkommit till Sverige efter att ha tvingats emigrera till USA i början av 20-talet och där gått igenom den s k ”ekluten”. De hade börjat ute på verkstadsgolvet och fått en grundlig skolning i vad jag vill kalla praktisk järnhantering…. har utan tvivel varit av betydelse även rent pedagogiskt här hemma, särskilt under 30-talet, i det praktiska handhavandet av problem med människor, ugnar, maskiner och stål.

2 N Elfström, 14.

3 S Carlsson 1976, 128; Ernst Söderlund & P. E. Wretland, *Fagerstabrukens historia 3. Nittonhundratalet* (Uppsala, 1957), 47-49.

4 R Adamson, 95-133; Kristine Bruland, “Skills, Learning and the International Diffusion of Technology” in *Technological Revolutions in Europe. Historical Perspectives,* eds. Maxine Berg & Kristine Bruland (Cheltenham, 1998), 175-176; C Evans & G Rydén, 188-205; T Gårdlund 1942, 233-259; L Jörberg, 189; Claus Wohlert, ”The Introduction of the Bessemer Process in Sweden” in *Technology Transfer and Scandinavian Industrialisation,* 295-306; Klaus Wohlert, ”Svenskt Yrkeskunnande och Teknologi under 1800-talet: en fallstudie av förutsättningarna för kunskapstransfer” in *Historisk Tidskrift,* 4/1979, 398-421.

5 R Adamson, 127-130.

6 T Gårdlund 1942, 238-239.

7 P-O Grönberg 2000, 32-33.

8 Göran Hedin, ”Högbo Bolag” in *Ett svenskt jernverk,* 16*;* Gillis Andersson, *Gästrikland och järnet. Från järnåldersugnar till global verkstadsindustri* (Sandviken, 2000), 245-248, 273; G Carlestam; O Hedebrandt, 10, 26, 51.

9 *Ett svenskt jernverk.*

10 G Carlestam, 378-386, 516.

11 *Svenska Teknologföreningen* I, 4.

12 G Andersson, 252; Jeanne McHugh, *Alexander Holley and the makers of steel* (Baltimore, MD, 1980); Thomas J. Misa, *A Nation of Steel. The Making of Modern America* (Baltimore, MD, 1995), 11.

13 Lars Yngström, ”Järnverkets tekniska utveckling” in *Ett svenskt jernverk. Sandviken och dess utveckling 1862-1937,* ed. Göran Hedin (Uppsala, 1937a), 111, 115.

14 T Gårdlund 1942, 234.

15 He was for instance registred as arriving at Ellis Island in 1919, 1921 and 1923, http://www.ellisisland.org/search/passRecord.asp?MID=06833889580064259584&FNM=KARL&LNM=GORANSSON&PLNM=GORANSSON&CGD=M&RF=4&pID=603982150058; http://www.ellisisland.org/search/passRecord.asp?MID=06833889580064259584&LNM=GORANSON&PLNM=GORANSON&CGD=M&RF=171&pID=103393030914; http://www.ellisisland.org/search/passRecord.asp?MID=06833889580064259584&LNM=GORANSON&PLNM=GORANSON&CGD=M&RF=171&pID=601546020004, all available on Internet, 7/4-2003.

16 *Svenska Teknologföreningen* I, 585; *Ett svenskt jernverk,* 379-380. Apart from his duties at the iron works, Göransson also held positions in several employer’s associations. He was also at a time member of the county council in Gävleborg and the municipal council of Sandviken

17 G Carlestam, 92.

18 Karl Fredrik Göransson to H Göransson, 31/7-1900, 5/8-1900, 13/9-1900, 26/2-1901; K F Göransson to Emma Göransson, 4/2-1901; K F Göransson to Karin Göransson, 18/9-1900, GS, SKCA, volume 13.

19 K F Göransson, *Hur man sköter sitt folk. Samförstånd mellan företagare och arbetare* (Stockholm, 1927); K F Göransson 1928. The booklets are identical.

20 G Carlestam, 378-386; Sune Sunesson, ”Onsdagsklubben och klasskampen – från tjugotalets arbetarrörelse i Sandviken” in *Arkiv för studier i arbetarrörelsens historia,* 11-12/1977, 40-56.

21 S Meyer III 5; D A Hounshell, 249-253; Daniel M. G. Raff, “Ford Welfare Capitalism in its Economic Context” in *Master to Managers. Historical and Comparative Perspectives on American Employers,* ed. Sanford M. Jacoby (New York, NY, 1991).

22 K F Göransson to E Göransson, 13/12-1923, GS, SKCA, volume 13.

23 S D Brandes, 14; S Meyer III, 5; T Svensson, 21.

24 T Svensson, 22.

25 T Svensson, 22.

26 S D Brandes, 29; B Sund, 30-32.

27 S D Brandes, 12-14, 36, Daniel Nelson & S Campbell, “Taylorism Versus Welfare Work in American Industry: H. L. Gratt and the Bancrofts” in *American Business History Review* 46/1972, 1-6.

28 T Svensson, 24.

29 Arthur Pound, *Industrial America. Its Way of Work and Thought* (Boston, MA, 1936), 39-40; T Svensson, 22-23.

30 Carl Björk, ”Arbetarrörelsen” in *Ett svenskt jernverk*, 302.

31 K F Göransson 1928, 42-44.

32 Minutes of the board meeting of Sandviken Järnverks AB, 26/2-1916, SA, SKCA, volume A2; Göran Hedin, ”Ur Sandvikens krönika” in *Ett svenskt jernverk*, 93; Sigrid Göransson, ”Järnverket och Sandvikens sociala problem” in *Ett svenskt jernverk,* 271.

33 K F Göransson 1928, 45.

34 S D Brandes, 38-83.

35 K F Göransson 1928, 29-40.

36 T Svensson, 23.

37 T Svensson, 23.

38 Andrew Carnegie, ”An Employer’s Views. Adjustment between labor and capital. Andrew Carnegie’s conclusions” in *New York Daily Tribune*, 23/3-1886, CSCR 1853-1912, HSWP.

39 On Schwab, see R Hessen.

40 T Svensson, 22.

41 K F Göransson, 24-25.

42 T. B, ”Onsdagsklubben – ett frö till industriell demokrati” in *Konvertern,* 2/1960, 26.

43 S Sunesson, 45.

44 G Carlestam, 379; T. B, 26.

45 K F Göransson 1928, 22-34.

46 K F Göransson 1928, 7-53; G Carlestam, 386-387.

47 G Carlestam, 379, 387.

48 K F Göransson 1928, 25.

49 A Carnegie 1886.

50 R Hessen, 254.

51 K F Göransson 1928, 24.

52 On the Saltsjöbaden agreement, see *Saltsjöbadsavtalet 50 år. Forskare och parter begrundar en epok 1938-1988,* eds. Sten Edlund et al (Stockholm, 1988).

53 For more details about the pre-history of the Saltsjöbaden agreement see Anders L Johansson, ”Saltsjöbadspoltikens förhistoria” in *Saltsjöbadsavtalet 50 år,* 20-33.

54 T. B, 26.

55 G Carlestam, 378-379.

56 William T. Hogan, *Economic History of the Iron and Steel Industry in the United States,* volume 1 (Lexington, MA, 1971), 192-193; E. D. McCallum, *The Iron and Steel Industry in the United States. A Study in Industrial Organisation* (London, 1931), 44-48; William Sisson, "A Revolution in Steel: Mass Production in Pennsylvania, 1867-1901" in *IA. The Journal of the Society for Industrial Archeology,* volume 18, No 1 and 2/1992, 80.

57 A Elzinga, A Jamison & C Mithander, 130; N Runeby 1978, 22-25.

58 A Elzinga, A Jamison & C Mithander, 130-131; M Fridlund, 41; S Hansson, 19; N Runeby 1978, 22-25.

59 *Emigrationsutredningen. Bilaga XV: Arbetsmetoder i Amerika* (Stockholm, 1908), 5.

60 T Gårdlund 1942, 234, 239.

61 Wilhelm Haglund, *Levebröd. Strövtåg i minnet och brukshistorien* (Stockholm, 1978), 200. Swedish original: ”Ja Sandviken är nog när det gäller moderna verk och anordningar Sveriges Amerika”.

62 *Ett svenskt jernverk,* 381; *Svenska Teknologföreningen* I, 96, 132, 184, 192; ”Henning Sparr” in *Sandvikens Tidning*, 18/8-194; SCB Summariska Folkmängdsredogörelser, Gävleborg county, 1914; http://www.ellisisland.org/search/matchMore.asp?MID=06833889580064259584&FNM =HENNING&LNM=SPARR&PLNM=SPARR&kind=exact&offset=0&dwpdone=1, available on Internet, 10/3-2003.

63 *Svenska Teknologföreningen* I, 184; *Ett svenskt jernverk,* 381-382.

64 ”Gottfrid Lindskog” in *Sandvikens Tidning,* 13/2-1914; ”Carl Gottfrid Lindskog” in *Teknisk Tidskrift. Veckoupplagan,* 28/3-1914, 115.

65 ”Gottfrid Lindskog”. Swedish original: ” Inom den närmaste kännekretsen som varit i tillfälle att lära af hans rika erfarenhet och hvars förebild i oegennyttigt och plikttroget arbete han alltid varit, skall han i minnet bevaras såsom en värdig representant för den generation, som varit bäraren av Sandvikens utveckling under det första halvseklet af dess tillvaro”.

66 L Yngström 1937b, 184-185. Swedish original: ”Det torde böra påpekas, att konstruktionsavdelningen genom sin ständiga anpassning efter de ökade kraven, genom att tillvarataga och utnyttja impulserna från verkets egna erfarenheter och genom att avlyssna den moderna teknikens röst ute i den industriella världen är ett utomordentligt betydelsefullt instrument för järnverkets alltjämt fortgående modernisering och utveckling.”

67 B Berner 1987, 268.

68 B Berner 1981, 145.

69 B Berner 1981, 147.

70 Robert Ardell, ”Systematiskt ritkontorsarbete och ritkontorets samarbete med verkstaden” in *Teknisk Tidskrift. Mekanik och elektroteknik,* 14/2-1903, 23, 45.

71 Ernst A. Hedén, ”System för ritkontor” in *Teknisk Tidskrift. Veckoupplagan,* 26/3-1910, 101.

72 L Yngström 1937b, 147, 183.

73 W Haglund, 198.

74 ”Henning Sparr”; L Yngström 1937b, 148.

75 *Ett svenskt jernverk,* 375; Bengt Eiserman, *Minnen och episoder* (Stockholm, 1937), 107.

76 B Eiserman, 107, 169. Eiserman did however call Larsson an engineer.

77 B Berner 1981, 122.

78 Lars Yngström, ”Järnverkets tekniska utveckling” in *Ett svenskt jernverk,* 146-147.

79 L Yngström 1937b, 148; Artur Attman, *Fagerstabrukens historia. Adertonhundratalet* (Uppsala, 1958), 487; P. O. Strandell, ”Valsverksteknik – Introduktion” in *Varmvalsverk. Teknisk utveckling i Sverige från 1870-talet till 1990-talet,* eds. Torsten Palm, John Bäckman & Otto Stjernquist (Stockholm, 1997), 38.

80 L Yngström 1937b, 148.

81 B Eiserman, 173. Swedish original: ”Men amerikaniserad var han! När man kom ner till honom och han hade tid, så var man alltid välkommen. Bjöds först på en cigarr (cigarett – eller piprök tolererade han inte på sitt kontor), satte sig tillrätta i sin stol, lade fötterna på skrivbordet, och sedan kunde man få sitta hos honom hur länge som helst, ändå tills man fått sitt ärende uträttat”.

82 B Berner 1981, 213-218; B Sundin 1981, 72-75; B Sundin 1991, 255.

83 A Johansson 1990, 95.

84 Alf Johansson, *Den effektiva arbetstiden. Verkstäderna och arbetsintensitetens problem* (Motala, 1977), 105.

85 ”Ingenjören och ingenjörsyrket”, *Teknisk Tidskrift. Veckoupplagan.* 22/3-1913, 95.

86 *Svenska Teknologföreningen* I, 428.

87 Carl Björk, *Minnesskrift vid Metalls Avdelning n:o 135 Sandviken, 30-årsjubileum 1906-1936* (Sandviken, 1936), 45-46. Swedish original: ”så att de djävlarna hör det ända upp i Överbyn, att det går här nere”.

88 C Björk 1936, 45-46.

89 Ernst Haglund, “Eric Esselius Född 30/10-1873 – Död 26/12-1948” “ in *Dödsrunor: Sancte Örjens Gille,* 18 (Stockholm, 1950), 75.

90 H Göransson to Sebardt, 12/9-1905, 23/9-1905; Sebardt to H Göransson, 16/9-1905, SA, SKCA, volume F1:4.

91 B Eiserman, 170-171.Swedish original: ”Det berättades emellertid, att det hade skurit ihop så pass skarpt emellan den gamle praktikern och den unge moderne teoretikern ifråga om praktisk erfarenhet från ledande länders stordrift, att Esselius till sist lär hava sagt ifrån till Brukspatron, att det nog inte ginge för honom att komma någonstans med detta kompakta motstånd från gamle verkmästaren”.

92 B Eiserman, 171-172. Swedish original: ”..stod förmodligen inte ut med att behöva ”tiga still” och endast se på de nymodigheter, som denne nye man fick ledningens tillåtelse att upptaga”.

93 Gustaf Sandström to H Göransson, 30/10-1908; Sandström to Eric Esselius, 18/11-1908, SA, SKCA, volume E1a:7. It is not clear whether Eric Esselius retook his Swedish citizenship at that point of time.

94 B Eiserman, 169-172.

95 Minutes from the SJAB board meetings, 26/4-1906, 9/2-1911, 16-17/11-1914, 5/10-1918, 13/3-1920 and 1-2/10-1920. Appendix to the Minutes from the iron works’ board meeting, 1-2/10-1920: Esselius to Tord Magnusson, 8/9-1920, SA, SKCA, volume A2.

96 H Göransson to Sebardt, 12/9-1905.

97 Kenneth Warren, *Big Steel. The First Century of the United States Steel Corporation 1901-2001* (Pittsburgh, PA, 2001), 86.

98 Joel Sabadasz, “The Mon Valley - Discovering the Genesis of the Modern American Steel Industry” in *Cultural Resource Management (CRM),* volume 16, number 3, 1993, 28.

99 Herbert N. Casson, *The Romance of Steel. The Story of a Thousand Millionaires* (New York, NY, 1907), 131, 141.

100 H J Habakkuk, *American and British Technology in the Nineteenth Century. The Search for Labour-Saving Inventions* (London, 1967), 201.

101 ”Järnindustriens utveckling i Nordamerika under senaste tid” in *Bihang till Jernkontorets Annaler* 1902, 142-152.

102 H N Casson, 124-130; K Warren, 86.

103 James Howard Bridge, *The Inside History of the Carnegie Steel Company. A Romance of Millions.* (New York, NY, 1907), 181.

104 Robert Hessen, *Steel Titan. The Life of Charles M. Schwab* (Pittsburgh, PA, 1990), 79.

105 J H Bridge, 166.

106 ”Sammandrag af till Jernkontoret under år 1902 inlämnade tjänsteberättelser” in *Jernkontorets Annaler,* 1902, 439-440.

107 W T Hogan, I and II, 287.

108 W Sisson, 92.

109 B Eiserman, 169-172.

110 B Eiserman, 172. Swedish original: “Detta, må man väl säga, var bra marscherat!“

111 Eric Esselius, “Ombyggnad af div. valsverk. Esselius utredning af 1910”, unpublished paper, 1910, SA, SKCA, volume F8:b47.

112 C Björk 1936, 33-34.

113 Minutes of the board meeting of Sandviken Järnverks AB, 17/12-1926, SA, SKCA, volume A:2.

114 L Yngström 1937b, 159-160.

115 L Yngström 1937b, 152-153.

116 I Magnusson 1933, 1.

117 This was before Tord Magnusson’s study trip to Chicago in 1893.

118 *Ett svenskt jernverk,* 381.

119 *Ett svenskt jernverk,* 379.

120 Ivar Magnusson to T Magnusson, 19/9-1905; 20/9-1905; 4/10-1905; 8/10-1905; 12/10-1905; 15/10-1905; 18/10-1905, GS, SKCA, volume F1:4.

121 I Magnusson to T Magnusson, 25/2-1905; 28/3-1905, GS, SKCA, volume F1:4.

122 I Magnusson to T Magnusson, 5/12-1906, GS, SKCA, volume F1:4.

123 T Magnusson to I Magnusson, 14/11-1906, GS, SKCA, volume F1:4.

124 T Magnusson to I Magnusson, 20/12-1906; Elisabeth Magnusson to Elma Krey, undated, GS, SKCA, volume F1:4; *Svenska Teknologföreningen* I, 630. The parents’ dislike of Elma Krey was most obvious in the letter Elisabeth Magnusson wrote to her and she got on 18/2-1907 (according to Ivar Magnusson’s letter to Tord Magnusson later that year), Elisabeth Magnusson has not dated the letter, addressed it “To Elma” (instead of “Dear Elma”) and has not signed it either.

125 According to the letter from I Magnusson to T Magnusson, 10/3-1907, GS, SKCA, volume F1:4.

126 E Magnusson to Krey, not dated, GS, SKCA, volume F1:4. Swedish original: ”En studieresa, men ej en emigration var hvad han tänkte sig när han lämnade Ivar medel till denna resa och därför hoppas han att Ivar måtte mer ha för ögonen att få en sysselsättning hvilken bibringar honom kunskaper, med hvilka han kan gagna sitt land (om än på anspråklösare plats) än en som ger stora inkomster för tillfället och löfte om framtidsplatser i Amerika”.

127 T Magnusson to I Magnusson, 10/12-1909, GS, SKCA, volume F1:4; *Svenska Teknologföreningen* I, 158.

128 I Magnusson to E Magnusson, 4/4-1907; I Magnusson to T Magnusson, 28/4-1907; 9/7-1907, GS, SKCA, volume F1:4.

129 I Magnusson to T Magnusson, 28/4-1907, GS, SKCA, volume F1:4.

130 I Magnusson to T Magnusson, 18/11-1907, 8/12-1907, GS, SKCA, volume F1:4.

131 A possible explanation is that someone in Sandviken’s management has sorted out the letters from this period from the archives. If they were filled with details from the technologically advanced iron works in Duquesne and some of these things were copied in Sandviken, it can be viewed as a form of industrial espionage which someone may have had reasons to cover.

132 For instance T Magnusson to I Magnusson, 20/12-1906, GS, SKCA, volume F1:4.

133 I Magnusson to T Magnusson, 13/5-1909, GS, SKCA, volume F1:4.

134 I Magnusson to T Magnusson, 29/6-1909, GS, SKCA, volume F1:4. Swedish original: ”Om jag kunde få någon plats där, anser Pappa, jag bör taga den hellre än att söka komma till Sverige eller Tyskland från Duquesne? Skulle en sådan plats ej vara en merit för Sandviken”?

135 I Magnusson to T Magnusson, 31/7-1909, GS, SKCA, volume F1:4. Swedish original: ”Republic skall emellertid göra stora nybyggnader – de nuvarande verken äro till stor del mycket omoderna – och därför kan jag lära mycket här. De ha ej så stora resurser som Steel Corporationen, utan måste se på kostnaderna en smula, hvilket gör att Republic närmar sig mycket ett verk af europeiskt utseende”.

136 I Magnusson to T Magnusson, 31/7-1909.

137 I Magnusson to T Magnusson, 24/9-1909, GS, SKCA, volume F1:4.

138 T Magnusson to W Sebardt, 26/7-1910, GS, SKCA, volume F1:4.

139 I Magnusson to T Magnusson, 20/7-1910, GS, SKCA, volume F1:4. Swedish original: Jag är villig att våga försöket att arbeta mig upp i Sandviken då många andra tillfällen att få komma hem till Sverige ej lära erbjuda sig.

140 ”Chefsingenjör Ivar Magnuson död” in *Sandvikens Tidning,* 12/8-1936.

141 K F Göransson to Sebardt, Sandviken, 27/7-1910, GS, SKCA, volume 13. Swedish original: Hans underbyggnad bör vara lämplig för denna plats, då han studerat både metallurgi (och därvid särskildt ståls förhållande vid värmebehandlingar) och mekanik d.v.s. tjänstgjort som ritare i Amerika.

142 K F Göransson to Sebardt, 27/7-1910; T Magnusson to Sebardt, 26/7-1910.

143 T Magnusson to Sebardt, 26/7-1910.

144 L Yngström 1937b, 163-165; I Magnusson 1933.

145 ”Något om arbetsförhållandena vid Sandviken” in *Arbetarbladet,* 2/8-1922.

146 M Wyman 1993, 87-88.

147 I Magnusson to T Magnusson.

148 ”Chefsingenjör Ivar Magnuson död”.

149 B Eiserman, 216-217.

150 ”Något om arbetsförhållandena vid Sandviken”. Swedish original: ”Den nämnda avdelningschefen synes i stort njuta av att hans arbetare lider, då han behagar nonchalera alla deras framställningar samt håller sig för det mästa borta, så han ej kunna anträffas, utan hans underordnade få vara de som skola taga första törnen, och dessa ha ingen rätt att på något sätt lämna besked, utan det heter alltid: vi kunna ej göra något, vi se att det är svårt, men vi få ingenting göra, vi ska tala med chefen”.

151 I Magnusson 1933, 13-14.

152 Ivar Magnusson, ”Utredning angående om- och tillbyggnad af Sandvikens Jernverks Aktiebolags tråddrageri- och kallvalsverksafdelning”, SA, SKCA, F 3:18; Yngström 1937b, 154; Lars Yngström, ”Ivar Magnusson Född 1/8-1880 – Död 12/8-1936” in *Dödsrunor: Sancte Örjens Gille* (Stockholm,1937), 99-101.

153 I Magnusson 1933, 13-14.

154 L Yngström 1937a, 100.

155 *Ett svenskt jernverk,* 382.

156 L Yngström, 1937a, 101. Swedish original: ”Inom kallvalsningstekniken och härdningen av stål gäller det att behärska en hel del detaljer och finesser och komma med fyndiga uppslag och konstruktioner. Vid utformandet av en del stora kallvalsverk som byggdes av Krupp nedlade Ivar Magnusson mycket betydande förtjänster och utan hans insatser hade de nog ej blivit så fulländade som de äro”.

157 L Yngström 1937b, 119.

158 “Torsten Wahlberg”, *Sandvikens Tidning,* 20/4-1943.

159 Axel Wahlberg, “Några anteckningar om träkolstackjärns beredning i Nordamerika år 1892” in *Jernkontorets Annaler,* 1893, 243-272; A Wahlberg to H Göransson, 12/5-1892, 18/5-1892, SA, SKCA, volume E1a:16.

160 *Svenska Teknologföreningen* II, 884.

161 Statement by Gerard De Geer, referred in *Jernkontorets Annaler* 1923, in addition to von Friesen’s article, 252. Swedish original: “När det gäller att i större utsträckning gå in för elektrostål inom Sveriges järnhandtering, kunna vi i stor utsträckning bygga på erfarenheter från Amerika. Vi böra ösa ur den stora källa till erfarenhet, som amerikanarna samlat på området. Jag syftar härvid på deras erfarenhet i fråga om konstruktioner och konstruktiva detaljer. På detta område hava amerikanarna nedlagt ofantliga kostnader och även lyckats utarbeta ugnstyper, vilka i drifthänseende knappast lämna något övrigt att önska. Vi ha icke råd att experimentera med nya ugnstyper, vilket ännu pågår i ganska stor utsträckning. Vårt arbetsfält, vår plats för nya initiativ ligger i att utnyttja ugnarna på det metallurgiska området. Där har svenska järnhandteringen stora förutsättningar att komma längre, betydligt längre, än amerikanarna ha nått”.

162 T J Misa, 251.

163 Lennart von Friesen, “Den moderna amerikanska elektrostålindustrin. Några erfarenheter från en studieresa i Nordamerikas Förenta Stater år 1922” in *Jernkontorets Annaler* 1923, 215.

164 “Torsten Wahlberg”.

165 L Yngström 1937b, 140-142; L von Friesen, 217, 233.

166 L Yngström 1937b, 140-142, L von Friesen, 217, 233. W T Hogan II, 416, T J Misa, 247-251.

167 L Yngström 1937b, 137-142.

168 G Carlestam, 143-145, 153-158.

6. MINING INDUSTRY: Bolidens Gruv AB

> It was fairly interesting with the daily comradeship with the American workers. One learned to understand and respect their points of views on many different conditions. – And I got a solid opinion about the necessity of limiting the working-hours to 8 hours per day.[1]

So it was that mining engineer Oscar Falkman wrote about his experiences during his time as greaser at the Carrie Furnaces[2] around 1905. The working day was hot, hard and lasted twelve hours; as such, it could wear a worker down.[3] Falkman's experience led him to agree with a demand from the Swedish labour movement. This awareness perhaps made him an advocator of a conciliatory spirit between employers and workers in similar ways to what has been stated for his contemporary colleague Karl Fredrik Göransson in Sandviken. But there were other influences brought back from the United States to Swedish mining. As we discussed in chapter two, mining engineers were less prone to emigrate than engineers from all sectors except civil engineers and constructional engineers. Compared to emigrating engineers from other educational sectors, the mining engineers did not distinguish themselves in a particularly way when it came to choose the United States as their destination. The likelihood of them going to the United States was more or less average for the entire cohort. The destinations were often located in upper Michigan, Minnesota, but also in the western mining districts such as Montana and Arizona. Did stays and study visits to these and other places influence a mining company established in northern Sweden in the 1920s?

6.1. The history of mining in Sweden before World War I[4]

Bog iron was the major raw material for the iron trade in the middle ages. Mining became of real importance for the production of copper and osmund iron from the thirteenth century and for silver production from the sixteenth. Mining was one of the most important bases for the growth of the country and its expansion, for instance during the great power era in the seventeenth century. At these times, the mines were mainly located in the central Swedish district of Bergslagen but there was also a growing mining trade in the northernmost part of the country but the large scale exploiting of the minefields in Lapland did not begin until the decades before 1900.

Mining before the mid-nineteenth century required large finanical investments, especially in pumps and work organisation. Up to the early twentieth century technical improvements were made. Gunpowder was introduced as a complement to the older methods of manufacturing and during the eighteenth century it replaced them. Dynamite in turn replaced gunpowder in the 1870s. However, the technical proficiency and the level of mechanisation in the Swedish mining industry were still low in the years around 1900. Drilling, loading and haulage were still largely done by hand or with help of draught animals.

The mechanisation of Swedish mining went on all through the twentieth century, leading to higher productivity as well as changes in work organisation and transportion. Machine drilling and electrification contributed to this growth and Sweden was able to export iron ore particularly to Germany before World War I. In the early 1910s, iron ore made up about 10% of the total Swedish export.

Iron ore was viewed as the only major ore-resource Sweden had. Copper mining in Falun ended in 1893, but the silver mining in Sala kept going on until 1908. In Falun, the old mine was used for extracting lead, pyrite and zinc. Zinc was also won from the mine in Åmmeberg. Production there was considerable, but in the hands of a Belgian company. The lack of metals became acute because of the import restrictions during World War I. It was an incentive to start looking for ore in the area around the town of Skellefteå in the province of Västerbotten. This activity marked the earliest roots of what was to become the Boliden mining company.

6.2. The history of Bolidens Gruv AB [5]

Around 1920, the Skellefteå area had a local tradition of small-scale mining. As a result of the World War I lack of metals, a company called *Centralgruppens Emissions AB* [6] began looking for copper ore north west of Skellefteå in 1918. In the autumn of 1924 a rich ore deposit was discovered. The deposit included copper, arsenic, gold and silver. Oscar Falkman, who we mentioned earlier, was managing director of Centralgruppen and he immediately began the build-up of a new mining company whose first task was to investigate the deposit and determine how big it was and how long it could be expected to last. Falkman and his colleagues found that the deposit was large and, because of its richness, it was possible to start selling it immediately. The company began to build a model community with an office close to the mine and housing for the management, clerks and workers. It was a risky project and it was important that it succeeded in order to attract the necessary experts.

Two separate mining companies were founded, *Skellefteå Gruv AB* and *Västerbottens Gruv AB*. In 1931, the two companies merged and got the name *Bolidens Gruv AB* (The Boliden Mining Ltd).[7] The reason for this division was a will to separate ores geographically. The mine in what was to become the village of Boliden began working in 1926 and in 1928 the company began building a smelting plant of their own at the island of Rönnskär outside of Skellefteå that produced its first copper ore in 1930. The reason for the building at Rönnskär was that the ore from Boliden had an unusual composition and when smelting tests in Germany failed, the company was forced to develop its own methods.[8]

Through the twentieth century the Boliden Company was the dominant industry in northern Västerbotten. The village of Boliden is still a centre for mining in the region although the original mine was closed down in 1967. After the war the company developed into one with diversified activity and with subsidiaries all over Sweden and abroad. In 1987, it was bought by the Swedish industrial group *Trelleborg* and was a subsidiary within that group until 1996, when the group decided to sell the assets of Boliden. A new company was formed and due to many activities in North America, the headquarters of Boliden Ltd. were in Toronto. In 2001, however, the company was repatriated to Sweden and the headquarters were located to Stockholm.[9]

6.3. Previous research on the Boliden Company

The early history of the Boliden Company has been the subject of several writings. The works of historian of technology and superintendent of the Technical Museum in Stockholm, Torsten Althin and Stig Ek, probably a former Boliden engineer, basically offer written presentations of the company in their books, which were published by the company itself.[10] These books were useful to identify persons and processes but need to be studied some cautiously as they were mostly used to celebrate the company. Oscar Falkman's own account about the start of the company was also a sort of company history, but more detailed.[11] It is easy to agree with Jan Glete, who has used another of Falkman's manuscripts, when he stated that it was an advantage that it was written by the person most close to the processes taking place in Boliden, but a disadvantage because it was written from his own perspective. Falkman tended to estimate his own role highly and probably exaggerated it.[12] The same goes for his paper *I industriens tjänst* (In industry's duty) quoted in the beginning. The sentence with which Falkman ended his account about his work at Boliden provides a good example. Falkman wrote that he remained the person who built up the company until retirement age in 1943.[13] Furthermore, both Falkman's writings were done long time after his activity in the Skellefteå area and even longer time after his stay abroad.

Glete's own work focused on the relations between the main owner Ivar Kreuger and the Boliden Company in the 1930s. Glete studied how Kreuger's aims to establish an international contact net came to influence the growth of the Boliden Company. His main conclusion was that Kreuger saw the company as an investment object. The ore deposits were to be exploited as fast as possible so that the company could bring immediate profits to the Kreuger group. The management under Falkman saw the Boliden Company as one that was to bring long-term gains. The management intended to develop all the possibilities, make technical improvements, accumulate know-how and employ skilled engineers, foremen and workers. Kreuger's short-sightedness made that development difficult and Falkman, therefore, began looking for other owners who were more interested in the company's long-term development.[14]

Gunnar Lundkvist's study of the Boliden Company from 1980 emphasised the reverse pattern of development in the Skellefteå area when compared to the rest of Sweden in the early 1930s. The country witnessed an economical crisis, but the development in the Skellefteå area went in the other direction. The reason was the exploitation of the ore deposits found in Boliden. It developed Skellefteå into an industrial centre in the upper north of Sweden. The exploitation of the Boliden ore meant that investments were made in infrastructure and the establishment of large-scale mining in the region created a demand for labour. Thereby, the population of the Skellefteå area increased in the early 1930s. [15]

The economic historians Torbjörn Danell and Sven Gaunitz and the librarian Ulf Lundström made a study dealing with the company in 2002. Their book did not deal with the Boliden Company exclusively but with industrial development in the area in the nineteenth and twentieth century and the factors that promoted entrepreneurial activity. One major conclusion about the establishment of the Boliden Company was that the company facilitated in-migration to the region as it could offer comparably high wages and fairly good social conditions. Another conclusion was that the establishment created industrial knowledge in the region with few historical counterparts. It was important for the development of the engineering industry around Skellefteå. The Boliden Company introduced workshops and building departments that were larger and more technically advanced than the ones that were located at the area's sawmills. Furthermore, some of the smaller mechanical workshops developed as subcontractors for the large mining company.[16]

The foreign, and particularly American, impulses have been mentioned by previous writers of the company's history, but only peripherally and without any deep attention paid to the importance of them were for the development of the company and the region. With a few exceptions it has not been emphasised that some of the leading engineers had been residing in the United States for several years. [17]

6.4. The managing director: Oscar Falkman (1877–1961)

Thus the Boliden Company had its forerunners in three companies, Centralgruppen and the two mining companies merging in 1931. From 1915 and until 1943 Boliden and its forerunners had only one managing director – Oscar Falkman. He was the son of a colonel and graduated as a mining engineer from KTH in 1900. After graduation, Falkman worked at the iron works in Söderfors and Ludvika.[18] Already during his time as student at KTH, he had made plans to work a few years in Sweden and then to make study trips to iron works in Europe and the United States. During his study trip in 1903 he spent most of his time in Upper Silesia *(Oberschlesien)* where a lot of iron works were concentrated. He revealed that the blast furnaces in Upper Silesia were run with coke, whereas those in Steiermark were run with charcoal and comparable to many iron works in Sweden.[19]

Falkman returned to his employment in Ludvika, but thought that his foreign studies were unfinished. In 1904, he went through France and Britain to the United States and disembarked at the Swedish Engineers Society in Brooklyn. This was often the first stop after arrival for Swedish engineers who aimed to go westwards in the United States in the search for employment. Before he came to Pittsburgh he made a visit to the Lyon Mountain iron works close to Albany in upstate New York and made a journey to the World Exhibition in St. Louis. At the exhibition he could view the development in the American industry as well as get good advice and new knowledge.[20]

Falkman obtained employment as worker in the blast furnace and in the repair department and later as greaser in the machine department. It was during this employment Falkman became an advocat of the eight-hour working day. This was something that was not practiced either in the United States or in Sweden at the time.

During his time as a chemist in Duquesne, Falkman felt insulted because the chief chemist called his competence into question and thought he was unable to undertake analyses according to the standards used. In Duquesne, the management learned that Falkman was looking around the steel works in his free time and, therefore, he had to leave earlier than he had intended.[21] Falkman was thus caught for a kind of industrial espionage although it was not possible to connect his studies to the systematic activity that was common practise at ASEA. Falkman's free time activities in Duquesne were probably more aimed at acquiring knowledge valuable for his own career and not directed by a company.

After his employment in the Pittsburgh district Falkman visited the Lackawanna Steel Company in Buffalo. He failed to get work but was permitted to see the modern works. Falkman carried on to the charcoal districts in Michigan and saw some charcoal foundries that were interesting to him. Before he went to Japan via California and Hawaii, he made some more study visits in the United States and Canada. At the iron works in Vakamatsu, close to Nagasaki, Falkman noted that it was similar to works in Germany and there was also a German engineer employed. Before he returned to Sweden, Falkman also visited India. He stated himself that he did not see any iron works and that there were probably not any worth seeing either.[22]

It was thus an experienced engineer that took the initiative to start looking for ore in northern Västerbotten. Apart from the experiences revealed above, Falkman had visited several countries and stated that he had been in all states in the United States except Georgia, Florida and Texas.[23] His foreign experience, however, originated from a time ten years or longer before Centralgruppen began searching for ore. Therefore, there are reasons to be careful about the interpretations of the importance of Falkman's foreign experience for the starting up of this activity.

6.5. The search for ore in Västerbotten

Falkman was an optimistic engineer who, according to Althin, believed in northern Sweden's possibilities and was able to improve technical and social conditions. The establishment of the Boliden Company meant that Swedish mining once again had conquered the wasteland.[24] Falkman was the only one who had been in the United States among the three men mentioned by Karl Fahlgren as important for the development of mining in Västerbotten. The two others, Eric Wesslau and Axel Lindblad, lacked foreign experience.[25] American impulses were seemingly not so important at least in a quantitative sense, when the search for ore began in Västerbotten. It was necessary to find an instrument, which could identify the source of the ore. A method to search for ore in an electrical way had been developed by the Swedish engineers Harry Nathorst and Hans Lundberg. None of them had any experience of working and/or studying abroad. The invention probably had its origins in Sweden. Falkman stated that the principle had been called into question abroad, but that there was no practical experience of it.[26] Lundberg led the prospecting for Centralgruppen and found blocks of copper ore close to the village of Kristineberg in 1918. It was a technical success spurring Centralgruppen to continue the search in the Skellefteå area, but as the economic results of it were scanty, it was also an incentive to improve the method further. Axel Lindblad improved the sensitivity of the method by introducing a stronger lamp.[27]

Lindblad was also involved in the development of the next step in the search for ore in Västerbotten using a new method believed as superior in comparison to the older ones. It was the only method used by Centralgruppen from 1923.[28] Mining engineer Karl Sundberg who had worked in Norway and Finland for some years, suggested the method.[29] A third man taking part in the development of it was the Belgian born radio technician Mauritz Vos. He studied at the university in the Austrian City of Graz between 1908 and 1911 as well as in Marburg in Germany between 1911 and 1914. Before he came to Sweden in 1919 he had five years of experiences working as the head of the laboratory at the society for wireless telegraphy in Berlin. Vos worked with Telefunken's system, and this must have been an important experience in the developing the electrical search method.[30] It is probable that Vos' primarily German experiences contributed to the success in finding the deposit which in the long run led to the formation of the Boliden Company. The basic "sources" of ideas seem to have been more domestic or European than American.

6.6. The mine in Boliden

The Boliden mine began producing ore in March 1926.[31] The director of the mine, Eric Wesslau was a mining engineer from KTH 1912 who was employed by Centralgruppen in 1919. Wesslau was a son of a merchant in Stockholm and had never been abroad.[32] There were American experts present in the Boliden mine from the beginning. In the jocular personnel paper *Guldkalven* (The Golden Calf) from 1932; one page included a "Klondike ABC", in which it was stated that the American expertise had left Boliden [X-pertisen ifrån USA, slutat har i gruvan lusa].[33] They had probably returned to the United States as the paper was issued six years after the mine opened. According to this statement, the Americans probably did not contribute much, but in this case there needs to be careful consideration about the validity of the source.

The mines of Grängesberg in central Sweden were described as an "America in miniature".[34] When it came to engineers who had returned, Boliden and the other mining communities in northern Västerbotten seem not to have been the same. Wesslau had not been abroad, whereas the chief mining engineer in Boliden Nils Rosén had several years of foreign experience although not from the United States but from Germany and Norway.[35] The chief engineers at the mines in Adak and Kristineberg came directly to their positions from the mining school in Falun.[36] The same held true for several of the mining engineers working as mine surveyors in Boliden, Adak, Kristineberg and Laver. American experience was largely absent, except for the expertise and perhaps in the planning of the Boliden community.

6.7. The Boliden mining community and the company's welfarism

Tage William-Olsson and the "garden city"

The first buildings for workers and civil servants as well as offices and a hotel were set up during 1926. It was necessary to arrange housing in for more or less everyone who was to work in the mine and at the office. The company took responsibility for the planning of the community and the Stockholm architect Tage William-Olsson was engaged to make a suggestion for a town plan. [37]

He was born in London in 1888 and the son of Swedish wholesale dealer William Olsson. He studied at the technical upper secondary school in Örebro between 1903 and 1906 and had a lot of experiences from working and studying abroad. In Britain, he studied one year at the University of Sheffield (1906–1907), worked one year for William Beardmore & Co. in Glasgow (1910–1911) and three years for The Direct Reduction Co. in London (1913–1916). William-Olsson also spent a year at Maryland Steel Co. and made study trips in the United States and Britain as well as in Austria.[38] It was a fairly long time before the Boliden Company engaged him. William-Olsson worked for a Stockholm patent company until 1924, and was then employed by the Professor of architecture at KTH, Erik Lallerstedt.[39]

William-Olsson suggested a town plan for Boliden that was fan-shaped and consisted of radial streets as well as streets in half circles. The school was placed in the centre of the circle and the house of the managing director was placed on a height together with the company hotel. Water supply, drainage and electrical leads were placed beneath the streets, which were lighted more than usual. Water was taken from a source on a height nearby, but later completed with a pump arrangement and a sewage treatment works.[40]

In the late nineteenth century, the Austrian architect Camillo Sitte (1843–1903) worked in order to make a break with the dullness and the mechanic ideas that characterised contemporary town planning. It was not the street system that was to be the base in the forming of a town. Instead, the streets and the market squares were to be treated as trunks, which were to be surrounded by the walls of the houses. Bends, street angles and irregularities in the street system were to be artistically planned. Main traffic routes were to be placed outside residential areas in order to make possible the narrowing of the street system. Sitte aimed to re-introduce a medieval type of narrow picturesquely crooked street.[41]

According to architect Göran Åberg, Sitte's ideas were often applied in Sweden before 1930 and were of immensely important for the town plan in Boliden. Åberg stated that William-Olsson incorporated Sitte's theories about town planning after artistic models wanted to demarcate the community in different parts. A person should have the possibility to experience each part independently from the other ones.[42] William-Olsson had been on study trips in Austria, some time between 1909 and 1913. Sitte passed away in 1903, but his ideas became influential.[43] William-Olsson's period studying in Austria was probably important in this context.

The Boliden mining community was also described as the ideal of a garden city realised in the middle of the forest.[44] Garden cities were becoming more or more common in the United States in the late 1910s.[45] However, William-Olsson had also spent several years in England and Scotland and the ideal of a garden city was established by London born Ebenezer Howard (1850–1928). One idea behind the garden city was to create more tolerable living conditions for the workers when cities became crowded due to in-migration as a consequence of industrialisation. It was thus a socio-political thought behind the creation of the garden cities, but also a parallel ambition to create "green" communities in suburban areas for an increasingly richer middle and upper class. This was common in the United States as well as in Australia.[46]

In Boliden, it was clearly the housing conditions for the workers that were the focus. The building of houses for the workers was a central theme in mining companies' recruitment of a labour force. It was part of a paternalistic ideal combining social care with effective production and control.[47] The Boliden Company had two alternatives: look only to profits and let a Klondike society arose around the mine; or create a model society in a similar way as the Luossavaara-Kirunavaara mining company had chosen to do around the iron ore mines in Kiruna twenty years earlier. The company choose the latter according to historian Björn Horgby because they realised that it would be profitable in the long run.[48] Falkman was to some extent a representative of an older, more conservative view of company management practices because his family had roots to the iron works in central Sweden. Glete stated that it is widely superficial to view the conflict between Falkman and Kreuger as a conflict between the tradition and the modern capitalism. However, Falkman's far-sighted perspective included an argument that the company should provide a safe employment and give something back to the region where it worked. This was in sharp contrast to the short sightedness of the Kreuger group.[49] A way to fulfil this paternalistic ideal was to engage the young, but nevertheless experienced architect William-Olsson to create a model community in Boliden. Good housing, gardens, etc. were designed to make the workers feel good. This can be connected to Falkman's early experiences as a worker in Carnegie Steel's plants in the Pittsburgh area when he became an advocat of the eight-hour working day. Falkman wanted to develop the Boliden Company into a large-scale company based on the sulphide ores of Västerbotten.[50] In order to do that it was important to give the workers good conditions and not to wear them out. The model community in Boliden was one step forward for good working relations and high productivity.

The Boliden Company's welfarism

The Boliden mining community was a part of company welfarism with many similarities to the one in Sandviken, discussed in an earlier chapter. There were of course other parts of this as well, even if the records do not mention anything about the length of the working days. Health care, safety devices, sanitary equipment, a mine solarium as well as schools for the workers' children and churches were mentioned in a lecture held by Falkman's predecessor Eric Bengtson, probably in 1943.[51] Historian Jonny Hjelm stated that the management's willingness to send engineers and foremen on education trips, implement works councils and implement suggestion systems were examples of the will to create a spirit of cooperation at the Rönnskär plant in the 1930s and 1940s.[52] There are reasons to underline that this desire was not typical for the Boliden Company, but something characterising many companies in Sweden at the time. This is true even if Bengtson wanted to emphasise the importance of the fact that the Boliden Company did not have "old ground to build on".[53] The Boliden Company was a newly formed company taking influences when it came to personnel policy. It is to be interpreted in a similar manner as Sandvikens Järnverk, a company where the Boliden management followed developments closely. Both these companies belonged to a group of companies whose managements realised the impossibility of controlling the labour force by autocratic methods and Taylorist principles alone. This group of companies was also the most influential when it came to the Swedish Employer's Confederation's (SAF) attitude towards cooperation. Some of the names in this group are interesting: Oscar Falkman, Karl Fredrik Göransson and Hugo Hammar. Sigfrid Edström is seldom mentioned in this context, but he also participated in the negotiations in Saltsjöbaden in 1938, which are to be interpreted as a part of this conciliatory spirit.[54] Later the Boliden Company's assistant managing director Sven Schwartz was elected to SAF's board.[55] As for Edström, Falkman, Göransson and Hammar, Schwartz had worked in the United States.[56] Employment in the United States seem almost always to be a part of the experiences for those participating on the employers' side of this equation, even if it is easy to agree with Martin Alm's conclusion that both similarities and differences between Sweden and the United States are relevant. It was not a question of transferring everything American over to Sweden, but a case of blending American techniques with Swedish industrial culture. From the employers' view, industrial democracy in the United States had gone too far and there was a fear that the unions would take power over American industry and thereby influence Swedish ones. Alm argued that the American Federation of Labour's more moderate attitude in the 1920s meant a turning point in the Swedish employers' views about American unions and that these unions now were seen as models for Sweden. The employers still viewed the formal Swedish collective agreements as the best forms of relations. The Americans had the attitude, the Swedes the organisation, and a combination was seen as ideal.[57] This spirit probably permeated the core of Swedish industry around 1940 but had some of its origins earlier in the construction of model communities such as the Boliden village. The community of Skelleftehamn which expanded because of the establishment of the smelting plant at Rönnskär was built in the same spirit as Boliden, and possibly also incorporated with foreign models.[58] But when it came to the smelting plant it is possible to talk about American models, in a more "purely" technical sense.

6.8. The smelting plant at Rönnskär

> The smelting plant at Rönnskär is probably without counterpart in the whole of Europe. It is only America and Japan that were able to put up equally extensive and modern arrangements besides the Rönnskär plant. [59]

Several journal articles from the early 1930s were very impressed with the new smelting plant at Rönnskär. One example is the 1932 issue of the journal *Norrland i ord och bild* (Northern Sweden in words and pictures). Torsten Althin wrote that Rönnskär was a superior arrangement set up in a short time and a forerunner to the real large-scale production.[60]

In the discussions about where the smelting plant was to be located there were few alternatives suggested. Lundkvist emphasised two major reasons behind the choice of Rönnskär. The island belonged to Skellefteå town, whereas the alternative places belonged to the rural parish. This meant that the local tax was lower if the Boliden Company decided for Rönnskär. The other major reason was environmental and we will soon return to that discussion. In the end of the 1920s the smelting plant at Rönnskär was finished and around midsummer 1930, the first tapping of copper was made. In the early 1930s, the plant was gradually expanded to include an electrolyte plant and a precious metal plant.[61]

The chief engineer when the smelting plant was started was Paul Palén. He had seven years experience of work in copper mining in the United States between 1905-1912. Palén worked one year as draftsman at De Lamar Copper Refining Co. in Chrome, New Jersey, a short period at the Elkhorn Silver Mining Co. in Montana, about a year at the Washoe Smelter in Anaconda in the same state, and five years as chemist and assistant smelting superintendent at Old Dominion Copper Mining & Smelting Co. in Globe, Arizona. Before he returned, he also worked shortly in Norway.[62] Palén's stay in the United States occurred several years before he came to the company.

Palén was far from the only engineer at Rönnskär who had worked in the United States. Unfortunately, published as well as unpublished records of the Boliden Company do not allow the same kind of systematic investigation as was done for ASEA and the iron works in Sandviken. This also makes a quantitative comparison between American and German experiences very difficult. There were engineers who had been elsewhere as well as engineers who were not abroad at all.

However, the leading engineers in the pioneer stage at Rönnskär seem to have had American experience. Palén was one and the article in *Norrland i ord och bild* stated for instance that his closest associate Torgny Torell also had many years of experience in copper smelting in the United States.[63] The records of Torell are unfortunately sparse, but according to the Ellis Island records he was in New York between 1907 and 1911 and arrived again at Ellis Island in January 1920 when he was "in transit to Canada".[64] In 1930, Torell moved from Västerås to Skellefteå.[65] It was not stated how long he was in North America.

Another engineer who had been in the United States (and in Germany) was the workshop engineer Eugén Herman Rosén. Between 1921 and 1923, he worked at a steel works in Dortmund and between 1924 and 1926 Rosén was in the United States. He first went to U S Gypsum Co. in Fort Dogde, Iowa and later to Wolverine Iron works in Detroit.[66]

Workshop practises from the United States were seemingly important as one of the few engineers with experiences from the United States in the Boliden village, Erik Oskar Wilhelm Clason, also was a workshop engineer. He stayed only for a short time.[67]

Paul Adrian Lundman was the works engineer and head of the laboratory at copper plant's by-product works from 1934 and onwards. He worked both in Norway and Germany before he went to the United States in 1923. He stayed five years and worked as a chemist at Illinois Steel Corporation's plant in East Chicago, at that company's cement plant in Buffington, Indiana, and as assistant chief chemist at U S S Lead Refinery Inc. in Graselli, Indiana.[68] Lundman probably had a reputation of being "Americanised" as *Guldkalven* pictured him singing "The Star-Spangled Banner" holding an American flag in one hand.[69] If this picture was accurate, Lundman probably also brought practises from the country he so much admired but it is difficult to ascertain. The clearest indications of these influences are connected to Palén.

American influences at the Rönnskär plant

Palén had several years of experiences from the United States. Old Dominion Copper Mining & Smelting Co. in Globe, Arizona, where Palén had five years of working experience, partly as assistant smelting superintendent, was the world's largest copper plant in the years around 1910. In Palén's obituary from 1945, his colleague Sture Mörtsell stated that it was natural to engage Palén in the planning of the metallurgical treatment of the Boliden ore. [70]

There was a link between the size of the copper refining plant in Arizona and the one at Rönnskär. The head of construction at the smelting plant in Rönnskär was Helmer Törnqvist who had not been in the United States himself[71] but oversaw the construction work in cooperation with American as well as German experts.[72] In January 1933, the newspaper *Svenska Dagbladet* stated that the Rönnskär smelting plant was extraordinary proof of the capability of Swedish engineering and that the enormous conglomerate of buildings gave the writer the impression of a "Ruhr in small scale".[73] In April 1928, the newspaper *Nya Dagligt Allehanda* wrote about the plans of a smelting plant at Rönnskär. The plant was to be of such a kind that there was not anything alike it in Europe and that it was necessary to go to the United States to find a counterpart. As the Boliden ore was unique, however, the comparison could never be complete.[74] Even though a long time had passed, the conclusion that Old Dominion's copper smelting plant in Globe was closest to "the American counterpart" seems reasonable. It is important to remember that Palén also made study trips to the United States after he had returned to Sweden. His years there had given him a large net of contacts, which facilitated his study visits at later points of time. When the discussions about the refining of the Boliden ore began in the mid 1920s, Palén made a longer study trip to American copper smelting plants together with Falkman.[75] As the time interval between Palén's return and the starting up of the Rönnskär plant was comparably long, it is reasonable to assume that not all of his American ideas originated from the time he actually was residing in the United States. However, the extensive net of contacts he had managed to create during his years in the United States made it easier to go on study trips and "pick up" ideas at a later stage. Such ideas concerned, for exmaple the use of arsenic, even though they were applied selectively.

The use of arsenic

The ore deposit in Boliden contained so much arsenic that there was no counterpart in the entire world. The main reason behind the establishment of the smelting plant was that it was absolutely necessary for the company to refine the ore itself. It was only possible to export the ore that contained most gold without refining it, and it was impossible to refine the ore in order to get rid of the arsenic without loosing large quantities of gold at the same time. The main problem was how to smelt the ore without causing large damages because of the excessive quantities of arsenic. The arsenic problem was one of the main issues during Palén's and Falkman's study trips in the American copper districts in the 1920s and early 1930s while Axel Lindblad experimented with other methods than the American ones.[76]

Several methods were tested before the Boliden Company decided to follow the American main principle of rusting away the arsenic and the sulphur from the ore before smelting and to precipitate the arsenic acidity from the departing rust gases through successive refrigeration. The method used in the United States for refrigeration of the rust gases and collecting of the arsenic was however viewed as dissatisfactory for sanitary reasons. Therefore, the Boliden Company developed a method of their own, that involved refrigeration done in steel cooling chambers. The transporting of arsenic was completely automatic. But this was only the "industrial" part of the arsenic treatment. The precipitated material was to be treated in such a way that the health of human beings was protected. The American methods were not suitable for the Boliden Company in this respect either. The copper foundries in the United States had largely failed to avoid damage to the surrounding vegetation.[77] But in Anaconda there was perhaps a solution after all.

Europe's tallest smokestack

In the "Klondike ABC" from the 1932 issue of *Guldkalven,* there was also a rhyme about the tall smokestack at the Rönnskär plant. In the rhyme, it was stated that the smokestack brought the smoke towards Russia [Skorsten kallar vi det rör, som mot Ryssland röken för]. [78] In a lecture held by Captain Harald Gustafson at the technical association in Norrköping in the beginning of 1929, the smokestack was the subject. It was impossible to disarm the gases. Instead there was a need to direct them away from the immediate surroundings in order to protect the vegetation around the smelting plant. A high smokestack was needed so that the gases could be dispersed and thereby be as harmless as possible to the local people and environment. Therefore, the decision was to build a smokestack that was 145 metres high. When it was finished, it was Europe's tallest.[79]

During the years 1906–1907, Palén was employed as chemist and testing engineer at the Washoe Smelter of the Anaconda Mining Company. Bjork wrote that Anaconda was the copper Eldorado of the West, and a place that attracted many foreign mining engineers.[80] Already in 1902 ranchers and farmers in the Anaconda area filed complaints against the Anaconda Mining Company for destroying land, water, crops, and livestock. The company responded by constructing a new 300-foot-high smokestack 1.100 feet above the valley floor, which would pump poisons higher into the atmosphere, but it was not satisfactory for the ranchers and farmers. In 1905 they sued the mining company again and demanded economic compensation.[81] The company's response was to construct an ever newer and larger smokestack, which was to disperse the pollution caused by smelting. It seems to have been a long legal process as the new smokestack in Anaconda did not start working until May 1919. At that time, the smokestack was the largest in the world, 585 feet (178 metres).[82]

The conflict between the Anaconda farmers and ranchers versus the mining company was thus underway already when Palén was employed in the Washoe Smelter. It seems reasonable that Palén followed the discussions of how the company was to deal with the conflict already at that time, and that Palén with his collection of American contacts followed the development closely also after he left Anaconda. No records state that he was actually in Anaconda together with Falkman during their mid 1920s journey in the United States, but it was more or less a matter of course that the two Boliden engineers were there. Falkman stated that American and German experience showed that a 145-meter smokestack would bring environmental safety to the immediate surroundings of Rönnskär. There would have been a need of a height of 170 metres if the smelting plant had been placed directly at the mine in the Boliden village. One reason was that the island of Rönnskär was mainly surrounded by water and that the coast was lowland.[83] This was not the case in Anaconda, and therefore there were demands for a higher smokestack there. *Guldkalven* indicated that the engineer Ernst Boholm was working with the smokestack.[84] He alighted from the Swedish-America Line's steamer in Gothenburg late June 1930 and had his last American residence in Chicago where one of his children also was born.[85]

Whether the interest to protect the neighbourhood and instead "send the smoke towards Russia" grew out of a real environmental concern is doubtful. Falkman openly argued that another solution may have polluted the rivers with arsenic and that the company risked agitation with troubles following hand in hand.[86] It was probably more of a fear of conflicts than real environmental concern that guided the company's decision. Althin's explanation for the main reason why the Boliden Company choose Rönnskär as the place for the smelting plant also pointed in that direction:

> At the plant, large quantities of arsenic acidity were to be produced and regardless how careful one is, an accidental occurrence could lead a small quantity astray. If this then ran out in the ocean, it has no practical meaning whatsoever, but if the plant is located at another place, in the inland, and the same quantity had ended up in a watercourse and caused the death of some fishes, an outcry certainly would have occurred bringing a lot of difficulties.[87]

The economic consequences of such a conflict were naturally taken into consideration when the company made the choice of location as it was possible to build a somewhat shorter smokestack. The experiences from the United States, however, still led to the decision of building the tallest smokestack in Europe.

The flame furnaces

In *Teknisk Tidskrift* from April 1908, Paul Palén stated that the first flame furnaces were built after a pattern used at Swansea in Great Britain.[88] During the last decades of the nineteenth and early years of the twentieth century the development of the Swansea-type furnace went fast at the smelting plants in western United States and Palén obviously had difficulties to recognise the original furnace when he studied the one used in Anaconda.

He stated that the Anaconda furnace was the model for most of the flame furnaces produced for the smelting plants in the western part of the United States at the time and described it thoroughly.[89]

In January 1933, Falkman lectured about the Boliden Company and mentioned the three flame furnaces. He stated that, "they were the first, and are still the largest ones in Europe".[90] In Axel Lindblad's two articles about the Rönnskär smelting plant in *Teknisk Tidskrift* in 1930 and 1933, he also noted this fact and stated that the flame furnaces were the Boliden Company's own constructions but essentially made after models from American copper plants.[91] Thus Palén together with his colleagues brought American flame furnace practises to Sweden and also to the whole of Europe at least according to their own accounts.

The long interval between Palén's employment in Anaconda and his arrival at Rönnskär speaks to some extent against the interpretation that it was the Anaconda furnace that was transferred to Rönnskär. There were twenty years between the articles and the flame furnace development in the United States also went forward during this period. Palén studied the development during his study trips. The similarities between the Anaconda furnace described by Palén in 1908 and the ones at Rönnskär described by Lindblad and Falkman in the 1930s were that both of them were run by coal. The regulus was tapped through openings on one of the furnaces' long sides both in Anaconda and at Rönnskär, whereas the clinker products were tapped on the opposite side.[92] The descriptions of the flame furnaces were detailed and it is difficult to compare the processes. The interpretation is that the flame furnaces at Rönnskär possibly were developed from the Anaconda furnaces but that unique ideas were added and possibly also ideas from elsewhere. In the account of the Anaconda furnaces, Palén stated that there was no flame furnace at Old Dominion in Globe but that the company had decided to build one.[93] It is reasonable to assume that this happened while Palén was there and he probably picked up some ideas from there as well.

Other ideas

The arsenic problem and the smokestack were perhaps not the only environmental issues solved with American methods at Rönnskär. The mosquitoes used to like it on Rönnskär because the island had many thickets and small pools of water. The way to exterminate them was to pour crude oil over the pools and thereby prevent the mosquitoes from reproducing. This was a rational and American way according to the article in *Norrland i ord och bild* and the result was that the mosquitoes disappeared totally from the island. Palén talked about this method with the journalist and the article referred to his years in the United States.[94] There are reasons to apply some criticism of the sources in this case, as it may be a method the journalist interpreted as rational and American, even though it perhaps did not originate from the United States.

The Boliden Company's need to arrange housing for workers in Skelleftehamn diminished when an agreement with the Swedish National Railway Company *(Statens Järnvägar)* about local trains from Skellefteå town via Skelleftehamn to the Rönnskär plant was made. The timetable was adjusted to the shifts in the plant and stations were established in the villages between the town and its harbour. The trains went all the way in to the plant and stopped by the dressing room. According to Falkman this practise was American.[95]

6.9. Concluding discussion

The search for copper ore in Västerbotten began as a reaction to the lack of metals in Sweden in about 1914. American influences were hardly important in this initial stage, even if the founder Oscar Falkman had worked at the Carnegie Steel Company's plants around Pittsburgh. The electrical methods were Swedish inventions, possibly improved with some ideas from continental Europe, particularly from Germany. When the mine opened in the newly founded village of Boliden in 1926 there were obviously some American experts present but none of the leading Swedish engineers had been working in the United States. It is difficult to ascertain how much influence the American experts were able to exercise.

In the planning of the Boliden village, the Austrian architect Camillo Sitte's ideas about artistic town planning were evident and it is reasonable to assume that William-Olsson's studies in Austria contributed to it. There were possibly also American ideas present when the village was planned as a garden city, but it is more reasonable to believe that the influence came from Britain where the architect had spent a longer time and which also was the origin of the garden city movement. These cities often had socio-political aims and one was to make the housing conditions for workers more tolerable. In the background we can possibly find Falkman's experiences with harsh conditions for the workers in steel mills of the Pittsburgh district. From his perspective, it was important with satisfied workers for the company to prosper and develop and his belief in welfarism permeated his actions within the company and on a national arena. He belonged to a group of managing directors believing in these ideas.

The Boliden Company's America was definitely the smelting plant at Rönnskär and it was the only one of its kind in Europe according to some of the articles referred to. Paul Palén's eight years in the United States, mostly at copper mining companies in the West, made his name more or less self-evident when the company was to organise the smelting plant and he was far from the only engineer who had been in the United States who worked there. The large plant outside Skellefteå can be traced to Palén's experiences with the world's largest plant, Old Dominion in Globe, Arizona and so can the flame furnaces constructed from American models. The arsenic problems were solved by selectively applying American methods and the construction of Europe's tallest smokestack was based on experiences from the copper plant in Anaconda, Montana. The trains from Skellefteå did not stop before the workers could get into their dressing room, as at some places in the United States. Of course, some of these ideas were picked up during study trips. However, Palén's extensive contact net in the United States enabled him to make Rönnskär an "America in miniature". That conclusion is possibly more relevant than the comparative reference made to the German Ruhr district.

Notes

1 Oscar Falkman, ”I industriens tjänst”, Unpublished paper, not dated., FFA, MSA, 12. Swedish original: ”Det var ganska intressant med det dagliga kamratskapet med de amerikanska arbetarna. Man lärde sig förstå och respektera deras synpunkter på många olika förhållanden. – Och jag fick en grundmurad uppfattning om nödvändigheten av arbetstidens begränsning till 8 timmar pr dag”.

2 For more about the Carrie Furnaces, see the chapter about Sandvikens Järnverks AB.

3 O Falkman, n.d., 12; H Lindblad 1995, 205.

4 Based on *Nationalencyklopedin* 8, search word “gruvindustri”, (Höganäs, 1992), 112-113.

5 For more history on the Boliden Company, see for instance Torbjörn Danell, Sven Gaunitz & Ulf Lundström, *Industrialismens Skellefteå. Med intervjuer av Lars Westerlund* (Umeå, 2002), 262-276; Stig Ek, *Boliden 50* (Stockholm, 1975); Oscar Falkman, *Så började Boliden* (Stockholm, 1953); Jan Glete, *Kreugerkoncernen och Boliden.* (Stockholm, 1975).

6 From this point on called *Centralgruppen.*

7 From this point called “the Boliden Company”, whereas if only “Boliden” is used, it refers to the village.

8 S Ek, 16-24.

9 http://www.boliden.se/index.htm, available on Internet, 13/5-2003.

10 T Althin; S Ek.

11 O Falkman 1953.

12 J Glete 1975, 32.

13 O Falkman n.d., 77.

14 J Glete 1975, 117-121.

15 Gunnar Lundkvist, *Skelleftebygdens historia. Del 2. Den industriella utvecklingen 1900-1975. Basindustrin Boliden* (Skellefteå, 1980). On the Boliden Compay’s importance for the Skellefteå area, see especially 202-206.

16 T Danell, S Gaunitz & U Lundström, on the Boliden Company, see especially 275-276, 282-285.

17 T Danell, S Gaunitz & U Lundström, 186, mentioned that Falkman had been working at Carnegie Steel, but no more than that.

18 *Svenska Teknologföreningen* I, 520.

19 O Falkman n.d, 6-8.

20 O Falkman n.d, 9-10.

21 O Falkman n.d., 11-16.

22 O Falkman n.d., 16-19.

23 O Falkman n.d., 17 a.

24 T Althin, 4.

25 Karl Fahlgren, *Skellefteå stads historia 1845-1945* (Uppsala. 1945), 386; *Svenska Teknologföreningen* I and II, 456, 791.

26 O Falkman 1953, 6-7; *Svenska Teknologföreningen* II, 997, 1043.

27 O Falkman 1953, 8-9; *Svenska Teknologföreningen* I, 456; Oscar Falkman, ”Axel Rudolf Lindblad. Född 23/4-1874–Död 6/11-1944” in *Dödsrunor:Sancte Örjens Gille* (Stockholm, 1945), 391-399.

28 O Falkman 1953, 9.

29 *Svenska Teknologföreningen* II, 955.

30 *Svenska Teknologföreningen* II, 905.

31 T Danell, S Gaunitz & U Lundström, 266.

32 *Svenska Teknologföreningen* II, 791.

33 *Guldkalven* 1/1932, 6 OB, Foark.

34 T Gårdlund 1942, 241.

35 *Svenska Teknologföreningen* II, 1021.

36 *Bergsskolan i Falun,* 217.

37 O Falkman 1953, 23.

38 T Althin, 35; *Svenska Teknologföreningen* II, 878.

39 *Svenska Teknologföreningen* I and II, 287, 878.

40 O Falkman 1953, 23.

41 Göran Åberg, ”Boliden – Brukssamhälle och Trädgårdsstad”, Föreningen för Skellefteforskning, report no. 3/1988, 34; George R. Collins & Christiane Craseman Collins, *Camillo Sitte and the Birth of Modern City Planning* (London, 1965); http://www.aeiou.at/aeiou.encyclop.s/s606159.htm, available on Internet 24/5-2003.

42 G Åberg, 34-36.

43 G R Collins & C C Collins, 76-102.

44 http://museet.skelleftea.se/index97/index/bildv/start/historia/periferi/boliden.htm, available on Internet, 16/4-2003.

45 Lewis Mumford, ”The Garden City Idea and Modern Planning” in Ebenezer Howard, *Garden Cities of To-Morrow* (London, 1945), 39.

46 G Åberg, 33; Johan Rådberg, *Den Svenska trädgårdsstaden* (Stockholm, 1994), 51-53; http://www.letchworthgardencity.net/heritage/index-3.htm, available on Internet 16/4-2003.

47 Stefan Warg, *Familjen i gruvmiljö. Migration, giftermålsmönster och fertilitet i norrbottnisk gruv-industri 1890-1930* (Umeå, 2002), 60. This has to some extent been dealt with in the chapter about Sandvikens Järnverk.

48 Björn Horgby, *Med dynamit och argument. Gruvarbetarna och deras fackliga kamp under ett sekel* (Stockholm, 1997), 149-150.

49 J Glete 1975, 117-119.

50 J Glete 1975, 117.

51 Eric Bengtson, ”Bolidenföretaget och de sociala problemen”, Unpublished paper, 1943?, BCA, volume 111.

52 Jonny Hjelm, *Begåvningsreserven inom industrin. Förslagsverksamhet i Sverige under 1900-talet* (Lund, 1999), 101-111, 116-118, 241-242.

53 E Bengtson, 1.

54 *Saltsjöbadsavtalet 50 år,* 96, 115.

55 J Hjelm 1999, 239-244.

56 *Svenska Teknologföreningen* II, 953. Schwartz worked at Federal Mining & Smelting Co. in Baxter Springs, Kansas, between 1924 and 1925.

57 M Alm, 193-195.

58 G Lundkvist, 150.

59 ”Från malmhögen till koppartackan. Hur bolidsmalmen förädlas i smältverket på Rönnskär” in *Norrland i ord och bild,* 1932, 525. Swedish original: ”Smältverket på Rönnskär lär också sakna motstycke i hela Europa. Det är endast Amerika och Japan, som kunna ställa upp lika omfattande och moderna anläggningar vid sidan av Rönnskärs-verket”.

60 T Althin 1945, 53.

61 G Lundkvist, 53-55; K Fahlgren, 384.

62 *Svenska Teknologföreningen* I, 667

63 ”Från malmhögen till koppartackan”, 525.

64 http://www.ellisisland.org/search/shipManifest.asp?MID=06833889580064259584&FNM=TORGNY&LNM=TORELL&PLNM=TORELL&RF=3&pID=602925120044&lookup=602925120044&show=I%3A%5CT715%2D2721%5CT715%2D27210572%2ETIF&origFN=I%3A%5CT715%2D2721%5CT715%2D27210571%2ETIF, available on Internet 15/4-2003.

65 Swedish Census for 1930, Skellefteå stadsförsamling (Skellefteå town parish).

66 *Bergsskolan i Falun,* 192.

67 *Bergsskolan i Falun,* 213.

68 *Bergsskolan i Falun,* 182.

69 *Guldkalven* 1/1932, 35, OB, Foark.

70 Sture Mörtsell, "A. G. Paul Palén", Född 4/4-1881 – Död 23/10-1944" in Dödsrunor: *Sancte Örjens Gille* (Stockholm, 1945), 123.

71 *Svenska Teknologföreningen* I, 728.

72 O Falkman 1953, 28.

73 "Rönnskärs stora smältverk ett utomordentligt prov på svensk ingenjörskonst" in *Svenska Dagbladet,* 3/1-1933.

74 *Nya Dagligt Allehanda,* 19/4-1928.

75 O Falkman 1953, 27.

76 O Falkman 1953, 98-99.

77 O Falkman 1953, 35, 98-99.

78 *Guldkalven* 1/1932, 6, OB, Foark.

79 *Teknisk Tidskrift. Allmänna avdelningen,* 2/3-1929, 139.

80 K O Bjork, 245-246.

81 Laurie Mercier, *Anaconda. Labor, Community, and Culture in Montana's Smelter City,* online version http://www.press.uillinois.edu/epub/books/mercier/ch1.html#ref21, available on Internet, 24/4-2003.

82 http://www.golfjournal.org/features/97/jan_feb/works_restoration.html; http://www.mtstandard.com/inbus6/anaconda.html, both available on Internet, 24/4-2003.

83 O Falkman 1953, 30.

84 *Guldkalven,* 1/1932:40, OB, Foark.

85 "Emigranten 2001", CD-Rom (SEI), Foark; Church records, Skellefteå town parish, Foark.

86 O Falkman 1953, 30.

87 T Althin, 40. Swedish original: Vid verket skulle stora kvantiteter arseniksyrlighet komma att framställas och hur försiktig man än vore, skulle av en tillfällighet någon ringa mängd kunna komma på villovägar. Om denna rann ut i havet, har det ingen som helst praktisk betydelse, men om verket förlagts till annan plats inne i landet och samma mängd kommit ut i ett vattendrag och förorsakat några fiskars död, så hade säkert ett ramaskri höjts och en mängd besvärligheter kommit åstad.

88 Paul Palén, "Skärstenssmätning i flamugn" in *Teknisk Tidskrift. Kemi och bergsvetenskap,* 25/4-1908, 50. Palén incorrectly places Swansea in England. The correct geographical location should be Wales. Palén probably wrote England because it was commonly used as a term for the whole of Great Britain.

89 P Palén, "Skärstenssmältning", 50-51.

90 Oscar Falkman, "Föredrag om Boliden Jan. 1933", Unpublished paper, Bolidens Centralarkiv, Skelleftehamn, Sweden, volume 111, 10. Swedish original: De voro de första och äro ännu de största i Europa.

91 Axel Lindblad, "Kopparverket på Rönnskär" in *Teknisk Tidskrift. Bergsvetenskap,* 15/11-1930, 644; Axel Lindblad, "Smältverket på Rönnskär" in *Teknisk Tidskrift,* 20/4-1933, 182.

92 P Palén 1908, 51; A Lindblad 1933, 182.

93 P Palén 1908, 50.

94 "Från malmhögen till koppartacken", 524.

95 O Falkman 1953, 92.

7. ENGINEERING INDUSTRY: J. & C. G. Bolinders Mekaniska Verkstads AB

> In the year 1873, Bolinders totally lacked the tool machines that the American methods brought. There were neither turret lathes nor milling machines. Only a couple of decades later, these machines were not only common in the Bolinderian production apparatus – they were also important products in the company's assortment. [1]

This quotation, from an article written by superintendent Bo Sahlholm at the Museum of Science and Technology in Stockholm, illustrates precisely the development at Bolinders during the decades around 1900. The company on the Stockholm island of Kungsholmen was founded as a workshop, in the 1840s, following the then dominant British approaches. As with many other companies in this branch, Bolinders reoriented towards more American production methods around the turn of the century. This chapter will reveal the importance of American experiences in a leading Swedish workshop's shift from being inspired by Britain to being dependent upon the United States as the main source of ideas. As we shall see later, engineers with experience from working in the United States started to staff several of the engineering workshops in Sweden and thereby they became agents of this Americanism. Bolinders was one of them.

7.1. Engineering industry in Sweden

Before the mid-eighteenth century, iron works developed manufacturing workshops in connection to their iron making and the state owned factories manufacturing weapons. The first real engineering workshop was Bergsund, founded in Stockholm in 1769 by a Scottish immigrant. The second was also in Stockholm and founded in 1806 by the Englishman Samuel Owen.[2] Bergsund specialised in the production of consumer goods whereas Owen's main products were machinery for other industries. In the 1820s a third one was founded in Motala whose main purpose was the support of the construction of Göta Kanal and whose production was characterised by heavy products for transport and communication needs. Into the 1830s, these three workshops were alone on the Swedish market and it was not a favourable position as the demand of machines was low from other industries.[3] All three were dominated by British technology and employed technicians from England and Scotland.[4]

In the 1830s different workshops were founded in Eskilstuna, Nyköping, Gothenburg, Stockholm, Malmö and Norrköping. In the 1840s Motala was the largest one in Sweden. It had about three hundred workers employed and a turnover that was bigger than all other engineering workshops in the country combined.[5] The increasing demands both from industry and agriculture led to the opening of several workshops in the middle of the century. The production was often diversified.[6]

As mentioned in Chapter one, "Americanism" in forms of interchangeable parts and mechanisation first came to Sweden in the 1860s. The Swedish engineering became increasingly Americanised. In the late nineteenth and early twentieth century, Bolinders was one of the workshops in the forefront among the older diversified ones when it came to applying this new technology.[7]

Around the turn of the century, new and specialised workshops arose. Some of them were new establishments while others were old companies that had undergone radical changes. Several companies were founded on Swedish inventions and among those were ASEA. The electrical industry was to be viewed as a sub-group of the engineering industry in the same way as car, bicycle, aviation, defence and shipbuilding industry. The core areas in the Swedish engineering were however metal and machine industry and this is what this chapter about Bolinders discusses.[8]

It is also connected to the educational sectors at the institutes. ASEA mainly employed electrical engineers, but this more "traditional" engineering industry was primarily a labour market for mechanical engineers. As stated in Chapter three, the mechanical engineers were among the groups, apart from the naval architects, that were most likely to emigrate (45%). The return rate was a little above average (76%). With regard to their decision go to the United States, the mechanical engineers were about average. Bolinders was the company employing most returning engineers in this sector and it has, therefore, been selected as the subject for this case study.

7.2. The history of Bolinders Mekaniska Verkstads AB

During World War I, Bolinders had achieved a world reputation for the type of motor constructed in 1905 by the Swedish engineer Eric Rundlöf. The foundation was set already in 1845, when the two brothers Jean and Carl Gerhard Bolinder founded it at the shores of Klara Lake in Stockholm. In 1873, the company was re-organised into a joint-stock company. At this time, the production mainly consisted of castings, cooking-utensils, stoves and steam engines. In the 1890s, Bolinders started to manufacture machines for working wooden material, saw-frames and planning-machines. In 1894, the workshop started to manufacture stationary quadruple time kerosene motors constructed by the Swedish engineer John Weyland and the motors mentioned above began replaced them in 1905.

In 1907, the company bought a property in the Stockholm suburb of Kallhäll and founded a smith and foundry there. Gradually all production except for machines was moved from central Stockholm to Kallhäll. The recession in the early 1930s led Bolinders into a consolidation and the company merged with *Munktells Mekaniska Verkstads AB* (the Munktell Mechanical Workshop Ltd) in the central Swedish town of Eskilstuna in 1932. The manufacturing of machines moved to Eskilstuna and the Kallhäll workshops were taken over by a newly formed company called *Bolinders Fabriks AB* (The Bolinders Factory Ltd).

7.3. Previous research on Bolinders Mekaniska Verkstads AB

The main work about of the Bolinders workshop was authored in 1945 by Torsten Gårdlund to mark the hundredth anniversary of the founding. It has valuable parts about the British experiences important in the beginning of the workshop's existence as well as the Americanisation of the production around 1900. Gårdlund wrote a detailed history of the company, but it has some shortcomings. The book was a company history, paid for by the people whose forerunners was its subject matter. As with many such works, this book was designed to celebrate more than analyse Bolinders. This possibly made some of Gårdlund's statements exaggerated. Furthermore, Gårdlund's was very sparse when it came to identifying names of engineers at Bolinders especially after 1900. The fact that Gårdlund was an economist probably shines through as he was very keen on mentioning bankers, financiers, cashiers and so on. Members of the Bolinder family were mentioned as was August Westman and some of the leading persons on the technical side in the beginning. However, the long-time chief engineer Per Werner was not mentioned at all, let alone engineers in lower positions.[9] Unfortunately, no other source material has been found making a systematic approach in a similar way as was done in the chapters about ASEA and Sandvikens Järnverk possible. This study is somewhat different in character and more similar to the chapter about Boliden.

The British engineer Walter Pollock wrote a book in 1930 to celebrate his friend Erik August Bolinder and his company. Pollock was more systematic than Gårdlund and mentioned the different products of the company, which to a smaller extent was valuable for this study. As was Gårdlund, Pollock was reluctant to mention any names outside the top management. Even more than for Gårdlund, the character of this work as a celebration of the company needs to be taken into consideration.[10]

Bolinders was also the subject of some shorter articles in the 1982 yearbook of *Föreningen Stockholms Företagsminnen* (Center for Business History in Stockholm). The most interesting for this study was the one by Bo Sahlholm, quoted in the beginning of this chapter. Sahlberg mentioned that the machines connected with American methods were largely absent in 1873, but were a part of the workshop's assortment a couple of decades later. The other articles dealt with different topics; the archive itself, stoves, and workers' housing.[11]

There have been some writings on the Bolinder workshops, but this study is the first dealing exclusively with foreign and particularly American influences at the workshop.

7.4. A workshop founded in the British tradition

The founders Jean Bolinder and Carl Gerhard Bolinder were sons of an assistant vicar in the parish of Vaksala close to Uppsala and had spent around a year in Britain before the founding of the workshop. The two Bolinder brothers went to Britain together in 1842. Gårdlund revealed the brothers' stay in detail. They were well acquainted with British technology prior to receiving a grant from *Jernkontoret* (The Ironmasters' Association) to go to Britain to study workshop technology and organisation. Between 1829 and 1834

Jean Bolinder was a student of Gustaf Broling, the mining commissioner and, according to Gårdlund, the Swedish technician who had the deepest knowledge about the British industry at the time. Carl Gerhard Bolinder had practised at Owen's workshops and in Motala. In July 1842, the two brothers were on their way to Britain. They were two young and educated mechanics on their way to a country with industrial methods they had heard praised ever since their very first day as apprentices: Britain was then the most advanced country in terms of engineering industry and technology.[12]

Jean Bolinder claimed that he had much use of the experiences he gained while serving as a draftsman in Birmingham and the visits he made to study other industries later in his life. He also visited Manchester and was impressed by the Nasmyth workshop's patented steam hammer, which he claimed was one of the most impressive machines he saw during his time in Britain. In the area around Newcastle-upon-Tyne, he learned a lot about the iron industry and he also found that the methods used for manufacturing steel at the Jessop & Son cast steel works in Sheffield largely differed from the ones he had used himself in Stockholm. Jean Bolinder returned to Sweden in June 1843 and took on his old place at the Swedish Mint for a short period before he founded the workshop together with his brother.

Carl Gerhard Bolinder accompanied his brother to Birmingham and had a place at Joseph Bramah, Fox & Co, a firm mainly manufacturing railway cars. In Manchester, he got experiences in the production of textile machines and locomotives at Sharp, Roberts & Co. According to a letter to his brother, Carl Gerhard Bolinder was happy to be in the industrial capital of Manchester. Probably, he spurred his brother's curiosity to come to Manchester for a visit and the brothers went together to Nasmyth's. While there Carl Gerhard Bolinder made drawings of a plane and a machine for manoeuvring the ladle used in the iron industry. When his brother was returning to Sweden, Carl Gerhard Bolinder decided to remain in Manchester because he thought that he still had a lot to learn. However, in the autumn of 1843, he received money for his journey home and in November that year, the two brothers reunited in Stockholm.[13]

The founding and early decades of the workshop

Gårdlund considered that the idea of their own workshop probably did not occur when the brothers still were in Britain. It seems to have been Jean Bolinder who came up with it when he was back in Stockholm and it was most certainly one of the reasons behind his sending money to his brother in Manchester.[14] Clearly, the founders were inspired by British engineering industry to a large extent. It was natural to look to the other side of the North Sea in the mid-nineteenth century. British technicians served as masters in workshops all through Europe. It was also a country with which Sweden had had close trading relations for a long time.[15]

The early Swedish engineering industry received technical impulses from Britain and most chiefs at the larger mechanical workshops had been practising in British industry.[16] The Bolinder brothers were by no means exceptional, nor were they pioneers as several other Swedish technicians had gone to Britain before them.[17] Grants were often awarded to Swedish mining experts to go abroad to study matters of special interest for Swedish trade and manufacturing in the eighteenth century. Britain was not the only country of interest for them as Germany and Hungary were also sources of knowledge but it was rare that a Swedish mining expert going abroad missed the opportunity to visit Britain.[18] There are reasons to discuss whether it is appropriate to call the Bolinder brothers mining experts. Nevertheless, their business was closely connected to the iron trade and they were a part of an older tradition of study trips to Britain and contributors to a larger technical import from there. Their introduction of British ideas of efficient production methods and a good industrial organisation in the newly founded workshop in Stockholm was a process happening in almost all larger mechanical workshops in Sweden in the mid nineteenth century. Many of the managing directors of the Swedish workshops had experiences in Britain.[19]

As a consequence of their previous experience of British technology, the brothers organised the workshop's early production according to British standards. This system meant that the workers as far as possible made use of machines in order to manufacture individual products.[20] It was however not only a question of production methods transferred from Britain. In 1854, Bolinders started to manufacture the steam hammer the brothers had seen and were impressed by when they visited James Nasmyth in Manchester. It would, however, be an exaggeration to say that the steam hammer was one of Bolinders' main products as only six of them were manufactured before 1873. Gårdlund also discussed, unfortunately in a rather vague way and without any conclusions or even interpretations, the possibilities of influences from Britain in the manufacturing of sawmill-machines. Among the drawings Jean Bolinder sent to the National Board of Trade *(Kommerskollegium)* after his return from Britain, included a description of a circular saw located at Regent Canal in London and among the earliest drawings from Bolinders were some of similar saws. However, Gårdlund did not really state if the workshop actually did manufacture them. Instead, he went on to discuss if the brothers had also observed steam driven frame saws in Britain and reached the interpretation that the answer of the question probably was no. Gårdlund doubted the very existence of them in Britain in the early 1840s and even if they were there, he doubted that the brothers observed them, as there was nothing about them in the accounts of the brothers' journey. Gårdlund found it strange that two technicians would choose not to write about such an uncommon observation.[21] A question mark continues to hang over the steam driven frame saw delivered to the sawmill in Sandö in the province of Ångermanland in the autumn of 1853. The source of its inspiration and provenance remains unknown. Gårdlund's interpretation was that the Bolinder brothers were preoccupied with the problem of driving sawmills with steam power long before the delivery to Sandö. In this context, the brothers must have been discussing the problem with reference to their experiences from Britain.

Neither did Gårdlund discuss the roots of other early products of the workshop in any depth. The production of castings was one of the workshop's sources of income in the early decades. Carl Gerhard Bolinder was an experienced founder who had studied unique methods of founding used in Britain already in the eighteenth century and described in the accounts of journeys to Britain made by Broling and by the chief blast-master Svedenstierna around 1800.[22] Gårdlund only indicated that these methods were used in Carl Gerhard Bolinder's daily duty at the workshop from 1845 and onwards. He stated however that continued improvements of the castings were made under his supervision, and it was a natural interpretation to reach that his experiences of British methods were important.[23]

7.5. Re-orientation towards American production methods

The successor as managing director, Alban Jacobi (1841–1913), who took over the position in the early 1880s had also been in Britain. He began at Bolinders in 1865, after his three years of service there and in the United States. Jacobi became master mechanic of Bolinders's workshops. It is worth noting that Gårdlund and several scholars after him set the date for the introduction of modern workshop technology from the United States in Sweden to 1867 and that Jacobi actually arrived in Stockholm two years earlier. However, Carl Gerhard Bolinder's son Erik August Bolinder must be interpreted as the main "agent" of Americanism at Bolinders. After his graduation from CTI in 1884, he went to the United States and was employed at William Sellers & Co as well as at J. P. Morris & Co. Both companies were located in Philadelphia. Both on his way to the United States as well as on his way back, he stopped in Britain for studies.

The re-orientation towards the United States as the industrial model on a general level in Sweden also meant that the Bolinders workshop began to abandon the British methods and became more American oriented. When Erik August Bolinder took over as managing director after his return in 1888, he began this re-orientation on a larger scale.[24] The two companies he worked for in Philadelphia were among the most developed ones in the United States and it was probably natural for him to seek employment there.[25] Bjork stated that many Norwegian engineers were looking to William Sellers & Co. as their first choice of place to work when they arrived in the United States.[26] There are no reasons to believe that the Swedes would have valued the possibilities to learn a lot about machine tool technology at the company differently. William Sellers was an inventor in mechanical engineering, who according to Monte A. Calvert, revolutionised and systemised the manufacturing of heavy and specialised machine tools and was a pioneer in the manufacturing of interchangeable iron bridge parts.[27] In *Teknisk Tidskrift* from 1878 there were several pages about the modern machines at William Sellers and it was stated that it was one of the most prominent machine firms in the United States. During the exhibition in Philadelphia in 1876, William Sellers won a lot of acknowledgement in this field.[28]

A four-year stay at these two companies gave Erik August Bolinder a chance to study highly developed work machines and workshop technology.[29] He picked up a lot of useful ideas for his future mission to take over the family business in Stockholm. His stay in the United States was important for that reason. In the minutes of the board, it was mentioned that the first machines from the United States were bought directly after Erik August Bolinder's return. In an investigation from 1898 it was found that Bolinders had a high number of modern work machines compared with other mechanical workshops in the Stockholm area. Bolinders had fourteen milling-machine operators out of 350 workers (4,0%) whereas the other workshops had nineteen out of 801 (2,4%).[30] This emphasis on milling-machines at Bolinders must have been an impulse from Erik August Bolinder's stay in the United States. Milling-machines also came to the Munktell workshop in the 1890s and were well equipped. The most advanced machine at Munktells in 1895 was a lathe of "American model".[31] It is clear that it was a development not only influencing Bolinders even if there are reasons to assume that Bolinders was in the forefront. Based on the statistics mentioned above, Gårdlund concluded that Bolinders' position was warranted because of the considerable application of American technology among the old engineering workshops with a diversified production. However, compared to the specialised workshops – for instance ASEA – Bolinders was still a company in the "English" tradition, where milling-machines, turret lathes, etc. were used to support production rather than a standardisation of American type.

The interchangeable part method adopted at Bolinders was built up around the milling-machines.[32] In the account about engineer Emil Flach's study trip in the United States in the early 1890s, he stated that the milling-machines were widely diffused there. They made a variety of works possible without the employment of skilled workers and had, therefore, a prominent position in every equipped workshop.[33] Flach's account was written some years after Erik August Bolinder's stay in the United States. As Sellers and J. P. Morris were two workshops in the forefront and the production technology was established decades before, Erik August Bolinder must have been studying these machines in Philadelphia and applied more of this technology when he returned to Bolinders. In engineer Gustaf Sellergren's account of the World Exhibition in Chicago in 1893, he mentioned Sellers together with several other American companies, though not J. P. Morris, in connection with the manufacturing of milling-machines.[34]

Pollock claimed that Erik August Bolinder was the man behind all the success achieved by the workshop in the early years of the twentieth century. Under his "leadership the firm was entirely re-organised, new buildings were erected and equipped with the most modern machine tools and appliances which could be found".[35] This modern development was, according to Pollock, mainly the work of his friend, the managing director. Pollock continued

> In 1912, an engineer and organiser of world-wide experience went through the Bolinder Works at Stockholm and its many distinct and complex departments. At the conclusion of his visit, he remarked, "It is running so smoothly that the Company appears to run by itself"; a higher compliment could not be paid to its hard working Chief. [36]

In Pollock's case, we shall keep in mind that his long-time friendship with Erik August Bolinder may have made him exaggerate the positive qualities. It is without question though, that Erik August Bolinder made a huge impression on the workshop. He possessed the qualities to get the position at Bolinders. Family ties, social capital, as well as symbolical capital in form of four years with two leading machine companies in the United States were a definite asset. But it was also a question of human capital in a more real sense. Erik August Bolinder obviously managed to carry out his intentions and make a modern workshop out of the creation of his father and uncle. But he was not alone. Gårdlund concluded that the new products that began being produced in the 1890s – planning machines, wood milling-cutters and more importantly the oil motors - were prerequisites for economic success. Gårdlund continued:

> At the same time as these new manufactures were taken up, the workshop began applying the more modern operational methods. Jean and Carl Bolinder had built up an order of production after "the English way": for the manufacturing of "individual" products the workers made use of the machines as much as possible. Erik August Bolinder and his engineers, of whom many had practised in the now leading industrial country in the west, carried out an Americanisation of the operations: precision manufacturing in long series

with the help of increasingly automatic machines. [37]

Thus Erik August Bolinder led the re-orientation, but he was not the only engineer with experience from the United States working at Bolinders.

The engine workshop

> The engine workshop was the most modern department with a large workshop of their own, its own construction office and ordering office; the directorate cherished it especially much and did not spare when it came to modern work machines.[38]

Thus Bolinders before 1900 had mainly a British touch, but possibly also to some extent a German one. In 1894, the company began producing stationary quadruple time kerosene engines from John Weyland's patent. He had been studying at the technical university in Berlin-Charlottenburg and worked at machine firms in Berlin and Mannheim. It was however another patent that gave the company a world reputation. Bolinders' own engineer Eric Rundlöf made this one. When his double time ignition engine was changed to crude oil in 1910, the reputation of the workshop was spread around the world. Rundlöf lacked foreign experience.[39]

Whether or not the application of Rundlöf's patent to crude oil had American influence is a difficult question. The Chalmers engineer Nisse Ericsson worked in the United States between 1903 and 1906 and was employed at the crude oil engine department after his return. He stayed only for a year, and it is therefore a very weak indication.[40]

The engine workshop was however American to a large extent. It was mainly the production of oil-engines that gave Bolinders the impulse to initiate a thorough modernisation of the production methods and in the early years of the new century the principle of interchangeable parts began being used in the motor workshop.[41] Production started already in the 1890s, from an idea by Erik August Bolinder, but not until 1907 did it become really successful. That year the new motor workshop was inaugurated and during the years to come it developed a modern organisation with mills and other different kinds of machines.

Bolinders acquired milling-machines, turret lathes and automatic lathes for the engine workshop as well as jigs and fixtures as much as was possible. The parts to different engine sizes were made mutual and serial manufactured and the engines could be set together by parts that were manufactured on lager. The principle of inter-changeable parts was used in the production.[42] These were reforms in a Taylorist spirit. Johansson has revealed that such reforms took place at *AB Separator* 1905–1910, and that it was possible to combine Taylorism with diversified manufacture, as there was room for many kinds of products on the domestic market.[43] The development at Bolinders to some extent possibly paralleled the development at Separator.

At the same time it was perhaps possible to call the engine workshop part of Bolinders specialised. The oil-engines became an economic success and brought in much more money than any of the other products of the company. Primarily the Bolinder oil-engine was used for shipping and it was exported to countries around the world.[44] The Bolinders oil-engines had advantages over users of steam engines, according to Pollock because of the degree of standardisation and inter-changeability.[45]

Erik August Bolinder was involved and so was the chief engineer of Bolinders 1903-1927, Per Werner. Both of them had comparably long-time experiences in the United States. Werner went there after graduation from KTH in 1892 and stayed until 1903. In the early 1890s he served as draftsman and constructor at the Keystone machine works in Philadelphia and in Drifton, Pennsylvania. Most of his time in the United States, however, Werner resided in Milwaukee, Wisconsin. He was general superintendent at The Filer & Stowell Co. for one year and had seven years in construction at the Edward P. Allis Co. and its successor Allis-Chalmers. For a year Werner was head of construction at that company.[46] Allis-Chalmers was known as a diversified manufacturer of steam engines, pumps and sawmills.[47] Alfred D. Chandler stated that Allis-Chalmers' administration was centralised, production rationalised, and that the company created an international distributing organisation.[48] Being head of construction at such a company must have been an advantage when Bolinders decided to appoint Werner to this responsible position. Werner must have come into contact with the principle of interchangeable parts. Jigs and fixtures were important cornerstones in the inter-changeability and in the early years of the new century the development of them for interchangeable part manufacturing was remarkable in the United States. In 1912, the ASME sub-committee on machine shop practice stressed that most major concerns employed jigs and fixtures and this ensured inter-changeability, low production costs and systematic production.[49] The use of fixtures was observed in the late 1880s, in the report sent to the National Board of Trade by the Swedish engineer J. E. Lagerman. He was employed at the United States Armory in Springfield, Massachusetts, Pratt & Whitney in Hartford, Connecticut, The Standard Sewing Machine Company in Cleveland, Ohio, and The Davis Sewing Machine Company in Dayton, Ohio.[50] Werner's experiences of these processes in Philadelphia and Milwaukee were probably important when as chief engineer he contributed to the new organization of the Bolinder workshops.

But returning engineers were not only involved in that field. In the 1890s, new moulding machines and wood milling cutters were inventions by an engineer who had returned from the United States in the mid 1890s.[51]

August Westman and his inventions

August Westman was born in Husby close to Falun in 1866 and moved at least officially to Stockholm from the United States in 1896.[52] Unfortunately, the records did not state where he had been and he was not in the Ellis Island files, maybe because he arrived prior to 1892. Gårdlund claimed that Westman constructed moulding-machines that were superior to those of the competitors' when it came to efficiency. Already after a year, Bolinders sold moulding-machines for more than 200.000 crowns per year and the income per year seldom dropped below that level.[53]

Westman's early inventions included moulding machines, shavings-cutters and re-sawing machines.[54] After the turn of the century he applied for patents for machines for the manufacturing of laths, frame saws, a cutter for tonguing of wood, etc.[55] Another of

Westman's constructions was also successful and this was a milling-tool for planning-machines made of steel with six, eight or twelve teeth.[56] In a lecture held at the Swedish Technical Association's meeting in late February 1903, Westman described the modern Swedish wood processing machines. He stated that the daily capacity of the Bolinder export moulding-machines was more than twice as high as ten years earlier. The explanation was mainly due to the construction, which allowed a significantly higher rotation speed compared to before. The loose steel was replaced by milling-machines.[57]

It is unfortunate that the records do not reveal Westman's stay in the United States and his experience there. The conclusions therefore must be more of a tentative character. It is clear that Westman's stay in the United States took place around 1893, the year of the exhibition in Chicago, and it is probable that Westman also visited it. The modern moulding-machines showed in Chicago, as well as Westman's studies at American companies must have been important for him when he became a skilled inventor at Bolinders. [58] Gårdlund claimed that Westman's new constructions were the most important ones for Bolinders, together with the oil-engine. Furthermore, Gårdlund argued that Westman's technical contributions were among the most remarkable ones in the industrial history of Sweden.[59] This statement may be somewhat exaggerated and the background was probably that Gårdlund's book was issued by the company itself.[60] However, to sum up, it is possible to state that returning engineers from the United States made some of the most important contributions to the Bolinder workshop's development in the late nineteenth and early twentieth century. Erik August Bolinder, Per Werner and August Westman were important people when it came to pushing development in these years.

Other engineers

There were also other engineers with experience from the United States at Bolinders. Their contributions were perhaps not as clear as the three engineers mentioned above, but their experiences will be revealed. One of them was Ragnar Hallström who went to London in 1907 and to the United States in 1908. When he came back to Sweden in 1911 he was employed as constructor and correspondent at Bolinders' sawmill department until 1918. In the United States, Hallström was employed as draftsman at Baxter D. Whitney & Son in Winchendon, Massachusetts and at Gisholt Machine Company in Madison, Wisconsin.[61]

Olof Östlin emigrated in 1901 and was employed one year as constructor at E. W. Bliss & Co in Brooklyn, New York, and ten years as head of construction at American Can Company in Chicago. This company manufactured canning-machinery and used continuous process canning machinery developed in the United States in the 1880s.[62] Östlin was an active member of the Swedish Engineers' Society of Chicago. From 1912, Östlin was employed as workshop engineer and constructor at Bolinders. [63] As Westman, Östlin was an inventor. In 1921, he invented an arrangement at log cars to frame-saws.[64] It is not stated whether this product was successful for Bolinders or not.

Ludvig Thyrsin returned to Sweden in 1928 after having spent five years as diesel engine constructor at Pacific Diesel Engine Co. and Imperial Diesel Engine Co. – both located in Oakland, California. Thyrsin was employed as an engineer at Bolinders, but we do not know in which department. Pollock claimed that none of the Bolinder engines manufactured until 1929 could be called a diesel engine but he thought that the development in the future was to be different when he wrote the book in 1930 as Bolinders prepared to produce a cold-starting motor. Possibly Thyrsin had some influence on this development before he started a workshop of his own in the Stockholm suburb of Ulvsunda in 1934 but it is difficult to ascertain as the records are sparse.[65]

The same is due for C. J. Wåhlström – employed before 1914 – and Adolf Caldenius, employed in 1928.[66] What we have seen, however, was that returning engineers were important in key positions at a leading Swedish workshop in the decades around 1900.

7.6. Concluding discussion

Bolinders was founded as an engineering workshop in the dominate British tradition in Sweden in the-mid nineteenth century. The re-orientation towards American methods began with Erik August Bolinder's entrance as managing director around 1890. He was well equipped to introduce new technologies to the workshop and Bolinders was at the forefront among older ones when it came to using modern work machines such as moulding-machines, milling-machines, etc. In a comparison with new, specialised workshops, however, Bolinders was still "lagging behind".

Some of these machines were August Westman's inventions and had a speed and efficiency that was superior, to even foreign products. Westman was an engineer who possibly developed his inventions from ideas he had got from modern machines studied while he was in the United States.

Westman's patents were one part of Bolinders' success in the early years of the twentieth century. The engines developed from patents by two Swedish engineers were other parts. The quadruple time kerosene engine possibly had German influences but the idea of double time igniting engine probably was more Swedish. If the switch to crude oil had an American influence is an interesting but difficult question. The engine workshop certainly was Americanised. As for the managing director, the chief engineer of Bolinders had experience in the American engineering industry and most certainly the principle of interchangeable parts. The development in this area was remarkably rapid in the years around 1900. As the chief engineer had been at a company at the forefront of rationalisation, his studies must have been important when newer machines were introduced, serial manufacturing began, and jigs and fixtures were used. The principle of interchangeable parts was established at Bolinders and probably also contributed to its success as it was easy for customers who only needed to change a part for some repairs. It was a development influencing several workshops in Sweden, but the investigation of the late 1890s indicates that Bolinders lay in the forefront among the traditional and diversified workshops where technology was increasingly outmoded. On the other hand, it is possible to call the engine workshop suitable for specialised types of work such as the oil-engine.

Although there undoubtedly were other influences from the United States at Bolinders, it was much more problematic to prove a causal link to developments in the firm. Such influences include, for instance, sawmills and saws, as well as diesel engine development.

However, the most important developments seem to have been the rational organisation of the workshop, standardisation and automatic machines. It was, to use David Hounshell's words, "an American system leading to mass production".[67] Possibly, such a system was introduced on a wider scale in Sweden during the years 1890–1930. The next chapter will give us an indication of this as it focuses on the proportions of returning engineers in leading positions at major companies in the four industrial branches we have scrutinised.

Notes

1 Bo Sahlholm, ”Maskinverkstaden vid J & C G Bolinders Mekaniska Verkstad AB – en funktionell verkstad” in *Årsmeddelande 1982/Föreningen Stockholms Företagsminnen* (Stockholm, 1982), 26. Swedish original: ”År1873 (sic!) saknades hos Bolinders helt de verktygsmaskiner som de amerikanska metoderna förde med sig. Där fanns varken revolversvarvar eller fräsmaskiner. Bara ett par decennier senare var dessa maskiner inte bara vanliga i den Bolinderska produktionsapparaten – de utgjorde då också viktiga produkter i företagets sortiment”.

2 *Nationalencyklopedin 19,* search word: ”verkstadsindustri”, (Höganäs 1996) 387.

3 T Gårdlund 1945, 38-39.

4 *Nationalencyklopedin,* search word: ”verkstadsindustri”, 387.

5 T Gårdlund 1945, 39-44.

6 *Nationalencyklopedin,* search word: ”verkstadsindustri”, 387.

7 T Gårdlund 1945, 130-131.

8 *Nationalencyklopedin 19,* search word: ”verkstadsindustri”, 386-387.

9 T Gårdlund 1945.

10 Walter Pollock, *The Bolinder Book* (Stockholm, 1930).

11 B Sahlholm, 26.

12 T Gårdlund 1945, 19-24.

13 T Gårdlund 1945, 33-37.

14 T Gårdlund 1945, 48.

15 T Gårdlund 1942, 234; L Jörberg, 188-195.

16 T Gårdlund 1942, 242-245.

17 G Friborg, 15; L Jörberg, 190-191.

18 S Rydberg, 139.

19 T Gårdlund 1945, 222.

20 T Gårdlund 1945, 222-224.

21 T Gårdlund 1945, 80-82.

22 T Gårdlund 1945, 21, 83; S Rydberg 1951, 202.

23 T Gårdlund 1945, 84.

24 T Gårdlund 1945, 224.

25 T Gårdlund 1945, 109.

26 K O Bjork, 57.

27 M A Calvert, 9-10.

28 W. H. ”Meddelanden från verldsutställningen i Filadelfia. 33. William Sellers & Co’s verkstäder och utställning af verktygsmaskiner” in *Teknisk Tidskrift* 1878, 12-15, 36-37, 87-88, 159-160.

29 T Gårdlund 1945, 109.

30 T Gårdlund 1945, 132-133.

31 Lars Magnusson, *Arbetet vid en svensk verkstad: Munktells 1900-1920* (Lund, 1987), 61, 93.

32 T Gårdlund 1945, 131.

33 Emil Flach, ”Berättelse angående resa i Nordamerikas Förenta Stater åren 1891, 1892, 1893”, travel account 270, 1893, KTHB, 30.

34 Gustaf Sellergren, ”Nyare verktygsmaskiner på Chicago-utställningen” in *Teknisk Tidskrift. Mekanik och elektroteknik* 1894, 53.

35 W Pollock, 5.

36 W Pollock, 5.

37 T Gårdlund 1945, 224. Swedish original: ”Samtidigt som dessa nya tillverkningar upptogos, började verkstaden tillämpa de modernare driftsmetoderna. Jean och Carl Bolinder hade byggt upp en produktionsordning efter ’det engelska sättet’: för en tillverkning av ’individuella’ produkter togo arbetarna så långt som möjligt hjälp av maskinerna. Erik August Bolinder och hans ingenjörer, av vilka flera hade praktik från det nu ledande industrilandet i väster, genomförde en amerikanisering av driften: precisionstillverkning i långa serier med hjälp av alltmer automatiska maskiner”.

38 T Gårdlund 1945, 135. Swedish original: ”Motorverkstaden var den modernaste avdelningen med egen stor verkstad, eget konstruktionskontor och orderkontor; den var särskilt omhuldad av direktionen, som inte sparade när det gällde moderna arbetsmaskiner”

39 *Svensk Uppslagsbok* 4, search words ”Bolinders, J. & C. G. mekaniska verkstads ab” (Malmö, 1955), 487.

40 *Chalmers,* 76.

41 T Gårdlund 1945, 134-135.

42 T Gårdlund 1945, 134-135; W Pollock, 142. On the history of interchangable parts, see for instance D A Hounshell, 3, 25-32; R S Cowan, 79-82.

43 A Johansson 1990, 288.

44 T Gårdlund 1945, 166-170.

45 W Pollock, 142.

46 *Svenska Teknologföreningen* I, 382.

47 http://www.owwm.com/MfgIndex/detail.asp?ID=22, available on Internet, 27/4-2003.

48 A D Chandler, 198.

49 Quoted from D A Hounshell, 372, note 45.

50 J. E. Lagerman, ”Rese-berättelse”, No. 256, 1890, KTHB, 25-26. Jigs and fixtures were used back in the Antebellum Period (D A Hounshell, 55-56).

51 T Gårdlund 1945, 157.

52 KLARA. Två rotar i rotemansarkivet 1878-1926, CD-Rom, Stockholms Historiska Databas; Foark; T Gårdlund 1945, 157, claims that Westman began at Bolinders in 1895.

53 T Gårdlund 1945, 157, W Pollock, 50.

54 *Special Catalogue of Wood-Planing Machines and Resawing Machines, etc* (Stockholm, 1900), 10-63, BMVA, FSF.

55 A. A. Westman, ”Fräs vid spåntning af bräder”, Patent No. 12735. Beskrifning offentliggjord af Kungl. Patent- och Registreringsverket (Stockholm, 1901); A. A. Westman, ”Anordningar vid matarvalsare å maskiner för sågning af ribbor och dylikt”, Patent No. 15098. Beskrifning offentliggjord af Kungl. Patent- och Registreringsverket (Stockholm, 1902); A. A. Westman, ”Anordningar vid maskiner för framtsällning af ribbor o.d.”, Patent No. 17727. Beskrifning offentliggjord af Kungl. Patent- och Registreringsverket (Stockholm, 1904); A. A. Westman, ”Anordning vid ramsågar”, Patent No. 23837. Beskrifning offentliggjord af Kungl. Patent- och Registreringsverket (Stockholm, 1905), BMVA, FSF.

56 T Gårdlund 1945, 157.

57 August Westman, ”Meddelande om moderna svenska träförädlingsmaskiner” in *Teknisk Tidskrift. Mekanik och elektroteknik,* 11/4-1903, 62-63.

58 G Sellergren 1893, 31-32.

59 T Gårdlund 1945, 224.

60 If Gårdlund was right, it could have been expected that Westman’s name would appear in for instance a Swedish encyclopedia. He is however not included in any of the major older or newer ones.

61 *Svenska Teknologföreningen* I, 688.

62 A D Chandler, 318.

63 *Porträttgalleri* 481; P-O Grönberg 1999, 133.

64 J. & C. G. Bolinders Mekaniska Verkstads AB to Th, Wawrinskys Patentbyrå, not dated, BMVA, FSF.

65 *Svenska Teknologföreningen* II, 876-877; W Pollock, 135.

66 The known were Adolf Caldenius, head of advertising 1928-1933, in New York for a Swedish company 1914-1916 and C. J. Wåhlström who emigrated, returned and was employed at Bolinders before 1914 (*Svenska Teknologföreningen* II, 884; *Bergsskolan i Falun, 94.*

67 D A Hounshell, 49, 107.

8. THE RETURNED ENGINEERS: A SOURCE OF DEVELOPMENT FOR SWEDEN?

The preceding chapters have focused on influences and impulses brought back by returning engineers at four companies in four branches. When Sweden witnessed its industrial breakthrough from the 1890s to the 1930s, steel and iron industry, mining and engineering industry were among the most important elements. The electrical industry was a kind of "sub-branch" to the engineering industry though nevertheless distinguishable.

Engineers with experiences from other countries were important at ASEA, at the iron works in Sandviken, at the Boliden mining company, and at the Bolinder workshops. But is it possible to draw general conclusions about their importance in Sweden as a whole during the large-scale industrialisation or were the companies exceptional when it came to engaging engineers with foreign experience? Djupedal's assumption was based on the fact that small actions could have a huge impact if several individuals in many places performed them over time. The fact that each individual returnee acted after American patterns in his or her own place and time created a fundamental principle for the modern transatlantic importation of culture, defined broadly as speeches, habits, clothing, but also artefacts and working methods.[1] In the same way, possibly, returned engineers were able to create a foundation for technical borrowing from the leading industrial countries. We have already seen that they were able to reach higher positions compared to engineers who never went abroad in the early twentieth century Swedish industry.

It has been described how present-day developing countries can benefit from return migration especially of highly skilled migrants.[2] It was emphasised by former United Nations development assistance practitioner, Henrik Olesen as important for rapid economic and social development in lower developed countries together with some other factors: foreign direct investments, trade liberalisation, development assistance, remittances and governance.[3] It was possible to turn what usually is called "brain-drain", i.e. the emigration of highly skilled people from lower developed countries to industrialised ones, into a resource of development for the country something often characterised as "brain-gain" in contemporary discussions. Hunger claimed this has happened with regard to the Indian Software industry and return migration from the United States. The latter expression can be equated to Cerase's categorisation *return of innovation.*[4]

A few things need to be taken into consideration. The expressions of "brain-drain" and "brain-gain" are modern terms and the former was coined for the first time in the early 1960s.[5] We are dealing with an earlier time period, but there are reasons to remember that there were discussions about the dangers of engineers leaving Sweden already around

1900. However, it may be an exaggeration to adopt these modern expressions on an historical period without considerations. Furthermore, Sweden was a country comparably well-off also before 1890. Rostow argued that there were two groups of countries when it came to the pre-conditions for an economic take off: one that included most countries in Europe, but also the greater part of Asia, Africa and the Middle East; and another that included the United States, Canada, Australia, New Zealand and a few other countries. In the first category, the take off required fundamental changes in traditional society altering both the social structure as well as the political system. The second group of countries were not so caught up in traditional structures, values and politics and thereby they were not so touched by changes.[6] In the discussion about the problems to place different countries in the two groups, Rostow stated:

> Similarly, Scandinavia, somewhat like Britain itself, faced less searching problems than many other parts of Europe in shaking off the limiting parameters of the traditional society. Sweden is almost in the second rather than the first category.[7]

From the results of international industrial exhibitions during the second half of the nineteenth century, Ahlström concluded that Sweden in many respects was at a level with most countries even before 1890 and so was the education of engineers. In all, it is not accurate to characterise Sweden as a lower developed country before 1890. What can be concluded, however, is that there were more technically advanced countries. Schön and Magnusson discussed the 1890s and the starting point for a second industrial breakthrough, when Sweden's growth was higher than all comparable countries.

Technical development may have two sides and is not necessarily positive. However, both Schön and Magnusson connected the above-mentioned breakthrough and the economical growth to technical development. As we have seen, for instance, the returning engineer Ernst Danielson actively took part in the development of electro-technology which has been described as the prime mover in industrial development after 1890. Danielson can be viewed as an example of a returnee who suited the conditions that former UN official and director of a programme for global migration management, Bimal Ghosh, concluded had to be fulfilled if the countries of origin were to experience change from returning emigrants. First, they needed to return with more advanced knowledge and skills then they could acquire if they had stayed at home; second, the knowledge and skills had to be relevant for the home country's economy; and third, the returnees had to have the willingness and the opportunity to use the skills after their return. In short, Ghosh concluded that this had happened in some present-day cases but that it also had failed primarily because the skills acquired were largely insufficient in the home countries.[8]

Undoubtedly, there is a no natural law stating that return migration – even of skilled persons – always leads to changes in the home country. However, let us assume that the Swedish engineers acquired skills that were more advanced than they would have if they had stayed at home. One example is that mass production was relatively uncommon in early twentieth-century Sweden. Furthermore, the view of development nationalism, that Sweden was to be uplifted with the use of American and German models and returning Swedish-Americans clearly shows that the skills and knowledge of the returning engineers were important for the Swedish economy. The fact that returning engineers often reached responsible positions within the industry was also in itself an indication of this. It also indicates that they were willing to use the skills in the Swedish context. It gave them a symbolic capital that was rewarding on the engineering field and thereby promoted their careers. Hypothetically, the conditions were fulfilled. This chapter will focus on key positions in other companies belonging to the same branches as the ones in the case studies, i.e. the engineering industry with its sub-branch the electrical industry, the steel and iron industry, and the mining industry. The approach will be a quantification of the managing directors and chief engineers similar to the one Hunger made of business leaders in the Indian software industry.

8.1. The engineering industry

Bolinders was one of the old engineering workshops in Sweden founded during the nineteenth century and with diversified production. ASEA can also be placed in the engineering industry, but it was a newer and more specialised company. The electrical industry can be viewed as a sub-group to the engineering industry. Therefore, this examination will begin with the group of companies to which Bolinders belonged, continue with ASEA's group, Sandviken's group, and finally Boliden's group.

Unfortunately, it has been difficult to find an appropriate criterion to rank the Swedish engineering workshops in size. The choice of old workshops with a manifold production has been made from different literature concerning the engineering industry in Sweden.[9] At Bolinders, we found that the leading engineers had experiences from abroad and that both managing director Erik Bolinder and the chief engineer Per Werner had been in the United States. In Table 8:1, we can see how the picture was in other engineering workshops.

TABLE 8:1: Managing directors and chief engineer of fifteen major diversified engineering workshops in Sweden, 1902–1921

CATEGORY	**Worked or studied abroad**	**Never abroad**	**No information**	**% returnees**
Managing directors	21	12	6	63,6
Chief engineers	15	4	4	78,9
TOTAL	**36**	**16**	**10**	**69,2**

SOURCES: *Sveriges Handelskalender* 1900, 1909, 1914 and 1922; *Chalmers; Svenska Teknologföreningen* I and II; *Porträttgalleri; Malmö Teknologförbund; Teknologföreningen i Borås.*

The table shows that foreign experience was common among both managing directors and chief engineers of the Swedish engineering workshops in the early decades of the twentieth century. Such experience was thus significant for the engineering industry. In Table 8:2, we can see where the returned engineers in the engineering industry had worked.

TABLE 8:2: Foreign experiences of managing directors and chief engineer of major diversified engineering workshops in Sweden, 1902–1921

COUNTRY OF EXPERIENCE	N	% of returnees (N=36)	% of all leading engineers (N=52)
United States	14	38,9	26,9
Great Britain	12	33,3	23,1
Germany	9	25,0	17,3
Finland	6	16,7	11,5
France	4	11,1	7,7

3: Switzerland, 2: Belgium, 1: Austria, Canada and Russia. 4 undefined cases.
SOURCES: see table 8:1.

About 40% of the engineers who had been abroad had been in the United States and 27% of all engineers in leading positions at major Swedish engineering workshops had been there. The United States was the single most common country followed, as we can see, by Britain and Germany. Glete stated that these diversified workshops developed at a slow pace, and that they often were easy prey when large-scale industry began to emerge.[10] Still, we can note that returnees at these companies often filled up major engineering positions. Bolinders, however, was one of the older workshops that also had a position when production became increasingly specialised and they seem to have been in the forefront in applying American methods. Bolinders had a favourable pattern of development compared to three other workshops: Motala, Nydquist & Holm and Munktells.[11] There were however engineers with American experience at these workshops as well.

Thus, Bolinders was far from alone in engaging engineers with American experience. At the workshop in Jönköping three chief engineers from 1899 and onwards had experience from the United States and managing director Gustaf Sandwall had been in Britain. The Motala workshop had a managing director between 1892 and 1908 with eight years of experience in the United States. Nydqvist & Holm's chief engineer Karl Kjällman had also been in the United States. The "Americanism" in these major engineering workshops probably could make an impact on the Swedish engineering industry as a whole. Gårdlund stated that the American workshop technology came to Sweden in the 1860s and was gradually diffused throughout the country. [12] Thus, the Swedish engineering industry became coloured by the United States but there are reasons to remember that the foreign experience of the leading engineers were geographically diffused and that the United States was only slightly more important than Britain. The pattern indicates that the British influence remained relatively strong also into the twentieth century. In the smaller electrotechnical companies, Britain seems to have been comparably important to the United States as well, as we will soon see.

8.2. Electrical industry

In the years 1883–1910, three company groups were ASEA's competitors on the home market in Sweden. All three later became parts of the ASEA group. The companies were *Luth & Roséns Elektriska AB* in Stockholm, *Elektriska AB Holmia* in Stockholm – a company also cooperating with *Adolf Ungers Industri AB* in Arbrå. The third group was *Elektriska AB Magnet* in Ludvika. In 1906, Holmia/Unger merged with Magnet and formed *Förenade Elektriska AB.* ASEA and the three company groups had the ambition of being electrical engineering companies with a diverse production. The smaller companies had their emphasis on the domestic market and their export was insignificant. Förenade Elektriska was independent until 1916, whereas Luth & Rosén remained an independent company until 1930.[13]

At ASEA there was a significantly high share of returning engineers in leading positions. As the company was much larger than the other ones the conclusion is that ASEA in itself is a proof of the foreign influence on Swedish electrical industry. In 1910, ASEA's electrical manufacturing had a value of six million crowns whereas the value of the three other companies' production was two and a half million. ASEA's other manufactures had a value of 1.6 millions, and the other's a value of one million.[14] The importance of returning engineers at ASEA could itself be taken as evidence of them being important to this industrial branch in Sweden. It is, however, interesting to see whether engineers with experience from abroad also were in leading positions in the smaller companies. In Table 8:3, we can study the managing directors and leading engineers of these companies before 1930.

TABLE 8:3: Managing directors and leading engineers of smaller electro-technical companies in Sweden, 1883–1930.

CATEGORY	**Worked or studied abroad**	**Never abroad**	**No information**	**% returnees**
Managing directors	6	5	1	54,5
"Leading engineers"	20	8	3	71,4
TOTAL	**26**	**13**	**4**	**66,7**

SOURCES: J Glete 1983; M J Helén 1955; *Malmö Teknologförbund; Svenska Teknologföreningen* I and II; *Chalmers; Porträttgalleri;* ASEA personell files.

In all, two-thirds of the leading engineers at these three companies, which occasionally also showed up at ASEA, had foreign experiences. It almost mirrored the pattern at ASEA as well as the engineering workshops. The foreign experienced engineers were probably able to bring skill and knowledge to this limited, but nevertheless important, branch of Swedish industry. In proportional terms, the level of experience was considerable and the conclusion must be that the returning engineers were a source of technical change for the Swedish electrical industry. ASEA and the smaller companies were not different in the sense that they wanted to apply foreign ideas and engage technicians with foreign experience in leading positions. In another sense, however, they were different. The experiences of their leading engineers seem to have been geographically differently diffused as we can see in Table 8:4.

TABLE 8:4: Foreign experiences of managing directors and leading engineers of smaller electro-technical companies in Sweden, 1883–1930.

COUNTRY OF EXPERIENCE	N	% of returnees (N=26)	% of all engineers (N=39)
Germany	14	53,8	35,9
Great Britain	8	30,8	20,5
United States	8	30,8	20,5
Switzerland	5	19,2	12,8

1: Finland, France, Italy, Norway, "South America" and "undefined"
SOURCES: see table 8:3

At ASEA more than half of the returnees had been in the United States whereas the corresponding share at smaller companies was much smaller. We can also note that half of the engineers who had been in the United States at the smaller companies later became employed by ASEA. For Germany, the picture looked different. Among the leading engineers at ASEA about a third had been in Germany compared to over 50% at the smaller companies. The quantitative relation between engineers with experience from the United States compared to Germany was thus reversed at the smaller companies and the German influence in these companies were seemingly more important than American. As a matter of fact, British experience was as common as American among the directors and leading engineers of the smaller companies. This may look peculiar as Thomas P. Hughes stated that British electrical industry lagged behind in the late nineteenth century and that the electrification in Britain was characterised by a lack of unified planning and standardisation.[15] It is, however, to draw too wide a conclusion to state that the smaller Swedish companies' were less important than ASEA because of British influences. One reason was their emphasis on the home market in Sweden compared to ASEA's export minded management.

The German influence accords with Glete's claim that Luth & Rosén used many of Siemens-Schuckert's drawings and received technical support from the Berlin-company in the years around 1900. Glete also stated that the people earlier in charge of AEG's bureau in Stockholm founded Holmia and that almost the entire staff at that bureau followed the founders to Holmia.[16] Helén revealed that the two first managing directors at Magnet were brought from Union Elektricitäts-Gesellschaft.[17] These people, Richard Göransson and Robert Bremberg also had experience in Britain and the United States (Göransson), but Union was their last employer before they came to Ludvika. Overall German experience seemed to be the most considerable at these companies. ASEA competed mainly with the German companies something that made it easier to co-operate with American ones.[18] For smaller domestically minded companies, it was probably easier to co-operate with Germany. The Germans did not view them as threats in the same way as they viewed ASEA. They possibly also had difficulties to engage engineers from the United States, as they perhaps were unable to offer wages comparable to what Swedish engineers earned in the United States or at ASEA.[19]

To sum up this discussion about the electrical industry, the emigration of Swedish electrical engineers was, in the long run, a source of technical development for the Swedish electrical industry as most of them returned and "occupied" high positions at large and small electro-technical companies in Sweden. The initial loss was thereby turned into a process that may have been profitable for the Swedish electrical industry as they made use of their experience from abroad in their professional lives. Swedish electrical industry "gained" most from the round-trips to the United States, Germany, and to a smaller extent Britain. The "giant" ASEA was the "American" coloured electro-technical company in Sweden, but the smaller ones were more influenced by Germany. As ASEA over time consumed the smaller companies, through a process of acquisition, the Swedish electrical industry probably became more and more "American".

8.3. The steel and iron industry

In Sandviken we saw that many engineers had been abroad and most of them travelling to the United States. This was the case both among the top management as well as the departmental heads. Were these kind of experiences common in the Swedish steel and iron industry in the early decades of the twentieth century? In Table 8:5 we can see how many managing directors and other leading engineers had foreign experiences. These ironworks were chosen according to their size measured by rates of production in 1913.[20]

TABLE 8:5: Managing directors and chief engineer of major steel and iron works in Sweden, 1902–1921

CATEGORY	Worked or studied abroad	Never abroad	No information	% returnees
Managing directors	7	13	1	35,0
Chief engineers	13	11	1	54,2
TOTAL	**20**	**24**	**2**	**45,5**

SOURCES: *Sveriges Handelskalender* 1900, 1909, 1914 and 1922; *Matrikel över tjänstemän vid Sveriges jernverk och gruvor* 1902, 1921; *Svenska Teknologföreningen* I and II; *Chalmers; Bergsskolan i Falun, Bergsskolan i Filipstad.*

Slightly under half of the leading engineers at the major Swedish steel and iron works had foreign experience and it was more common among the chief engineers than among the managing directors. This was somewhat less that at the traditional engineering workshops and the electro-technical companies. Thereby, the assumption is that the returning engineers were less of a source of development in this industrial branch. However, other factors than proportions ties need to be taken into consideration such as the size of the companies where the engineers were employed and the importance of certain individuals. In Table 8:6, we can see where the leading engineers at the steel and iron works had been.

TABLE 8:6: Foreign experiences of managing directors and chief engineer at major steel and iron works in Sweden, 1902–1921

COUNTRY OF EXPERIENCE	N	% of returnees (N=20)	% of all engineers (N=44)
United States	13	65,0	29,5
Germany	4	20,0	9,1
Great Britain	3	15,0	6,8
Canada, Norway and Russia	2	10,0	4,5

1: Switzerland, Austria and Finland.
SOURCES: see table 6:5.

As we can see, the dominance of the United States was clearer in this branch compared to the engineering industry and the electrical industry as 65% of the returning engineers in key positions at the major iron works had experience in the United States. Thus, even if the foreign influence proportionally was smaller in the steel and iron industry, American influence ended up about the same proportionate level as in the engineering and the electrical industry, i.e. around 30%. No other country came close to reaching such a share and only about 10% of the engineers had experience of second-placed Germany.

Chief engineers were in charge of the technical development of the companies. In the early decades of the twentieth century, their American experience was very important in the organisation of the companies. In 1902, three out of the four companies that were to become the largest ones in production in the-mid 1910s had engineers with experience in the United States as chief engineers. In 1909, the three companies that were to be largest in 1913 had returned Swedish-Americans as chief engineers and the same held true in 1914. The fourth ranked company had one from Germany. In 1921, five out of the six largest companies had engineers with experience in the United States as chief engineers. Olof Ekström had worked at The United States Mitis Co in the 1880s and became the long time chief engineer at Sweden's largest iron works, in Domnarvet close to Borlänge. Karl Fredrik Göransson (see Chapter five) was assistant managing director at Sandviken in the 1910s and Axel Wahlberg, earlier at Sandviken (see Chapter five), now held the position as chief engineer at Fagersta. Hugo Carlsson, with sixteen years in Canada and the United States, took over the position when Axel Wahlberg became managing director in 1914. In 1921, nine out of ten departmental heads in the rolling mills had worked abroad and in eight cases, their foreign stays included employment in the United States. It is obvious that the American practices must have been important.

It was at the largest iron works that American experience and expertise seems to have counted most. One of the clearest examples is Fagersta. In 1888, it was ranked as number twenty-one among the Swedish iron works based on the production volume. In 1913, the company had improved and was number two after Domnarvet achieving a production increase of over 1.000% in twenty-five years. In 1909, there were eleven engineers registered at Fagersta in the Swedish Calendar of Businesses*,* of which nine have been identified in other directories. Seven of those nine (78%) had worked abroad and all of them in the United States. For large export minded Swedish steel and iron companies, the experience these men gained from primarily the United States was important. The emigration of engineers with connections to the steel and iron industry could probably also be deemed profitable upon their return.

8.4. The mining industry

Mining was a business closely connected to the steel and iron industry. At Boliden we found that American influences were mainly present in the build-up of the smelting-plant at Rönnskär, but it seemed less important in the mining villages in inland Västerbotten. Here, there are reasons to remember that Boliden was a company dealing with an ore that in many ways was unique in the world. The people revealed in Table 8:7 were engineers who worked in the more traditional iron mining. This difference needs to be taken into consideration when discussing the results.

TABLE 8:7: Managing directors and chief engineer of mining companies in Sweden, 1902–1921

CATEGORY	**Worked or studied abroad**	**Never abroad**	**No information**	**% returnees**
Managing directors	11	25	3	30,6
”Leading engineers”	15	53	4	22,1
TOTAL	**26**	**78**	**7**	**25,0**

SOURCES: *Sveriges Handelskalender* 1900, 1909, 1914 and 1922; *Matrikel över tjänstemän vid Sveriges jernverk och gruvor* 1902, 1921; *Svenska Teknologföreningen* I and II; *Bergsskolan i Falun, Bergsskolan i Filipstad.*

About one third of managing directors had foreign experience, and about every fifth engineer among others in leading positions. Proportionally, mining had less influence from abroad than the industrial branches discussed earlier. In 1902, the foreign experience of the managing directors only consisted of study trips and one was Tord Magnusson's visit to the exhibition in Chicago in 1893 (see Chapter five). Besides his duty at Sandviken, he was managing director at the mines of Bispberg in Dalarna. Foreign experience seems to have been of little importance even if the managing director of one Sweden's major mining companies, LKAB in Kiruna, had been in Britain for studies. In Table 8:8, we can see to which countries the leading engineers went.

TABLE 8:8: Foreign experiences of managing directors and leading engineers at mining companies in Sweden, 1902–1921

COUNTRY OF EXPERIENCE	N	% of returnees (N=26)	% of all engineers (N=104)
United States	10	38,5	9,6
Norway	9	34,6	8,7
Germany	6	23,1	5,8
Austria	4	15,4	3,8
Canada and Spain	2	7,7	1,9

1: France, Belgium, Greenland, Burma and Hungary
SOURCES: see Table 8:7.

Almost 40% of the returnees had been in the United States, but Norway and Germany were other major destinations. Still, as the mining industry engaged returning engineers to a comparably small degree, only every tenth engineer that was managing director or other employee at a higher level had experiences from the United States. This was by far the lowest share of all the four branches investigated. This indicates that mining adopted fewer foreign practises, but the ones taken came primarily from the United States.

Two mining engineers at the minefields in Kiruna and Gällivare, LKAB's major ones, had been in the United States. Three out of six mining engineers at LKAB had been in the United States, but both the ones at the Stora Långvik company in Dalarna had been there. The mines of Grängesberg, described as "an America in Sweden" at a technical discussion meeting after the turn of the century,[21] only had one mining engineer with experience in the United States.

It is a reasonable assumption that Swedish mining had more to lose because of the emigration of engineers compared to other industrial branches in Sweden. Engineers with foreign experience filled a smaller number of key positions compared to the other branches investigated. It is worth remembering, however, that other engineers than the ones fitting the categories of being in a leading position in this study may have made important contributions.

8.5. Concluding discussion

Engineers who had foreign experience filled many key positions in the Swedish industry in the early twentieth century. In the engineering industry as well as the electrical industry, returnees filled up about two-thirds of the key positions and in the steel and iron industry it was slightly less than half, but a fourth in mining.

It is possible to interpret return migration of engineers to Sweden during the second industrial breakthrough as a beneficial process especially as the industrial branches mentioned above were important in the country's large-scale industrialisation and the companies investigated were the major ones within each branch. The growth of ASEA and Boliden, Fagersta's and Sandviken's expansion, Bolinders' favourable position internationally, all were accomplished under the management of engineers with foreign and primarily American experiences. It is most relevant to discuss the returning engineers as a source of development in connection with the electrical industry and the engineering industry and least relevant when it comes to mining. However, there are reasons to consider that individual engineers may have been very influential such as Palén at Rönnskär and the numbers therefore do not give the whole picture.

The influence of the United States in this context differed in the same way as the foreign influence as a whole. The electrical industry, the engineering industry, and the steel and iron industry had significantly higher shares of their leading engineers who had been in the United States compared to mining. In the electrical industry, engineering industry and steel and iron industry, engineers with American experience held about a third of the leading position. In mining about a tenth. The difference between the three former was small and we shall not jump to conclusions and state that the American influence was highest in the electrical industry. We shall also keep in mind that while Britain primarily "challenged" the United States in the engineering industry, and Germany in the electrical industry, the United States dominated the steel and iron industry. The same held true for mining, but in this industrial branch, the significance of return migration was smaller.

Germany was the "second" most important country. The German influence seems to have been most important in electrical engineering. At ASEA about a fourth of the leading engineers had experience in Germany, but the corresponding share for the smaller electrotechnical companies was more than a third. The German influence seems to have been greater than the American at the smaller companies, but the relation was reversed at ASEA. In all, ASEA's size and importance shows that the United States was more important for the industry as a whole. In the engineering workshops, a fifth of the leading engineers had experience in Germany, and Britain was proportionately more important. In the steel and iron industry, there was no clear number two and the influence of Germany fell to below that of Norway in mining. Germany, however, was influential in industrial branches not dealt with in detail in this thesis such as the chemical industry.

Major companies in important industrial branches in Sweden during the second industrial breakthrough often had returning engineers in their top-management. In the long run, therefore, the process of emigration and return migration of Swedish engineers was favourable for the country during the era of industrialisation. Hopefully, this conclusion can bring fresh perspectives into play in connection with the present-day debate about the dangers of "brain-drain".

Notes

1 K Djupedal, 1990, 131, 142.

2 Henrik Olesen, "Migration, Return, and Development: An Institutional Perspective" in *International Migration,* Volume 40, issue 5, 2002, 138-140; U Hunger 2000; U Hunger 2002.

3 H Olesen, 139-140.

4 U Hunger 2000; U Hunger 2002.

5 H Olesen, 136.

6 W W Rostow, 18.

7 W W Rostow, 18.

8 B Ghosh, 187-189.

9 E Dahlström; J Glete 1987, T Gårdlund, 1947. The workshops were Arboga, Bergsund (Stockholm), Bolinders (Stockholm), Carl Holmbergs (Lund), Huskvarna, Jönköping, Karlstad, Köping, Landskrona, Morgårdshammar, Motala, Munktells (Eskilstuna), Nydqvist & Holm (Trollhättan), Söderhamn and Södertälje.

10 J Glete 1987, 249.

11 T Gårdlund 1945, 201.

12 T Gårdlund 1942, 244-246.

13 J Glete 1983, 56-62, 70, 82.

14 J Glete 1983, 65.

15 Thomas Parke Hughes, "British Electrical Industry Lag: 1882-1888 in *Technology & Culture,* 1962.

16 J Glete 1983, 56.

17 M J Helén 1955, 403.

18 H Lindblad, 199.

19 M Fridlund 1999, 51.

20 A Attman 1957, 490.

21 T Gårdlund 1942, 240.

9. CONCLUDING DISCUSSION

This study has examined emigration and return migration of Swedish engineers, their occupational careers, technological diffusion and the returning engineers as a possible source of development after their return to Sweden. The four steps were intertwined with each other and one step was a prerequisite for another. Technical diffusion over national borders has often been connected to people's geographical movements. The opportunity to introduce and maintain technology was facilitated if an engineer with foreign experience acquired a responsible position. Finally, there was a need for the diffusion to occur if the returned engineers were to become a source of technical development or change in Sweden. This thesis has been focusing on these processes with regard to the United States, but other countries, primarily Germany, have also been discussed.

Late nineteenth and early twentieth century Swedish engineers were a geographically mobile group. Of 5.994 investigated engineers graduating between 1880 and 1919, 2.331 emigrated, representing 39%. If engineers who only were on study trips were included the rate increased to 48%. They mostly went to the United States and Germany. Later, 1.660 engineers or 71% returned to Sweden. In examining their reasons for these geographical moves, the theoretical frameworks developed by the Swedish scholars Charles Edquist and Olle Edqvist as well as the French sociologist Pierre Bourdieu have been used. The concepts have proved valuable.

Through different channels the engineers were informed about technical development in the leading industrial countries. For instance, the Swedish technical journals increasingly began to report about American technology. This spurred an interest among engineers to emigrate, learn about the technology, accumulate access/knowledge, and return to make use of what they had learned abroad in the native country. It should be pointed out that the decisions were taken on an individual basis and it is not possible to call it a group strategy. Personal and professional networks must, however, be considered as important when it came to the opportunities to get employment abroad. The often anticipated unconsciousness in the strategies that Bourdieu has emphasised was less relevant. The decisions to emigrate and return were conscious and the target migrant, a person who returns after a well-defined interval abroad, was the Weberian ideal type of an emigrating engineer. The fact that almost two-thirds of the emigrations took place within three years after graduation, that three-fourths of them lasted for a period up to five years, the high percentage of return migration – almost four times as high as for common Swedish emigrants, all offer strong proof. An emigration that included employment at General Electric, Carnegie Steel or studies in Berlin or Zurich and included a plan to return can be viewed as a prolonged education. Many engineers probably thought they needed the experience in order to become mature men, but also, as Steen wrote in the letter to Edström, for successful engineering work in the home country. The conclusion is clear: most emigrating engineers were preparing themselves for a future career in the home country based on their foreign experience. In that sense they were rational actors but it is necessary to consider that there may have been other underlying factors than personal career and wealth. Björck emphasised interest in the technology itself and to raise the status of the occupational group together with personal careers. Scientific management and rationalisation were viewed upon as means both for increasing the status for the engineers as a group, but also as a "salvation" for Sweden in an increasingly competitive international industrial market. The United States and Germany were looked upon as being ahead of Sweden in these respects. Swedish engineers could describe themselves as driven by visions about a rational Swedish industry where engineers with this specialist competence were the experts. They were able to represent the public interest and contribute to Sweden's development. The enhancement of the status was one of the major reasons underlying target migration.

In this way, emigrating and returning engineers fulfilled four of the criterions Edquist and Edqvist emphasised as important in order to become a real carrier of technology. They had the information about its existence, the interest to work with it, to implement it in Sweden, and the access to and/knowledge of how to handle it. However, they still lacked the crucial power criterion when they stepped on Swedish soil again. The access and knowledge of foreign technology could in this respect work as what Bourdieu has called symbolic capital. The engineers' back-and-forth migrations in order to acquire access and knowledge to the technology could be seen as a means to accumulate this type of capital. The accumulation of symbolic capital was one of the major activities on the engineering field. On such a field, persons who valued experiences from the major industrial countries highly were deciding what engineers were suitable for high positions in Swedish industry. The ones rewarding the participants in the game on the field were often other engineers who had reached responsible positions in the industry. Their vision of Sweden as a major industrial nation was based on the development nationalism occurring about the same time as the second industrial breakthrough. The way to reach a prominent position for the country went through the application of German and American ideas and by the help of returning Swedish-Americans. It was natural that engineers who shared a lot of these ideals made temporary emigrations to these two countries. Over time the United States and Germany took over from Britain and a majority of the emigrating engineers in the cohort stayed in one or both of these countries. As leading industrial nations and models in Sweden, they also took over from Britain as "best places" to accumulate symbolic capital. The patterns also reflected the rise of the German and American economies and the relative decline of Britain's world position.

However, mass emigration to North America, which saw Sweden lose a higher proportion of the population compared to most European countries, also contributed to this pattern as well as the fact that it was occasionally difficult for engineers to find employment in Sweden, something that encouraged emigration not only to North America but also to other destinations. Generally, we may say that the cohort of engineers who went to Germany consisted almost totally of target migrants, whereas the cohort going to the United States had multiple agendas. Most engineers crossing the Atlantic were also target migrants, but there was also a minor share of them who had more in common with the general emigrants. This is also shown in the significantly high return rate of almost ninety percent for engineers who had been in Germany compared to slightly below sixty percent for those who had been in the United States. North America had a kind of Swedish "infrastructure" consisting of several Swedish organisations including engineers' societies as the one in Chicago. These societies had an important function for newly-arrived engineers when they looked for employment in the United States. In that way, they may have had a facilitating role in the process of technology transfer, possibly comparable to Edquist's and Edqvist's organisation criterion. However, they also tended to foster assimilation into American society through the celebration of the ethnic origins rather than encourage return migration. To become Swedish-American was a way to become a good American. One way was to celebrate people of Swedish origin that had made important contributions to local as well as national development in the United States.

This minority group among the emigrating engineers was considerable, but "target migration" was the main ideal. The significance of Germany as an international destination was one example of this form of migration. It connected more to old patterns of student and journeyman migration than to the contemporary patterns. In the United States, the destination pattern also reflected the phenomenon. The most "Swedish" state in general, Minnesota, was an insignificant destination for engineers, whereas destinations like Pittsburgh, and particularly Schenectady, were typical engineers' destinations. In the engineering field, a few years of employment at these places offered more valuable symbolical capital than employment at a smaller and relatively unknown company in Minneapolis.

It could have been expected that the need to accumulate symbolic capital in the form of foreign experience was highest among engineers from a lower social background and with a lower level of education. In such a case, it could be viewed as a mean to compensate the disadvantage on the engineering field from a lower amount of social capital. This hypothesis did not hold true. Traditions of geographical mobility among those of upper- or middle class as well as in birthplaces and places where they were educated seemed to have mattered more. The higher social origin the more likely the engineers were to emigrate. Furthermore, engineers born in the southern counties and educated at Chalmers in Gothenburg, where the main port for Swedish emigrants also was, emigrated to a higher extent. What kind of engineers they were also mattered. Particularly naval architects, but also electrical, mechanical and chemical engineers emigrated to a high extent. At the other extreme lay the constructional and civil engineers with significantly lower rates of emigration than other groups.

Engineers from high social origins and with a high level of education were also more likely to return. They can be interpreted as having more social capital, which possibly led them to decide that the opportunities in engineering in Sweden were better for them compared with engineers from a lower social origin. When it came to the educational sectors, all had high return rates. We can note that civil and mining engineers were below average. However, 66% of them returned.

Emigrating engineers judged that the opportunities to accumulate symbolic capital in the leading industrial were good. At least if they wanted to reach management level within the Swedish industry, they seem to have made the right decision. There are reasons to state that using "management level" as evidence of success is made in this study in order to measure the relative positions of the engineers objectively. The engineers themselves may not have strove towards these positions. However, the letters from Sebardt to Henrik Göransson and Wallenberg's description of how he recruited Edström can provide two examples of how experience from the United States was valuable. The numbers show that a significantly higher proportion of engineers with foreign experience reached this level compared to those who never emigrated. A pattern showing that experience from the United States was particularly rewarding was however not as evident. Almost one-third of the engineers who had worked and/or studied abroad reached management level, a considerably higher level compared to engineers without foreign experience. Engineers who had been on study trips had more in common with the emigrants than with non-emigrants and foreign experience seems to be an important source of symbolic capital regardless of whether it consisted of "daily life" experiences such as employment or studies at a university or shorter study trips.

When the returning engineers came back they had a symbolic capital, which could be rewarding on the engineering field. The entrance ticket to this field, i.e. education was another type of symbolic capital. A division of education was made into three levels: one high level, defined by an education from the Royal Institute of Technology (KTH), one middle level, defined by an education from the Chalmers Institute of Technology (CTI) and one low level, an education from the technical upper secondary schools and mining schools (TESM, TESÖ, BSFA, BSFI). The KTH-education was a more valuable symbolic capital than an education from CTI, whereas that education was more valuable than one from the other institutes. Foreign experience worked in this way as compensation for engineers with middle and low-level education. However, for those with high-level education these experiences lifted them even higher than their non-emigrating student colleagues.

Social capital is another Bourdieuan expression. It related to family ties, friends and networks. As regards social status, there was a pattern similar to the one observed for educational levels. Forty-five percent of engineers who were sons of large-scale entrepreneurs reached management level if they were returnees and slightly below 30% if they were non-emigrants. Emigration experience lifted sons of higher officials above the latter level, sons of small businessmen reached the same percentage and sons of lower officials also came comparably close. The other groups lay with exception between fifteen and twenty-two percent, but foreign experience was rewarding in all of them. Social capital was a facilitating factor but probably not an absolute requirement for a good engineering position. It was probably possible for a person with the right experience, a symbolic capital that would compensate for the lack of social capital, to get a position within a company even if that person did not know anyone in the whole country. But knowing, and having friendship or even family relations to persons in key positions abroad as well as in Sweden after one's return facilitated the opportunities to acquire good engineering positions and thereby also the technology transfer. In some cases, like in Erik August Bolinder's case, it was obvious that it was the social capital that mattered most. However, it was often a combination in which the symbolic capital was more important. Emil Lundqvist was an example of this. He was a good friend of Edström, but also known by the latter as a good organiser. The first criterion alone would not have given him the position. Edström had an extensive net of contacts and all of them were not suitable to organise an electrical workshop. The symbolic capital, i.e. experiences in the United States and Germany as well as a reputation as a good organiser may have been rewarding for Lundqvist if he had applied for the position without knowing Edström. However, their friendship meant that Lundqvist had less to prove.

After all, the engineers with high education as well as high social origin and foreign experience were the ones that were best off. They could use the experience and create the most advantageous positions on the engineering field for themselves. Their high social origin was the base of their habitus, but they could add the symbolic capital of a high education and foreign experiences to it. The pattern was obvious. Persons in positions to reward on the field were often from their own social background. In addition, they shared a view of applying American and German models as a means to lift Sweden up to a first ranked position among the world's industrial nations. Therefore, they recognised both the social as well as the symbolic capital of this group of engineers.

In a way, class structures reproduced themselves the way Bourdieu has described, as it was only possible for a group of engineers that did not have the same amount of social or symbolic capital to lift themselves up to the level with non-emigrating "higher" colleagues. For individual engineers, however, it was possible. Foreign experience was an important symbolic capital for all groups of engineers. The civil engineers and naval architects were the ones that gained least, but otherwise the shares reaching management level were often twice as high for the returnees compared to the non-emigrants. Engineers on study trips had more in common with the returnees than with those who never were abroad. Somewhat surprisingly, the civil, chemical and mining engineers were the ones who gained most from choosing the United States while construction engineers and naval architects gained from choosing other destinations. It is an interesting point that engineers working in an area that has been viewed as primarily German, i.e. chemical engineering had so much to gain from the United States.

The symbolic capital consisted of knowledge of how workshops were organised particularly in the United States. These practices included ideas of mass production, interchangeable parts, standardisation, larger sizes of workshops, different construction and ideas of scientific management in a Taylorist spirit. The returning engineers later acquired the power to implement many of these ideas in different places in Sweden. Rational production was combined with ideas of welfarism and brought from the United States but adjusted to Swedish conditions. It would, however, be an exaggeration to state that all ideas at the companies were American. At ASEA, railway electrification and rail apparatus, commutating motors and transformers were areas in which primarily Germany and Switzerland seem to have made more influence and people with experience from these countries also contributed with ideas of standardisation. At Sandviken, rolling and cold rolling practices as well as ideas about the organisation of the construction department originated from the United States but it was rare for engineers with other foreign experience to be in charge. At Boliden, methods developed for the search for ore seemed to have been more domestic and European then American. The same held true for the planning and building of the Boliden village, whereas the methods used at the smelting-plant at Rönnskär largely were American. At Bolinders, engineers with experience only in Sweden and in Germany had patented the engines manufactured there whereas the workshop organisation with interchangeable parts was brought from the United States along with some ideas about moulding-machines. In all, foreign technical influence was a blend in which the United States and Germany were most important.

Development nationalism with its American and German models as well as the mass emigration to North America made this pattern hardly surprising. When we look at the proportions of engineers who worked in Sweden between 1880 and 1930 we find that approximately every third one had emigration experience, whereas every eighth had experience in the United States and every ninth in Germany. Taken together, a little more than every fifth engineer had worked in one or both of these countries. No other country of destination came close to these proportions. There must have been a considerable influence on Sweden through the returned engineers. In most sectors, the rates of engineers with emigration experience working in Sweden lay around one-third, with naval architecture at one extreme. More than half of them had emigration experience but only 20% of civil and construction engineers had been working/studying abroad. In naval architecture and electrical engineering, the American experience, at least in a proportionate context, was most considerable. In the former group almost forty percent of the engineers had been in the United States and the rate was slightly over twenty percent for the latter. Higher proportions of chemical, constructional and mechanical engineers working in Sweden had German experiences compared to experiences in the United States.

If we look closer into primarily ASEA and Sandviken and the different departments it appears as if the United States was even more important compared to other countries than on the general level discussed above. At ASEA, three-fourths of the departments were at some points of time managed by an engineer with experience in the United States and almost half of them for all or most of the time of their existence before 1940. In Sandviken, the corresponding proportions lay somewhat below. Both at Bolinders and Boliden, there were returning engineers in the top management positions, and we will later return to discuss this on a wider-scale. We need, however, to consider that it may be difficult to connect technology and other ideas both to individuals and to geographical locations. Technology and ideas were not developed in a vacuum, but through co-operation between people often active in different places. The influence may come from one place, which in turn had been influenced by another. Furthermore, we also need to consider that many engineers had not been abroad and that ideas could have occurred in Sweden.

The above mentioned career paths facilitated the implementation of technology and ideas that the returned engineers had picked up while they were abroad. A higher position meant power, one of the crucial criterions in Edquist's and Edqvist's theoretical concept. One question is if the returned engineers were a source of technical development for Sweden during the large-scale industrialisation. One piece of proof that this was the case is that they filled leading positions at major companies in the Swedish industry in the first decades of the twentieth century. In the mechanical and electrical workshops their shares were about two-thirds of the leading positions, in the steel and iron industry the share was about forty-five percent, whereas the share within mining lay on a fourth of the positions. Most of these returnees had been in the United States but the country was challenged by Britain in the area of mechanical engineering. Engineers who had worked in

Norway played a major secondary role in mining. In the area of electrical engineering, Germany was bigger than the United States at the smaller companies, but this was reversed at ASEA. In the steel and iron industry, the United States looked more unchallenged.

The influence of the returning engineers must have been considerable as so many engineers possibly acted in accordance to what they had learned abroad at several places and over time within major companies in the industrial branches. The Bourdieuan expression habitus is a system of dispositions allowing people to act, think and orient in the social world. It is based on previous experiences and memories and a kind of incarnated capital. These returning engineers acted in correspondence with their habitus and viewed Taylorism, rationalisation and other technical innovations as natural within the industry. In that way they possibly forced engineering colleagues without the same kind of experience to re-value their views about organisation, technology, etc. If this happened, the returning engineers were able to exercise technical influence on the Swedish industry, perhaps more than any other group. They became fundamental for technological importation. The engineers with experiences in primarily the United States and Germany thereby could largely shape the technological development within Swedish industry.

The very strength of the stream of return migration among engineers to Sweden, their ability to base occupational careers on previous foreign experiences and implement certain technologies were proof of the German-American blend influencing Swedish industry. There is no natural law stating that return migration, even of skilled people, always lead to development or change. Three conditions must be fulfilled according to Ghosh's conclusions about present-day return migration to lower developed countries. The returnees must be more skilled compared than if they had stayed at home the same time, their skills and knowledge must be relevant for the home country's economy, and they must have the willingness and opportunity to use the skills upon their return. Applied to the returning engineers in Sweden during the years 1880 to 1930, the first condition was fulfilled. The process of high emigration and return migration of Swedish engineers to the leading industrial nations indicates in itself that this happened. Furthermore, mass production was relatively uncommon in Sweden during the years around the turn of last century and there was a lot to learn abroad, standardisation was not common and the sizes of the generators and apparatus were generally smaller, etc. It seems obvious that the temporary stay abroad for a substantial number of engineers in Sweden meant an increase of the total amount of skills and knowledge.

Let us jump over the second condition for a while and continue with the third. We have seen that the returning engineers to a larger extent than non-emigrating obtained higher positions in the Swedish industry. We have also seen that there were high proportions of them in leading positions in the electrical industry, the engineering industry, and the steel and iron works. These two factors, and their actions at our case study companies, were proof that they both wanted and had the opportunity to use the skills. The experiences worked as a symbolical capital which gave them leading positions regardless of whether they were driven by the promotion of their own careers, were interested in technology as such, wanted to raise the status of the engineering occupation, or had a will to contribute to Sweden's technical development. From these positions, they were able to exercise influence.

The second criterion, that skills of the returnees had to be important for the home country's economy was also fulfilled. Rationalisation, standardisation and other production methods applied in the United States and Germany were seen as means to uplift the Swedish industry in the light of the development nationalism. Returning Swedish-Americans could be helpful. The problems that often occur in present-day developing countries, i.e. that the returnees who acquired skills abroad have difficulties to find appropriate positions because of the difference in technical level between the home and the host country, were not evident in Sweden during the time period 1880 to 1930. Sweden was among the countries that most easily could adjust to the pre-conditions required for economic growth. Swedish industry was successful at international exhibitions before 1890. The technological gap between the leading industrial nations and Sweden was not too wide and the country could easily adjust to the technologies brought about by the returnees.

Sweden was a country whose large-scale industrialisation occurred late but was not a lower developed country even by nineteenth century standards. The take off led to a Swedish industrial development and growth that was the world's fastest in the period from 1890 to the 1930s. It indicates that the practices implemented by the returning engineers often were successful in the longer run, even if they may have had negative short-term effects. The criterion referred to above was one of the factors Svante Lindqvist emphasised in his survey of crucial factors if technology transfer was to succeed. The technologies and ideas brought back could possibly be adjusted to the technical and political conditions in Sweden and contribute to the technical development in the country. The United States and Germany probably did not export technologies and practices that were most exceptional in their national contexts. Sweden was behind but not to an extent that it was impossible to implement and adjust the returning engineers' ideas. The country had a comparably high level of education of engineers already in the mid-nineteenth century. Sweden was also able through repatriation of engineers from the leading industrial countries to build up the technical expertise required in order to be able to receive the technical changes brought about by the returnees.

Swedish natural resources probably facilitated the implementation. All the industries investigated in this thesis were dependent on natural resources. It was a prerequisite for mass production and standardisation that the production was made in large quantities. A country rich on natural resources found it easier to bring about such production without being forced to import raw materials. The geographical conditions in the country made it easier for ASEA to develop competence in transmissions of electrical power over longer distances. As this happened, it is obvious that these conditions also must have enabled the development of machines connected to it and the implementation of ideas from other countries. It was easier to make tests, etc. if the country had the natural conditions. The unique ore deposit in Boliden was a prerequisite for the establishment of the smelting plant at Rönnskär, as the company needed to refine the ore themselves. It also created an environment for experiences with methods and technologies the returning engineers had picked up, primarily in the United States. The natural resources, thereby, became a facilitating factor for technical changes that were implied by the returned engineers.

They also had the appropriate political as well as economic backing. Resources were spent on workshops, rolling mills, smelting-plants, etc. where the returning engineers worked. ASEA's extensive resources spent on the laboratory, Bolinders' cheering of the motor workshop, the creation of the Rönnskär smelting plant, and the money spent on experimenting with methods when it came to the use of arsenic, the smokestack and the flame furnaces offer proof of this. We have also seen that the symbolical capital worked as an asset for the returning engineers in order to obtain high and powerful positions in the Swedish industry which can be viewed as a kind of political support for their ideas. Furthermore, several examples have shown that the actions taken by the returning engineers when they re-organised workshops and rolling mills were cost-effective. Esselius's reorganisation in the Sandviken rolling mills were examples of this, as well as the mass production introduced by Lundqvist at ASEA. These factors, thereby, worked in favour for a successful implementation.

Furthermore, the technology suited well the surrounding context of development nationalism with American and German models. The culturally conditioned views, where technological development was viewed as something good in one society and bad in another created no problems for the transfer to occur, since this was not the case. Although there were different political views in early twentieth century Sweden of both the United States and Germany, there was relative agreement about the advantages of American technology.

In the local societies, the technological changes must have had different impact on different groups. Esselius's actions in Sandviken meant that workers had to leave the department and this implies that his technological changes had a negative impact on many people's daily life in the community. It has not been possible to ascertain whether the workers were transferred to other departments. The total amount of workers at Sandviken increased with some exceptions in the early decades of the twentieth century and the same held true at ASEA after Edström's and Lundqvist's arrivals.[1] This indicates that it was possible for the workers to be transferred to other departments within the companies, and that the technological changes may have brought about surpluses that made possible the employment of more people. However, it is not possible to exclude the possibility that the statistics were based on replacement of some workers by other workers which would imply negative personal consequences and labour unrest. There were reactions from the workers towards Esselius's ideas, but the picture was two-sided. It is possible that the companies managed to compensate the workers for the rationalisations by transfers to other departments and possibly also by welfare practises, both in old and more modern periods of time. The emotional loyalty created by such practises probably facilitated technologies to be integrated into the local society. Both Sandviken and Boliden became leading companies when it came to welfarism and the former had a base to build from the elderly patriarchal structure. Falkman was described as a man who wanted the Boliden Company to give something back to the region where it was active. Bolinders and ASEA were also active when it came to arranging housing to the workers. It was earlier stated that Bolinders made use of more machines than comparable workshops in Stockholm. In arranging housing for the workers, the company was also more active than other workshops in Stockholm in the late nineteenth century.[2] It seems to be a pattern where rationalisation often was combined with a more extensive social policy from the companies' side. In the early twentieth century, the relatively strong Swedish labour unions could exercise influence and to some extent modify ideas that aimed to introduce more of Taylorism. The underlying purposes behind the employers' strategy may have been more connected to company and industrial interests than to a real concern about the workers and the negative impacts of rationalisation. But the strategies possibly "calmed" labour unrest and thereby facilitated integration of these ideas in the local communities.

It has been stated that returnees compared to foreigners could invest human capital resources based on experience from other countries more easily. The returning engineers were well integrated in the communities to which they returned. The study of ASEA showed that only a few of the engineers with experience from abroad were immigrants and it was also evident that they became integrated in the community. In Sandviken, all the foreign experienced engineers were returnees and many of the engineers had their roots in the immediate area or at least in the iron works region. The son of the founder overtook Bolinders and the chief engineer had spent time in Stockholm as a student at KTH. With the exception of Boliden, the returning engineers were often more or less connected to the regions, places or even companies they returned to. In the Boliden case, the returning engineers seem to have become integrated in the Skellefteå region although virtually all of them originated from places located more than six-hundred kilometres away from there.[3] The integration of these engineers was a factor that influenced the implementation of the technologies they brought about. It was advantageous that they were there to work with the technology.

In all, these factors encouraged the successful implementation of technology carried back to Sweden by the returning engineers during the second industrial breakthrough beginning in the 1890s. Sweden witnessed an extraordinary increase in the industrial productivity from 1890 and had a boom that lasted until 1920. The acceptance of ideas carried home by returnees must have been a considerable contribution, considering the proportions they constituted within major industrial branches. Technical change may not always be something positive and rationalisation could have had negative impacts in many people's lives especially on a short-term basis. When we were discussing the returning engineers as a source of development, we should not forget this fact. When we are looking more at a long-term perspective we can, however, state that Sweden managed to combine industrialisation, rationalisation, technical change, increased living standard and, in the longer run, an extensive welfare system. The returning engineers contributed to industrial growth, which generated economic resources for the country. In Sweden, their ideas were adjusted and moderated to suit the particular Swedish conditions, something that facilitated the integration of them in national as well as local contexts. The engineers were "Learning and Returning" and the initial loss of competence the country suffered when they emigrated was turned into a source of development when they returned and achieved responsible positions. The statement that Sweden was technologically inferior in the mid-nineteenth century is exaggerated but it can be safely concluded that other countries were in front and it was important to learn from them. Today's Sweden is different, and the discussions about "brain-drain" must of course take their point of departure in today's situation where Sweden is among the world's leading nations in information technology. Still, a historical perspective may cast light on the fact that what with modern words are called “brain-drain” and “brain-gain” are not entirely modern phenomena connected to what often is called globalisation in early twenty-first century debates. Geographical mobility is often connected to this expression. For many members of this group of late nineteenth and early twentieth century Swedish engineers, the world of opportunities probably looked as global as for anyone today. Still, the engineers returned to Sweden and brought knowledge to the country. Many of the engineers who are emigrating today can be expected to return later in their lives. Perhaps we shall focus more on efforts to make them do so than to make them stay at home during whole their careers since they can bring home important knowledge?

Notes

1 *Ett svenskt jernverk,* 402; J Glete 1983, 49.

2 T Gårdlund 1945, 148-149.

3 O Falkman, n. d, 77; S Mörtsell, 380; *Bergsskolan i Falun,* 182, 192.

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