

# **The Enlightenment, Industrial Development and the Industrial Enlightenment – Questions about a Useful Knowledge in Iron Making**

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In 1997 Robert Darnton published a short article, entitled *The Enlightenment: A personal view*, in which he was very critical of many recent studies of the topic. He set off by stating that ‘We live in an age of inflation’, a process that had spread to all parts of society, ‘inflated money, inflated grades ... and inflated ideas’. According to Darnton this process had even reached ‘our understanding of the movement at the beginning of modern political culture, the eighteenth century Enlightenment’ which ‘has been blown up to such a size that it would not be recognized by the men who first created it.’ Instead of sticking to the traditional definition of the Enlightenment as a very French movement around a small group of *philosophes*, centered around reason, liberty, secularisation, etc., scholars have begun to identify a number of different ‘Enlightenments’. First, there is now an Enlightenment for every country, but more recently many aspects of eighteenth century life have been connected to the movement, and, which seems to be Darnton’s idea, began to live an academic life of their own. There is ‘the Pietist Enlightenment, the Jewish Enlightenment, the musical Enlightenment’, as well as many more.<sup>1</sup>

From Darnton’s standpoint the situation has hardly improved in the last decade. In 2004 Gertrude Himmelfarb issued *The Roads to Modernity: The British, French, and American Enlightenments*, which not only reopens the debate on the different national characters of the Enlightenment but pointedly identified virtue, not reason, as the most valuable feature of the movement. For Himmelfarb, reason was the governing idea behind the French Enlightenment while virtue was the key British trait. It was the British notion of virtue, not the French notion of reason, that played the most praiseworthy role in the creation of the modern world.<sup>2</sup> The last years have also seen the Enlightenment encroach upon another sphere of action, that of industrialisation and technological development, with Joel Mokyr coining the term ‘The Industrial Enlightenment’. Like Himmelfarb, Mokyr seeks to trace the intellectual roots of the modern world, but contrary to his colleague he wants to uncover the intellectual origins of the modern industrial world and not the birth of a modern democratic society. For Mokyr the industrial revolution, with its emphasis on technological creativity, was rooted in a belief in the reason of the Enlightenment, the Industrial Enlightenment.<sup>3</sup>

Darnton has a cure for this development: ‘I propose deflation.’ The Enlightenment should be viewed according to the traditional definition, as ‘a concrete historical phenomenon’ located in Paris in the eighteenth century, with men of letters, such as Voltaire, Diderot, Hol-

bach, etc., as its intellectual bearers.<sup>4</sup> In so doing Darnton actually turns the clock back to a position held by Peter Gay, who in the late 1960s published the two-volume *The Enlightenment: An Interpretation*, in which the ‘Frenchness’ of the movement was highlighted. To Gay the Enlightenment was a French movement, or rather a programme, in which reason was used in order to achieve freedom and progress, and during which hostility to religion was omnipresent. Science, and the scientific approach, became the tool to investigate the World, instead of theological dogmas.<sup>5</sup>

Gay’s interpretation has remained a standard account ever since its publication, but the subsequent decades have seen a gradually more intense debate about the movement, moving in a direction towards the point which Darnton called ‘inflated’. Interestingly enough, Darnton can himself be accused of heading this march towards a larger and more encompassing view of the Enlightenment, with his study of the literary underworld in Paris, in the early 1980s.<sup>6</sup> This thematic detour by Darnton, away from the writings of the *philosophes*, was complemented by a near-simultaneous publication that questioned the very ‘Frenchness’ of the movement: *The Enlightenment in National Context*, in which scholars scrutinised the movement from different national perspectives.<sup>7</sup> From that point (of no return?) the debate about the Enlightenment has proceeded. By 1990 Roy Porter could state that it is hard to maintain that the *philosophes* acted in concert and that they should be seen as a unified family, for their views were too disparate. Nor should they be seen as ‘dogmatic system-builders’, as their use of reason always was tied to other qualities such as sensibility, experience and virtue. Instead we should view the Enlightenment as a much wider process of profound change within the *l’ancien régime*, that gradually affected the life of Europeans and Americans throughout the eighteenth century. We are dealing with a broadly-based process which articulated the need for a new and radically different society, in which the ‘men of letters’ might only constitute a kind of intellectual ‘avantgarde’.<sup>8</sup> Another scholar with a similar view is John Robertson, who argues that the Enlightenment must be seen in its international context, where ideas and views are transmitted over borders as well as oceans, and that the idea of human progress lies at its very heart. In making this argument, Robertson identified ‘political economy’ as an essential part of the Enlightenment (‘an intellectual and political movement for the improvement of the human condition’).<sup>9</sup>

Another strand of this recent debate about the Enlightenment has taken its starting-point in a (non-French) classical text of the movement: Immanuel Kant’s *An Answer to the Question: ‘What is the Enlightenment?’* According to Kant, reason was the springboard of social development, but the eighteenth century had not seen enough of reason and Kant therefore asserted that he did not live in an enlightened age but rather in an Age of Enlightenment, and he foresaw the progressive fulfilment of its promises.<sup>10</sup> This prediction of future progress and, as later scholars have interpreted it, the linking of the Enlightenment to the rise of modernity, has proved to be a tempting thought for many scholars. Darnton made that connection, stating that the Enlightenment marked the beginning of modern political culture, and so have – more explicitly – both Himmelfarb and Mokyr. Postmodern critics have, of course, denied any such connection, arguing that key concepts in Enlightened thought, such as reason and progress, are elusive and unstable.<sup>11</sup> Indeed, there has been a tendency to caricature the Enlightenment as ‘the other of postmodernism’.<sup>12</sup>

This paper takes its starting-point in this multifaceted debate about the Enlightenment – about its chronology, spatiality and content. We contend that we are dealing with a cosmopolitan process, and we also see the trait of progress as essential to the Enlightenment, as is

reason. We view the Enlightenment as the crucible of modernity. We are not wholly neglectful, however, of insights from the postmodern critique. In particular, we are interested in the developmental trajectory between the Enlightenment and industrial modernity.<sup>13</sup> We are concerned with the concepts of reason, progress, technological development, economic growth, etc. – and we have to ask what was meant by these terms during the eighteenth century.

## **Economics, technology and the Industrial Enlightenment**

Ever since Arnold Toynbee, in 1884, poetically wrote that the traditional society ‘was suddenly broken in pieces by the mighty blows of the steam engine and the power loom’ technology has been an important and persistent feature in academic writing about economic and social change.<sup>14</sup> Technological transformation became more or less synonymous with the concept of the Industrial Revolution, which Toynbee had fetched from a journalistic and political discourse and introduced to the scholarly world of the universities. As David Cannadine has reminded us, the impact of technology on economic growth has fared differentially over the years, but it has never totally disappeared from the agenda.<sup>15</sup> In the 1960s David Landes restated Toynbee’s dictum, about technology’s revolutionary impact on society, while Nick Crafts and Knick Harley have spent much time and resources to prove that it was not as important as earlier scholars had stated. Technology, however, remained still important in their thinking!<sup>16</sup> From the 1990s technology became once again a more crucial trait in the explanations of economic change. Joel Mokyr, and his *The Lever of Riches*, can be seen as a kind of ‘third generation Toynbee’, with the introduction of the somewhat more encompassing notion of ‘technological creativity’, and his distinction between ‘macroinventions’ and ‘microinventions’.<sup>17</sup>

Even if it is agreed upon that technology is one very important feature in explaining economic growth and change, it is not equally clear what different scholars have meant when they have discussed technology. Should we concentrate on material artefacts and their functioning? Or concern ourselves with the economic impact of new techniques, monitoring technology only as a residual – ‘a black box’ – in a production function? The origin of technological development has also been an area of disputes and discussions. Historians of technology have often pointed towards individual traits of brilliant inventors, while economically focused scholars have looked more in the direction of qualities within the society in which the inventions took place. Technological change have been explained by a very wide array of causes, such as labour shortages, resource endowments, secured property rights, wars, religion, scientific knowledge, etc.<sup>18</sup>

*The Lever of Riches* is to a large extent an exception to this divided structure. It is, for a start, an economic treatment beginning with an extensive narrative about the development of mechanical artefacts from antiquity to the nineteenth century, but its analysis uses a much wider definition of technology (‘the knowledge of how to produce a good or service in a specific way’), and offers a framework for dealing with this technological progress. According to Joel Mokyr we are studying a development similar to biological evolution, and that technological change is a process whereby ‘ideas catch on because in some way they suit the needs of society’. What Mokyr is proposing is a model where technology is ‘epistemological’, to know something, and where this knowledge is changed in an evolutionary way. The latter word can be used in different ways, but Mokyr uses it to mean ‘chaotic bifurcations and catas-

trophes leading to unpredictable new steady states'. Technological development is thus something that might be described but hardly fully understood or explained, and the model does not deal with what sets off the 'changes in our knowledge'.<sup>19</sup>

After more than a decade Mokyr returned to the matter of technology as knowledge, as well as its impact on economic change, and he has done so – according to a reviewer – 'with a vengeance',<sup>20</sup> in his *The Gifts of Athena. Historical Origins of the Knowledge Economy*. This time the discussion about knowledge has really been brought to the fore, with the new concept 'useful knowledge' as a kind of master trait for technology, and he has explicitly addressed the question of the origin to any alterations of our knowledge. The aim of the book is to analyse this 'useful knowledge' and how that relates to 'natural phenomena that potentially lend themselves to manipulation, such as artifacts, materials, energy, and living beings.'<sup>21</sup>

Central to Mokyr's analysis is the distinction between two types of knowledge, propositional and prescriptive knowledge, and the relationship between the two. With the first term is meant how society on a collective level understands the natural world, while the latter term, or *techne*, includes the techniques available for the manipulation of nature. Propositional knowledge is in turn divided into two parts: 'one is the observation, classification, measurement, and cataloguing of natural phenomena'; the second is the 'establishment of regularities, principles, and "natural laws" that govern these phenomena'. It is important to underline that Mokyr insists that propositional knowledge is far wider than 'science', and also include folk wisdom and artisanal practice as well as engineering knowledge.<sup>22</sup>

This foundation, with the two types of knowledge, is then put to practice in a discussion about industrialisation. 'The key to the Industrial Revolution was technology, and technology is knowledge', and we are thus back to the question of what it was that triggered the changes in the useful knowledge. Mokyr proposes that we should 're-examine the epistemic roots' to industrialisation, and the answer he comes up with is that there is a neglected link between the Industrial Revolution and the Enlightenment. The latter was, according to Mokyr, 'a multifaceted and complex phenomenon, aimed at least as much at changing the existing political structure and the distribution of income it implied as at increasing wealth by making production more rational'. It is of course the latter part that is of interest in *The Gifts of Athena*. The Industrial Enlightenment is about 'that part of rationality that involves observing, understanding, and manipulating natural forces.'<sup>23</sup>

The Industrial Enlightenment is the missing link between the Scientific Revolution of the seventeenth century and the Industrial Revolution of the nineteenth century. According to Mokyr it did so in three ways: 1) by surveying and cataloguing work practices it helped to determine the superior technology; 2) by understanding how techniques worked it created wider 'epistemic bases'; and 3) by facilitating 'the interaction between those who controlled propositional knowledge and those who carried out the techniques contained in prescriptive knowledge'. The Industrial Enlightenment inherited from the Scientific Revolution a method and a scientific culture, and armed with these qualities it was well prepared to enhance knowledge and thus to speed up technological change.<sup>24</sup> The Enlightenment is also seen by Mokyr as a veritable knowledge revolution during which knowledge was not only enhanced, but also more widely spread. The *Encyclopédie*, like other less exalted dictionaries, was an important 'container' of knowledge and information, which made the transmission of knowledge much easier.<sup>25</sup>

In a more recent publication Mokyr has sharpened his thoughts about the Industrial Enlightenment and at the same time brought it much closer to the debate about the Enlight-

enment. His smaller ‘slice’ of the larger movement is defined as ‘a belief in the possibility and desirability of economic progress and growth through knowledge’, and he states that the main trait must be seen as ‘the idea of improvement’. In so doing, the model gets a more pronounced purpose, and the concept of the Industrial Enlightenment becomes equipped with a will to change, a desire to put new knowledge to active use.<sup>26</sup> To oversimplify, one could state that in Mokyr’s model the scientific revolution of the seventeenth century, with its emphasis on knowledge structured along scientific lines, developed into the Enlightenment of the eighteenth century, where aspects of progress and improvement became more pronounced. The Industrial Enlightenment was ‘a more narrow and focused’ part of the larger movement with a growing awareness of the utility of ‘useful knowledge’ which in turn was the intellectual origin to the Industrial Revolution.

The Industrial Enlightenment might for Robert Darnton be ‘a concept to many’ – to use a phrase coined by D.C. Coleman<sup>27</sup> – but if one scrutinises the most recent of Joel Mokyr’s writings about the feature it becomes clear that he has closed in on a kind of traditional, or mainstream, definition of the Enlightenment. The very cornerstone of his analysis is a firm belief in reason, and in highlighting progress and ‘improvement’ he is also linking the Industrial Enlightenment to the creation of the Modern World. What Mokyr has given us is a model rather similar to the one proposed by Darnton or Himmelbarb, different in emphasis but comparable in its chronological structure. The difference is this: whereas Darnton or Himmelbarb put stress on politics and social thought, Mokyr addresses the use made of knowledge and attitudes towards production.<sup>28</sup>

With its emphasis on reason and progress, Mokyr’s model speaks to many of the major questions now at issue with respect to the Enlightenment’s chronology, spatial dimensions and content. These are big questions. In this paper we broach them in a modest way, by examining the intellectual foundations of technological change and economic development in a particular setting. We focus on Sweden, and its most important industrial sector: iron making.

## **Mercantilism, the Enlightenment and Swedish Iron Production**

Was there a Swedish Enlightenment? Tore Frängsmyr’s provocative investigation of 1993, *Searching for the Enlightenment*, concluded with a clear negative answer. He conceded that it was possible to find singular individuals, like Kjellgren and Rosenstein, who towards the end of the eighteenth century promoted ideas along French philosophical lines, but to infer that Swedish society was therefore permeated with enlightened ideas was wrong.<sup>29</sup> Frängsmyr’s view has not been unchallenged, and to a large extent one can say that he is more or less alone in denying the presence of enlightened ideas in Sweden. ‘Of course there was an enlightenment in Sweden’, according to another participant in this debate. Frängsmyr has been criticised for being too narrow in his definitions, for relying too heavily on Robert Darnton, and for doggedly searching for traces of French philosophical influences in Sweden.<sup>30</sup>

As will be shown below, we contend that enlightened ideas were very much present in Sweden during the eighteenth century. However, it must be stated, sadly, that discussion on Sweden’s Enlightenment has proceeded without much reference to the economy and economic development. The presence of the Enlightenment in Sweden has largely been analysed from a cultural angle, or in relation to Swedish scientific developments.<sup>31</sup> This omission of a thorough analysis of the economy in this debate is not only problematic but also very strange,

bearing in mind the research of distinguished Swedish scholars, from Eli Heckscher to Lars Magnusson, on mercantilism. Nothing of that has, however, been related to the existence, or non-existence, of a Swedish enlightenment.<sup>32</sup>

Instead one can say that the only attempt to relate the development of Swedish economic discourse and the enlightenment is the one performed by Frängsmyr. After dismissing the existence of a Swedish enlightenment he posed the obvious question of what Sweden was if not an enlightened society. The answer he came up with is that it was a country totally dominated by utilitarian dogmas, within which scientific progress marched hand in hand with mercantilist ideas. The connection between economic thinking and the enlightenment was, thus, a negative one. Frängsmyr, following Heckscher and Magnusson, sees the early decades of the eighteenth century involving not just the advent of a new, non-absolutist political system, (*The Age of Liberty*) after Sweden's defeat in the Great Northern War, it meant the introduction of a new way of thinking about economic matters. After the loss of so much of Sweden's Baltic empire, it became essential to regain strength, not to mention national pride, and to do so by economical means instead of military expansion. 'Utility' became the overarching aim, to which everything else was subordinated. Frängsmyr has gone so far as to say that the rapid growth of the natural sciences in Sweden, principally in botany and chemistry, should be seen as performing 'a refined economic role'. Magnusson has concurred: 'To develop this "utility" became a true patriotic task for the individual.' This was linked closely to mercantilist ideas about the importance of a large internal industry, or rather manufacture, and a positive balance of trade.<sup>33</sup> Linnaeus, no less, personified these links. In a programmatic text from 1740, included in the first volume of the *Proceedings of the Royal Academy of Sciences*, he proclaimed a unity between the sciences, the economy, manufactures and trade.<sup>34</sup>

No science in the World is higher, more necessary and more useful than Oeconomy, as the temporal welfare of all humans rests upon its foundation; this science ought therefore to be developed and employed with the utmost diligence; as should Physics and Nature-knowledge without no Oeconomy can exist.<sup>35</sup>

Another crucial figure in this quest for utility, and for aligning the natural sciences with economic reasoning, was Anders Berch, the first professor of economics in Sweden. In 1747 he published a general text-book on economic matters in Sweden, which remained in use well into the next century. He defined the object of economic science as the 'many ways of administering and augmenting... agriculture, mining and metal-making, handicraft and trade [which] are the sources from which the common goods of a society float'.<sup>36</sup>

Linnaeus, Berch and many others were busy expanding propositional knowledge and mediating it to a wider audience. Linnaeus travelled widely within Sweden, with a clear mission to learn more about the country and its resources, and he sent out his disciples to other parts of the world as well. At the same time there seems to have been a genuine movement within Sweden to participate in what Mattias Legnéér has called the 'just description of the fatherland'. From about 1740 a large number of topographical treatises were published with a clear focus on economic matters.<sup>37</sup> Sweden, from at least the 1730s, must be viewed as a country in which enlightened ideas had begun to spread, at least if we are to rely on the model proposed by Joel Mokyr. The enhancement of "utility" had become a leading motif of Swedish society.

Nowhere was this endeavour more pronounced than within the iron industry, the most important sector in the Swedish economy next to agriculture. Its importance had been confirmed already at the beginning of the seventeenth century with the establishment of *Bergscollegium*, the Board of Mines, as a state bureau with far reaching authority over the industry. From the

outset it was to monitor the performance of the industry, and from the late seventeenth century it also started to keep tracks of foreign iron making as well. Through its regional and local networks it was informed about the internal affairs, and by sending out travellers abroad it was able to monitor the international scene. At first informants went to central Europe, the centre of early modern mining and smelting, but from the early eighteenth century Britain gradually became the main destination. These travellers came back from trips, often lasting several years, with extensive diaries and travel reports that are filled with details about the British iron industry and the market for Swedish iron. Very often they also give information about general developments of the British economy as well as of other trades.<sup>38</sup>

A typical example was the journey undertaken by Samuel Schröder. Between 1748 and 1751 he travelled on foot through Europe, of which about eight months was spent in Britain. He was very much a traveller in the mould of Linnaeus and Berch, in that he went away with a clear ambition of enhancing the knowledge about a foreign country in general and its iron making in particular. He disembarked at Harwich in December 1748 and then headed directly to London where he spent some time improving his English and arranging introductions. Schröder, like other Swedes before and after him, met people connected to the Royal Society. He was then well prepared for an odyssey through the country and the first major stop was Birmingham, with its industrial landscape of metal-making workshops. Other ‘musts’ on the way included Ambrose Crowley’s workshops around Newcastle and steelmaking houses in Sheffield, as well as the Darby works at Coalbrookdale. He also visited Bristol, Liverpool and the textile towns of Lancashire and the West Riding, before ending his stay with a couple of weeks in the capital.<sup>39</sup>

Schröder was a typical Swedish traveller in many ways, but atypical in that he left one of the most substantial diaries of the century. It was in fact not just a plain diary, but rather a combination of day-to-day notes with longer and more substantial treatments of different aspects of Britain’s economy, society and life. In that sense Schröder can be said to be a transitional figure when it comes to mediating acquired knowledge about iron making and economic conditions in foreign countries. For much of the eighteenth century not many of these diaries/reports were published, although we do know that they were widely read in manuscript. Only in the later years of the century do we find them in published form. Another aspect of the changing forms of these reports relates to the structure used. In the first half of the century the ‘plain’ diary dominated; Schröder innovated by combining the diary with a more scientific analysis.<sup>40</sup> Change hastened after 1760. In 1766-67 Bengt Andersson Qvist travelled through Britain. Once back in Sweden he submitted a travel-report divided into sixteen different chapters, each devoted to different aspects of British iron making, starting with pig iron making in blast furnaces and ending with a description of the making of different metal wares.<sup>41</sup> A decade and a half later, Salomon von Stockenström came back from a journey in central Europe and France. He adhered to the principles that Linnaeus had developed for classifying plants and animals, dividing the methods used for making bar iron into seven different ‘classes’, each of which was divided in turn into the specific forging methods.<sup>42</sup>

This trend culminated in the work of Sven Rinman, the most highly renowned metallurgist in Sweden during the second half of the century. He was an employee of *Bergscollegium*, and had published widely since the early 1770s on many different aspects of the trade. In 1788 and 1789 he published his four-volume *Bergwerks Lexicon*, an encyclopaedia embodying all existing knowledge about mining and metal making known to the author. His organising principle was the alphabet.<sup>43</sup>

If Joel Mokyr's discussion about knowledge and the Industrial Enlightenment is to be our guide in assessing the Enlightenment in Sweden we are bound to come up with a positive answer, at least as far as the development of propositional knowledge goes. Seen from an international view-point Swedish achievement in science, and perhaps even more so in the communication of science, was quite remarkable. Linnaeus is, of course, the leading figure in this discussion, but he was followed by other important characters. Indeed, Swedish society seems to have been caught up in a whirlwind of observing and cataloguing scientific data, all related to the utility of society. The Swedish iron industry was no exception, quite the opposite. *Bergscollegium* led the way in accumulating knowledge about iron making, both domestic and foreign. A thorough study of the reports left from these missions reveals much about the international affinities of Swedish *savants*. Rinman's *Bergwerks Lexicon*, for example, can clearly be seen as a minor counterpart to the French *Encyclopédie*.

Yet problems arise when moving from an analysis of propositional knowledge to a discussion of prescriptive knowledge. The Swedish case gives ample examples of observing, classifying and cataloguing; that is, an enhancement of Mokyr's 'knowing "what"'. 'Knowing "how"' is much more difficult to evaluate. On the one hand it is obvious that this kind of knowledge was widespread in Swedish society. To take the iron industry as an example, it is clear that a range of actors, from workers to *Bergscollegium* officials, were well equipped with the prescriptive knowledge to make iron. On the other hand it is equally clear that it is difficult to talk about a development of this knowledge in the same way that Mokyr does. In eighteenth-century Sweden there was an improvement in propositional knowledge, but there are conspicuously few signs of a similar development *vis-à-vis* prescriptive knowledge. Samuel Schröder and his compatriots, trotted along the routes between Britain's industrial districts observing and cataloguing the different ways of making iron, steel, metal wares and textiles, but did not address what could be seen as *techne*, nor deal with anything that could be used as 'manuals' for 'manipulating natural forces'.

The conspicuous feature of these travellers diaries/reports, or even printed works from the period, is that production is not at all salient. Eighteenth-century Swedish travellers to Britain seem to have been as interested markets as they were production sites. Reinhold Angerstein, to name just one, steered his steps towards ironmongers before visiting ironworks, and when in metal wares workshops in Birmingham kept a keener eye on the sorts of iron they used than on how the wares were made. Even if Bengt Andersson Qvist, mentioned above, structured his report as a kind of production chain leading from blast furnaces to saw-making workshops, he acted in the same fashion, with a text that dwelt heavily on the marketing and exchange of goods. Production was analysed, and described, but hardly in isolation. Instead it is clear that it was inserted in a much wider framework, which constituted the basic concept with which these travellers created meaning.<sup>44</sup>

When Samuel Schröder, in 1749, compiled his 'Notes on the English Iron Trade' his starting point was a survey of bar iron making at English forges.<sup>45</sup> That led to a discussion of the market for bar iron in Britain, and how imports from Sweden, Russia, Spain and the American colonies swirled about it. A description of the uses to which malleable iron was put in British manufacturing followed. Finally he addressed the marketing of British-made hardware domestically and internationally. Schröder called this an 'Iron-system', and within this structure production was inseparable from marketing. Schröder was not alone in using the concept 'system', or 'sisteme'. The contemporary term 'näring' had the same connotations – a unity of

making and trading.<sup>46</sup> Interestingly, a similar conceptual structure was employed in English. Daniel Defoe's *Plan of the English Commerce* declared that

Trade, like Religion, is what every Body talks of, but few understand... The general heads of Home-Trade are best contain'd in the *two* plain and homely Terms *Labouring* and *Dealing*. 1<sup>st</sup> *The Labouring Part*, this consists of Art, Handicraft, and all Kinds of Manufactures; ...2. *The Dealing Part*; this consists of handing about all the several Productions of Art and Labour, when finish'd by the Hand of the industrious Mechanick, and made useful to Mankind; conveying them from Place to Place, and from one Country to another ...<sup>47</sup>

This way of linking production to marketing within the concept of trade (or *Näring/System*) was not just a mercantilist conceit, it was embedded within a still larger scheme, that of the Divine Order. It was common during the period to divide the economy into three different entities; *Oeconomia divina* (called by Linnaeus 'oconomia naturae'), *Oeconomia publica* and *Oeconomia privata*, and that behind this order stood the Creator. Berch talked about 'The Creation which had given so many precious gifts', and another economic writer, Jacob Fagot, pointed towards 'the gifts and benefits, which the Creator has laid down in our dear fatherland.' God thus created the conditions on which man made his living, and the latter had to adapt to the scene in which he was placed. This was an essentially passive world-view, in which there was limited scope for humankind to transform its environment. For Berch this was perfectly clear: 'The householding science is commonly practised as an art of acquiring, administering and maintaining properties.'<sup>48</sup>

It is within such a structure that the reports from Swedish travellers to Britain must be inserted, and it is also the structure that governed the possibilities to move from a propositional to a prescriptive knowledge. God had created a static world where all resources and natural endowments were already there, and where no distinction was made between production and marketing. In such a world how was it possible to analyse novelties that might be the basis for technological development? The 'iron-system' that Schröder described contained many different parts and aspects, but Schröder himself did not treat any of them as better, or more advanced, than any other. They were just different. Another striking example on this can be found in Rinman's *Bergwerks Lexicon*. In 1789, earlier than any other non-British writer, he described iron puddling – a process in which pig iron was refined to

a forgeable bloom, from which bar iron later can be drawn out, as in England with success have been made, only with the flames from mineral coal.<sup>49</sup>

Puddling, the most important of all the innovations within iron making in the eighteenth century, was, thus, analysed in passing by one of the most important Swedish eighteenth century metallurgist. It is clear, comparing it with other descriptions, that for Rinman puddling was just another way of making bar iron – nothing superior, or nothing to copy or imitate!

In the years 1755 and 1756 a debate took place in Sweden, often called 'The struggle about the Swedish factories' (*Striden om de svenska fabrikerna*). It started when Johan Fredric Kryger wrote a short pamphlet called *Thoughts on Swedish factories*, in which he pleaded for a strict regulation of the establishment of woollen factories. The key to increased production was for the state to give privileges to a fixed number of men who were suitable to run factories. His opponents, on the other hand, led by Carl Fredrik Scheffer, argued for a liberalisation of trade. The important point to stress is that throughout the discussion there was no mention of technology or technological development. Both parties were in agreement that

an ‘old system’ when large volumes of woollen cloth were imported to Sweden had to be changed into a new system where those textiles were made in the country. The transformation from the old to the new system was to be achieved by political actions from the state. The disagreement was about which measures should the state take.<sup>50</sup>

Samuel Schröder could not have agreed more. When summarising his thoughts on England in 1749 the major threat to Swedish interests that he identified was political, not technological. The only danger he foresaw for the ‘iron-system’ that then worked so successfully for Sweden was if the British government decided to take the iron they needed from countries other than Sweden:

The worst that could happen in relation to Sweden, seems to be if the English government would sometimes make a resolution to give the American Colonies the freedom to make bar iron and to export them.<sup>51</sup>

According to the Swedish travellers to Britain, and to economic writers in Sweden, it was not technology that changed economic systems, and it is therefore difficult to see how a prescriptive knowledge, or *techne*, could have developed in Swedish society during the eighteenth century.

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Sweden in the eighteenth century was thus a society in which enlightened ideas had begun to get a foothold. It was a place in which the gathering of scientific knowledge and the pursuit of “utility” had been given a pivotal position. However, it may well be a society for which Kant’s dictum of not living in an enlightened age but rather an Age of Enlightenment was formulated: scientific data were observed, classified and published, but within a static worldview. *Oeconomia divina* governed *oeconomia publica* and *oeconomia privata*, and within such a system there was little place for change, still less for progress. Towards the turn of the century all this was to be swept away, and a more fully-fledged version of the enlightenment was to emerge.

The Napoleonic era was one of immense difficulty for Swedish iron makers. Iron exports were at an all-time peak in the early 1790s, but the onset of European-wide war brought a sharp decline. The problems posed by wartime blockades were compounded by developments on the all-important British market. Henry Cort’s puddling and rolling technique, brought to perfection in South Wales in the early 1790s, swept across Britain, allowing for an epochal expansion in the production of malleable bar iron. Swedish iron was suddenly evicted from its most important market. The Swedish visitors who continued to tour Britain in these years could hardly ignore the coal technology revolution. Nor did they. The hugely successful application of mineral energy in British forges was a phenomenon that charcoal-dependent Swedes had to confront and understand.

Eric Thomas Svedenstierna, who tramped across England, Wales and Scotland in 1802-03, was a key figure in this process. An official of the Swedish Ironmasters’ Association, Svedenstierna became a genuine advocate of an Industrial Enlightenment in his homeland. At first sight, however, there was little to distinguish what Svedenstierna did from what people like Schröder and Angerstein had done half a century before him. Like them, he started in London, perfecting his English and visiting the Royal Society. Like them, he visited Birmingham, Sheffield and Newcastle, the well-established centres of metal ware manufacturing in

Britain. Unlike Schröder and Angerstein, however, he ventured to the coalfield locales where coke smelting and puddling were now in the ascendant: Merthyr Tydfil in Wales and Carron in Scotland.<sup>52</sup>

Svedenstierna was also equipped with a different worldview. Tellingly, he did not go straight to Britain from Sweden, but took a detour via Paris. A knowledge of chemistry was essential to understand what took place in blast furnaces and forges, and the place to improve that was the French capital. Svedenstierna spent months going to lectures by Louis Nicolas Vauquelin and R.J. Haüy. During the stay he also met Jean-Antoine Chaptal, his French counterpart: Napoleon's minister, chemist, entrepreneur and reformer.<sup>53</sup> Svedenstierna also departed from earlier practice when he returned to Sweden. Angerstein and Schröder had circulated their diaries privately. Svedenstierna acted in a complete different fashion. For a start his findings were published soon after his arrival back in Stockholm. Svedenstierna then re-worked his material, shifting from the chronological approach of his journals to an analytical presentation. The results were published in the first scientific journal to deal with matters of mining and metal processing in Sweden (1806), of which Svedenstierna was the editor and chief contributor. Finally, in 1813 he returned to his experience from Britain at book-length when he published 'Some notes on English iron making'.<sup>54</sup>

For Svedenstierna, as for his eighteenth-century predecessors, it was axiomatic that Swedish iron making was intimately linked to Britain. Production could never be sustained without the voracious British market, a theme that would recur in many of his texts. In the first years of the nineteenth century this dependence was painfully obvious. For Svedenstierna the problem had its roots in 'a surprising development in England's political, industrial and trading system'.<sup>55</sup> It is in his analysis of this new system that we can detect an important intellectual novelty. To his predecessors there had been a single, all-encompassing 'system' bridging production and marketing, but Svedenstierna abandoned that analytical model. For him, different 'iron systems' existed and competed with each other, and in his texts it is clear that the unifying concept of "Trade" (or *Näring/System*) had been broken into smaller, analytically distinct units. Svedenstierna saw marketing as distinct from production. He also differed from his predecessors in that he did not see the various technical practices within a 'system' as merely different from one another. He was clear that puddling was functionally superior to the older Walloon forging method, not just different. In short, Svedenstierna incorporated ideas about progress into his analysis of British iron making.

The first chapter of 'Some notes on English iron making' makes all that very clear. It is an attempt to trace the historical development of the British industry from its inception to the introduction of coal technology. Technological development was the thread that Svedenstierna followed through history. Dud Dudley's seventeenth-century 'inventions and indefatigable activity' were saluted as a first step forward, but the most important phase of development dated to the building of the Carron works and 'the improvements of the Steam engines and the Blowing machines, which Mr James Watt commenced from the 1760s'. It was from that decade that 'English iron making can count its start.' Svedenstierna did not, however, stop with an analysis of history; he looked to the future with predictions of 'an almost boundless production'.<sup>56</sup>

This conclusion led Svedenstierna to attempt alter the prescriptive knowledge on which Swedish iron making was based – rather than the refine propositional knowledge as Schröder and Angerstein had done. Swedish metallurgy was to be reformed on the basis of British practice. In 1811, at a time of crisis for Swedish iron making, Svedenstierna outlined how this

could be achieved. He did so by asserting his confidence in one of the Enlightenment's basic principles: the ability of humans to change their conditions and to create their own future.

During the last six years Swedish iron making has, in an economic as well as a mercantile sense, often been exposed to the toughest of turns from a surprising development of England's Political, Industrial and Trading system, and these forces have sometimes promoted and sometimes hindered our country... however [the Swedish iron industry] has had within itself enough strength, not only to preserve itself from destruction but also, with the use of an indefatigable *Direction of the Age* towards an expanded liberty of trade and arising improvements, created a situation from which general advantages could be made in more gentle business cycles.<sup>57</sup>

Svedenstierna was thus the herald of a new age, an age which had already been achieved by British industrialists. The 'Direction of the Age' pointed towards Britain!

It was not to be granted to Svedenstierna to be the person that led Swedish iron making in this process of change, to follow the direction of the age, or to transform propositional knowledge to prescriptive. He did not write any manuals. After about 1819 he withdrew from a more active role, and he died in 1825. This task was instead handed over to a new generation of technicians and metallurgist, armed as they were with two important 'tools'. On the one hand they possessed a large body of propositional knowledge gathered by the loyal body of travelling metallurgists during the eighteenth century. On the other hand Svedenstierna had equipped them with a radically new way of conceptualising this knowledge. Gone was the static worldview in which progress was impossible, and where technology was subordinate to the encompassing concept of trade. A discourse of progress was making its way into Swedish thinking about production.

From the late 1820s this new generation of Swedish industrial travellers began to tour the large integrated ironworks of Britain. Earlier scholars like John Harris analysed Sweden's eighteenth-century travellers as industrial spies.<sup>58</sup> As this paper makes clear, that is to miss the point; they were assessing markets, not looking for techniques that could be translated into a Swedish context. From the second quarter of the nineteenth century, however, espionage would be a valid characterisation. When Teofron Munktell visited Britain in 1835 he was very clear on this matter. After visiting a number of ironworks he picked a small works in Yorkshire 'as the one closest in size to what could be built in the fatherland by *Herrar* Ironmasters.' Technology transfer was now the nub. Munktell made a very detailed description of the works and its mechanical devices, along with a thorough account of the work undertaken at the place.<sup>59</sup> He was not alone in this endeavour; it was a crowded field. Johan Bolinder went to Britain in 1844, concentrating on the Low Moor ironworks outside Bradford, (which was also subject to a detailed study by J.S. Bagge), while A. G. Tamm compared the new British technology with what took place on the Continent. Most important of all was Gustaf Ekman, who went to Britain no fewer than three times in the late 1820s and 1830s, making a comprehensive study of contemporary iron making and engineering.<sup>60</sup>

The common feature in these travel accounts is the will to reform Swedish iron making, and to do so by emulating the British experience. Unlike their forebears, the travellers of the 1830s and 1840s were interested in knowing 'how', not just knowing 'what'. This is clear from their reports, which can be read as 'manuals' on how to change the ways Swedish ironmasters were to 'manipulate nature'. Ekman and his compatriots did not feel themselves constrained by *Oeconomia divina*. British technology was to be brought to Sweden in defiance of an outwardly unfavourable resource endowment. There was no coal to be had in Sweden, but

there was timber aplenty, so Ekman strove to adapt British technology to a wood-rich environment. The fuel-base was not transferable but many of the mechanical devices were. Thus, blowing cylinders replaced bellows, while steam hammers and rolling mills took the place of the water-driven forge hammers of old. As importantly, British organisational principles, combining high volume with celerity, were sedulously copied. By the 1850s an entirely production landscape, wood-fuelled but industrial in scale and intensity, was in place in the iron making districts of central Sweden. Prescriptive knowledge had propelled Britain's Industrial Revolution forward. And industrialisation in Britain brought a respect – indeed, a thirst – for prescriptive knowledge to Sweden.

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<sup>1</sup> Robert Darnton, 'The Enlightenment: A personal view', *Lychnos. Årsbok för idé- och lärdomshistoria 1997*, pp. 157-172. Quotes from p. 157.

<sup>2</sup> Gertrude Himmelfarb, *The Roads to Modernity. The British, French, and American Enlightenments*, New York 2004.

<sup>3</sup> Joel Mokyr, *The Gifts of Athena. Historical Origins of the Knowledge Economy*, Princeton 2002.

<sup>4</sup> Darnton, 'The Enlightenment', pp. 157f.

<sup>5</sup> Peter Gay, *The Enlightenment: An Interpretation*, New York 1966-1969.

<sup>6</sup> Robert Darnton, *The Literary Underworld of the Old Regime*, Cambridge, Mass 1982.

<sup>7</sup> Roy Porter and Mikuláš Teich, *The Enlightenmen in National Context*, Cambridge 1981.

<sup>8</sup> Roy Porter, *The Enlightenment*, London 1990. For a discussion about the place of virtue within the Enlightenment see Himmelfarb, *The Roads to Modernity*; Emma Rotchilds, *Economic Sentiments. Adam Smith, Condorcet and the Enlightenment*, Cambridge, Mass. 2001 and Victoria Höög, *Upplysning utan förnuft. Begär och frihet hos Thomas Hobbes, John Locke, David Hume och Montesquieu*, Stockholm 1999.

<sup>9</sup> John Robertson, 'The enlightenment above national context: Political economy in Eighteenth century Scotland and Naples', *The Historical Journal*, 40, 3 (1997), p. 672.

<sup>10</sup> Immanuel Kant, 'Svar på frågan: Vad är upplysning?', in Carl-Göran Heidegren, *Vad är upplysning?* Stehag 1993.

<sup>11</sup> For a brief introduction to these themes see Dorinda Outram, *The Enlightenment*, Cambridge 2005, pp. 1ff. See also James Schmidt, 'The Legacy of the Enlightenment', *Philosophy and Literature*, 2002, 26, pp. 432-442.

<sup>12</sup> Keith Michael Baker and Peter Hanns Reill, eds., *What's Left of Enlightenmen? A Postmodern Question*, Stanford 2001. See also Schmidt, 'The Legacy of the Enlightenment', p. 432. Both Darnton and Himmelfarb are very critical towards the postmodern challenges to the Enlightenment.

<sup>13</sup> See for example Baker and Reill, eds., *What's Left of Enlightenmen?*

<sup>14</sup> Arnold Toynbee, *Lectures on the Industrial Revolution in England*, London 1884, p. 31.

<sup>15</sup> David Cannadine, 'The Present and the Past in the English Industrial Revolution 1880-1980', *Past and Present* No 103, 1984, pp. 131-172.

<sup>16</sup> See for instance David Landes, *The Unbound Prometheus. Technological Change and Industrial Development in Western Europe from 1750 to the Present*, Cambridge 1969; Nick Craft, *British Economic Growth during the Industrial Revolution*, Oxford 1985.

<sup>17</sup> Joel Mokyr, *The Lever of Riches. Technological Creativity and Economic Progress*, Oxford 1990.

<sup>18</sup> See Joel Mokyr, 'Technological Change, 1700-1850', in Roderick Floud and Donald McCluskey (eds.) *The Economic History of Britain since 1700. Volume 1: 1700-1860*, Cambridge 1994, second edition, for a survey.

<sup>19</sup> Mokyr, *The Lever of Riches*, pp. 273-276.

<sup>20</sup> Christine MacLeod, 'Review', *Journal of Economic History*, 2003, vol. 64, No 4, p. 1179.

<sup>21</sup> Joel Mokyr, *The Gifts of Athena. Historical origins of the Knowledge Economy*, Princeton 2002, quotation from p. 3.

<sup>22</sup> Mokyr, *The Gifts of Athena*, pp. 4-15.

<sup>23</sup> Mokyr, *The Gifts of Athena*, p. 35.

<sup>24</sup> Mokyr, *The Gifts of Athena*, pp. 34ff.

<sup>25</sup> Mokyr, *The Gifts of Athena*, pp. 56-76.

- <sup>26</sup> Joel Mokyr, 'The Intellectual Origins of Modern Economic Growth', *The Journal of Economic History*, vol. 65, no. 2, June 2005, quote from p. 291.
- <sup>27</sup> D.C. Coleman, 'Proto-industrialization: A Concept to Many', *Economic History Review*, 36: 435-48.
- <sup>28</sup> In a still unpublished paper, 'Mercantilism, the Enlightenment, and the Industrial Revolution' has Mokyr also discussed the impact the Enlightenment had upon the creation of institutions suitable for technological change and economic growth. In so doing Mokyr has really installed himself in a school of thought that think that the eighteenth century is the founding period for our present situation. He has himself discussed his model of being a whig interpretation of history!
- <sup>29</sup> A second and updated edition of the work was recently published: Tore Frängsmyr, *Sökandet efter upplysningen. Perspektiv på svenskt 1700-tale*, Stockholm 2006. A French edition was published as *À la recherche des Lumières: Une perspective suédoise*, Bourdeaux 1999.
- <sup>30</sup> See foremost the two volumes devoted to this debate Ronny Ambjörnsson, Pär Eliasson och Björn Olsson, eds. *Upplysningen i periferin*, Umeå 1998, and Paul Hallberg, ed. *Ljus över landet? Upplysningen som drivkraft i 1700-talets svenska vetenskap och vitterhet*, Göteborg 2005. See also Marie-Christine Skuncke, 'Was there a Swedish Enlightenment', in Svavar Sigmundsson, ed., *Norden och Europa 1700-1830. Synviklar på ömsesidigt kulturellt inflytande*, Reykjavik 2003.
- <sup>31</sup> Marie-Christine Skuncke has, for instance, pointed towards the creation of the Royal Academy of Sciences, the Freedom of the Press Act as well as the teaching of the future Gustaf III, as three examples of the existence of a Swedish enlightenment. Skuncke, 'Was there a Swedish Enlightenment'. See also for instance Magnus Nyman, *Upplysningens spegel. Götheboirgs Allehanda om Frankrike och Världen 1774-1789*, Stockholm 1994.
- <sup>32</sup> See foremost Eli F. Heckscher, *Sveriges ekonomiska historia från Gustav Vasa. Andra delen. Det moderna Sveriges grundläggning*, Stockholm 1949, pp. 812-890; and Lars Magnusson, *Mercantilism: The Shaping of a Language*, London 1994; Lars Magnusson, *Åran Korruptionen och den borgerliga ordningen. Essäer från svensk ekonomihistoria*, Stockholm 2001. See also Karl Petander, *De nationalekonomiska åskådningarna i Sverige sådana de framträdde i litteraturen*, Stockholm 1912.
- <sup>33</sup> Frängsmyr, *Sökandet efter upplysningen*, quotation from p. 201; Magnusson, *Åran Korruptionen*, quotation from p. 23.
- <sup>34</sup> Staffan Müller-Willie, 'Nature as a Marketplace: The Political Economy of Linnean Botany', and Lisbeth Rausing, 'Underwriting the Oeconomy: Linnaeus on Nature and Mind', both in Margaret Schabas and Neil De Marchi, eds. *Oeconomy in the Age of Newton*, Annual Supplement to volume 35 *History of Political Economy*, Durham and London 2003.
- <sup>35</sup> Carl Linnaeus, 'Tanckar om Grunden til Oeconomy genom Naturkunnogheten och Physiquen', *Kungliga Svenska Vetenskapsakademins Handlingar*, Stockholm 1740, p. 406.
- <sup>36</sup> Anders Berch, *Inledning til Almänna Hushållningen, innefattande Grunden til Politie, Oeconomie och Cameral Wetenskaperne*, Stockholm 1747. The quotation from the introduction, without any page reference.
- <sup>37</sup> Mattias Legnér, *Fäderneslandets rätta beskrivning. Mötet mellan antikvarisk forskning och ekonomisk nytto-kult i 1700-talets Sverige*, Stockholm 2004.
- <sup>38</sup> For an introduction to Swedish trips to Britain see Sven Rydberg, *Svenska studieresor till England under Frihetstiden*, Uppsala 1951.
- <sup>39</sup> Dagbok rörande Handel, Näringar och Manufakturerna m.m. Ut i Danmark, Holland, England, Frankrike och Tyskland. Under verkstälde resor, åren 1748 – 1751 fördd af Samuel Schröder, volumes I and II, Kungliga Biblioteket, Stockholm X:303.
- <sup>40</sup> See for instance the most famous Swedish 'industrial' traveller of the century, Reinhold Angerstein, who only wrote a plain diary. See the published diary from his British trip: *R R Angerstein's Illustrated Travel Diary, 1753-1755. Industry in England and Wales from a Swedish Perspective*, Torsten and Peter Berg eds., London 2001.
- <sup>41</sup> Anmärkningar uti Hvarjehanda förefallande Ämnen samlade på resan i England åren 1766 och 1767. Benct Qvist Andersson, Jernkontorets Arkiv, Fullmäktiges Arkiv, Handlingar ordnade efter Ämne, Vol F II a:20, Riksarkivet.
- <sup>42</sup> Salomon von Stockenström, De utländska järn och stål processerna, del III, Jernkontorets Arkiv. Fullmäktige, F II a:26, RA.
- <sup>43</sup> Sven Rinman, *Bergwerks Lexicon*, Stockholm 1788-89.
- <sup>44</sup> *Angerstein's Illustrated Travel Diary* and Qvist 1766-1767.
- <sup>45</sup> Schröder, Dagbok rörande Handel, Näringar och Manufakturerna m.m. vol. II.
- <sup>46</sup> Berch, *Inledning til Almänna Hushållningen*; Carl Fredrik Scheffer, *Tillägg til Anmärkningar wid herr Commissarien Joh. Fredrich Krygers Tankar om Swenska Fabriquerne*, Stockholm 1756, p. 15.

- <sup>47</sup> Daniel Defoe, *Plan of the English Commerce. Being a Complete Prospect of the Trade of this Nation, as well Home as Foreign*, London, 2<sup>nd</sup> edition 1737, pp. 1-3. See also Malachy Postlethwait and Joseph Massey for a similar standpoint.
- <sup>48</sup> Berch, *Inledning til Almänna Hushållningen*, pp. 1-4; Jacob Faggot, 'Tanckar om fäderneslandets känning och beskrifwande', *Kungliga Svenska Vetenskapsakademins Handlingar*, Stockholm 1741, p. 26. For a modern discussion about this theme see Tore Frängsmyr, 'Den gudomliga ekonomin. Religion och hushållning i 1700-talets Sverige', *Lychnos. Lärdomshistoriska samfundets årsbok*, 1971-1972, pp. 217-244, and Magnusson, *Åran Korruptionen och den borgerliga ordningen*, pp. 32ff. Magnusson, *Åran Korruptionen och den borgerliga ordningen*.
- <sup>49</sup> Rinman, *Bergwerks Lexicon*, Part II, p. 413.
- <sup>50</sup> Johan Fredric Kryger *Tankar om Swenske Fabriquerne*, Stockholm 1755 and Carl Fredrik Scheffer, *Anmärkingar wid herr Commissarien Johan Fredrik Krygers Tankar om Swenske Fabriquerne*, Stockholm 1755 were the two first pamphlets. For a later treatment of this debate see Petander, *De nationalekonomiska åskådningarna*, pp. 123ff.
- <sup>51</sup> Schröder, *Dagbok rörande Handel, Näringar och Manufaktur m.m.* vol. II.
- <sup>52</sup> Eric Thomas Svedenstierna, *Resa igenom en del af England och Skottland, åren 1802 och 1803*, Stockholm 1804.
- <sup>53</sup> Jeff Horn, och Margaret C. Jacob, "Jean-Antoine Chaptal and the Cultural Roots of French Industrialization", *Technology and Culture*, Vol. 39, No. 4 (Oct., 1998), 671-698.
- <sup>54</sup> Svedenstierna, *Resa igenom en del af England och Skottland*; E. T. Svedenstierna och C. J. Lidbeck, reds. *Samlingar i Bergswettenskapen*, fyra delar, Stockholm 1807-1811; Eric Thomas Svedenstierna, *Om Svenska Jernhandteringen i Äldre och Nyare Tider. Hållit vid Præsidi nedläggande i Kongl. Vetenskaps-Akademien*, Strengnäs 1810; Eric Th. Svedenstierna, *Några underrättelser om Engelska Jernhandteringen*, Stockholm 1813; Eric Thomas Svedenstierna, "Försök till svar på den af bruks-societeten, i Inrikes-tidningen n:o 12, år 1806 frmaställda prisfrågan", *Jernkontorets Annaler* 1817. See also *Samlingar i Bergswettenskapen*, Eric Thomas Svedenstierna and C.J. Lidbeck, eds. Stockholm 1806-1811, and *Jernkontorets Annaler*, 1817-.
- <sup>55</sup> Eric Thomas Svedenstierna, Allmän öfversikt af de sedan år 1805 i Svenska Jernhandteringen gjorda förbättringar, Jernkontorets arkiv, Fullmäktiges arkiv, F III:a bunt 39, Riksarkivet.
- <sup>56</sup> Svedenstierna, *Några underrättelser om Engelska Jernhandteringen*, ss. 1-64. Quotes from pp. 13, 14 and 16.
- <sup>57</sup> E. Th. Svedenstierna, 'Allmän Öfversigt af de sedan 1805 i Svenska Jernhandteringen gjorda förbättringar, 1811' RA, Jernkontorets Arkiv, Fullmäktige, F III a:39. Italics added by the CE and GR.
- <sup>58</sup> John Harris, *Industrial Espionage and Technological Transfer. Britain and France in the Eighteenth Century*, Aldershot 1998, chapter 20. See also Alan Birch, "Foreign Observers of the British Iron Industry During the Eighteenth Century", *The Journal of Economic History*, Vol. 15, No. 1 (Mar., 1955), 23-33, and Rydberg, *Svenska studieresor till England*.
- <sup>59</sup> T Munktell, "Resa i England 1835", Jernkontorets Arkiv, Fullmäktiges Arkiv, F II a: 17, Riksarkivet.
- <sup>60</sup> For a much more thorough account of this process see Chris Evans and Göran Rydén, 'Tankar om teknik, den svenska järnhanteringen och den brittiska industrialiseringen', *Med Hammare och Fackla* 2006, forthcoming; Göran Rydén, 'Gustaf Ekman, Jernkontoret och lancashiresmidet – Ett inlägg i synen på teknisk utveckling', *Polhem. Tidskrift för Teknikhistoria*, 1994/2; Göran Rydén, 'Responses to coal technology without any coal resources. Swedish ironmaking in the first half of the nineteenth century', in C. Evans and G. Rydén eds. *The Industrial Revolution in Iron. The Impact of British Coal Technology in Nineteenth-Century Europe*, Ashgate 2005.