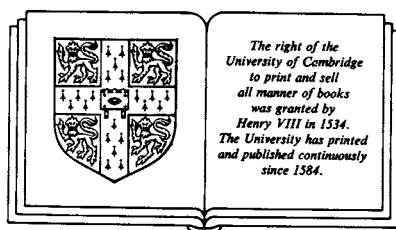


BRITISH TECHNOLOGY AND EUROPEAN INDUSTRIALIZATION

The Norwegian textile industry
in the mid nineteenth century

KRISTINE BRULAND



CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE

NEW YORK NEW ROCHELLE MELBOURNE SYDNEY

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
32 East 57th Street, New York, NY 10022, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

© Cambridge University Press 1989

First published 1989

Printed in Great Britain at the University Press, Cambridge

British Library cataloguing in publication data

Bruland, Kristine

British technology and European industrialization:
the Norwegian textile industry in the mid nineteenth century.

1. Norway. Textile industries. Technology transfer from Great Britain

I. Title

338.4'7677'009481

Library of Congress cataloguing in publication data

Bruland, Kristine.

British technology and European industrialization: the Norwegian
textile industry in the mid nineteenth century/Kristine Bruland.

p. cm.

Bibliography: p.

Includes index.

ISBN 0-521-35083-2

1. Textile industry – Norway – History – 19th century.

2. Textile industry – Great Britain – History – 19th century.

I. Title.

HD9865.N93B78 1989

338.4'7677'00948 – dc19 88-22822

ISBN 0 521 35083 2

The author and publisher gratefully acknowledge the generous financial support of NAVF (Norges allmennvitenskapelige forskningsråd) in the publication of this work.

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TECHNOLOGY AND EUROPEAN GROWTH

Underlying this study is the idea that we still know relatively little about the technological basis of European economic growth in the mid nineteenth century. The technologies employed within continental Europe changed sharply as it industrialized, but how did this happen? The following chapters are concerned with this aspect of European industrialization; they are in large part an empirical study of a pattern of technological diffusion, describing the acquisition and adaptation of British textile technologies by a peripheral European economy, Norway, from the early 1840s to around 1870. However, the focus of the study is not as narrow as this summary might suggest, for the empirical study is intended to throw some light on a wider, and to my mind very important, issue in the economic history of Europe.

Explaining the process of industrialization which occurred throughout much of Europe from around the middle of the nineteenth century has long been a key problem for economic history, yet its treatment remains unsatisfactory; for, although the literature on the topic is already very large, important questions remain unresolved. Continental industrialization involved new forms of enterprise in the creation of new industries or the transformation of existing ones, and a broad yet profound process of technological change. But what mechanisms generated, diffused and adapted these technologies? How did continental entrepreneurs and managers acquire the technological capacities first to operate the new technologies and secondly to do so at levels of efficiency sufficient to withstand competition from the world's technological leader, Britain? In fact we know relatively little about this, and in particular the nature, extent and effects of technology export have yet, in my view, to be adequately explored. What role was played by exports of machines and equipment from Britain, through the activities of British engineering firms, in the spread of industrialization through Europe from the 1840s? How significant, for continental industrialization, was the repeal of the prohibitions on the export of machinery from Britain in 1843? The existing literature on the economic history of continental European industrialization which will be discussed in the next chapter, is in the main organized around two rather different problem areas. The first, following the pioneering and

profoundly influential work of Alexander Gerschenkron, attempts to describe and account for the different economic and institutional mechanisms through which industrialization occurred. The second problem area deals with the spread of technology and technological knowledge through the interregional and international movement of individual entrepreneurs and technicians during what might be called the 'first phase' of industrialization, that is, during the period from about 1760 to about 1840.

Later periods and problems, however, have been relatively neglected; in particular the acceleration of European industrialization from the 1840s, and the technological details of how this occurred, deserve more attention. In Germany, for example, as Trebilcock has remarked, 'the motive power which had been accumulating since the late eighteenth century was translated into a definite forward surge between 1850 and 1914', with growth rates of net national product increasing sharply.¹ In France, a similar surge occurred in the period from the 1840s to the 1860s.² Russia saw a particularly rapid growth in the number of industrial enterprises from 1850, notably in textiles.³ Among the smaller economies of Europe – Belgium, Switzerland, Scandinavia – it was in the years after 1845 that industrialization took hold, survived and prospered. Despite important structural divergences between the continental European economies undergoing the process of economic change, and the regional differences within them,⁴ industrial change was nonetheless very widespread and of very great historical significance. Although we know a great deal about the quantitative outlines of this change,⁵ we still know surprisingly little about the details of how it happened, and little in particular about the process of enterprise formation and technological change which were the practical basis of the growth of new industries.

If we are to fill these gaps in our knowledge of the history of European industrialization then we need to give more attention to an important avenue of inquiry, namely the study of the acquisition of new technologies at enterprise level within the industrializing economies. After all, industrialization involves structural change by virtue of the creation of new industries, and these in turn rest on new enterprises actually deploying new technologies. But how was this possible? How did continental entrepreneurs and enter-

¹ Clive Trebilcock, *The Industrialization of the Continental Powers, 1780–1914* (London, 1981), p. 45.

² M. Lévy-Leboyer, 'Capital investment and economic growth in France, 1820–1930', P. Mathias and M. M. Postan (eds.), *The Cambridge Economic History of Europe. VII: The Industrial Economies: Capital, Labour and Enterprise*, Part I (Cambridge, 1978), pp. 266–7.

³ O. Crisp, 'The pattern of industrialisation in Russia', in *Studies in the Russian Economy Before 1914* (London, 1978), p. 37.

⁴ See S. Pollard, *Peaceful Conquest: the Industrialization of Europe, 1760–1970* (Oxford, 1981), where the regional character of European industrialization is emphasized.

⁵ See, for example, N. Crafts, 'Gross National Product in Europe 1870–1910: some new estimates', *Explorations in Economic History*, 20 (1983), pp. 387–401; 'Patterns of development in nineteenth-century Europe', *Oxford Economic Papers*, 36 (1984), pp. 438–58.

prise managers learn about, acquire and operate the new technologies of the industrial economy?

When posing such questions, one must necessarily consider the impact which prior British industrialization had on later continental developments, particularly from the 1840s. Did British technological leadership underpin, facilitate or enhance change elsewhere, and if so, how? If technologies originating in Britain were put to work elsewhere, was this through imitation of Britain by continental industrializers, on the basis of domestic resources, or was there a direct *diffusion* – perhaps via the export of equipment – of British technologies from the UK? The latter question leads in turn to a consideration of the importance of the removal, in 1843, of the prohibitions on the export of machinery from Britain.

Britain had forbidden the emigration of skilled artisans from the early eighteenth century, and from 1750 had enacted a range of regulations prohibiting the export of machinery: ‘By 1785 the tools and machinery used in the cotton, woollen and silk textile industries, as well as the tools and utensils used in the iron and steel manufacture, had been banned from export.’⁶ The regulations were in fact never completely effective, for some equipment could be exported under licence, and the prohibitions could otherwise be subverted by smuggling, by industrial espionage, and by general flows of technological information.⁷ Farnie remarks that ‘the repeal in 1843 of the Act of 1786 forbidding the export of machinery gave legal sanction to what had become a customary practice in defiance or in evasion of the law’.⁸ Nevertheless the Act did constrain the access of foreigners to British techniques and, by the same token, the size of the market available to the British capital goods industry. But the European market for machinery in the early nineteenth century was expanding, and thus prohibitions in effect protected an infant machine-making industry on the continent. This latter point was repeatedly made in the submissions to the Select Committee of 1841: ‘... the impossibility of getting it from England made machine-making a very good speculation in France, and machine makers have very much improved within the last ten years’, remarked one witness.⁹ Other witnesses emphasized the growing importance of the machinery trade as a whole, pointing out that ‘... the partial prohibition tends to deprive English machinists not merely of the

⁶ M. Berg, *The Machinery Question and the Making of Political Economy, 1815–1848* (Cambridge, 1980), p. 205.

⁷ P. Mathias, ‘Skills and the diffusion of innovations from Britain in the eighteenth century’, *The Transformation of England* (London, 1979), pp. 28–9; A. Birch, ‘Foreign observers of the British iron industry during the eighteenth century’, *Journal of Economic History*, 25 (1955), pp. 23–33; M. W. Flinn, ‘The travel diaries of Swedish engineers of the eighteenth century as sources of technological history’, *Transactions of the Newcomen Society*, 31 (1957–9), pp. 95–115; J. R. Harris, ‘Industrial espionage in the eighteenth century’, *Industrial Archeological Review*, 7, 2 (1985), pp. 127–38; D. Jeremy, *Transatlantic Industrial Revolution* (Oxford, 1981), pp. 40–1.

⁸ S. Farnie, *The English Cotton Industry and the World Market, 1815–1896* (Oxford, 1979), p. 56.

⁹ Evidence of G. Withers, quoted in S. Pollard and C. Holmes (eds.), *Documents of European Economic History. Vol 1: The Process of Industrialization, 1750–1870* (London, 1968), p. 325.

benefits of their inventive activity, but of the trade in unprohibited, as well as that for prohibited machines'.¹⁰ In recommending repeal of the prohibition the Committee in effect accepted these arguments, and therefore accepted also the view that Britain should attempt to achieve a dominant position in machinery supply to the world. The repeal came into force in 1843.

From that time, therefore, the technological environment faced by European entrepreneurs presumably changed sharply as British machines and equipment became legally available. But how did this affect the pace and direction of continental industrialization? How did it affect the ability and willingness of European entrepreneurs to deploy British techniques? If we are to answer such questions then we need to know much more than we do about how British engineering enterprises responded to the repeal, that is, about the extent to which they searched for European markets after 1843, about the nature of the goods and services they offered, about the competition among them, and so on. From the other side – the demand side – it seems to me that there are two broad questions. Firstly, there is the question of how market seeking by British engineering firms altered and perhaps eased problems of enterprise formation and technological innovation for European entrepreneurs. Secondly, there is the question about the conditions underlying differential responses by entrepreneurs in various parts of the continent.

This study takes an enterprise-oriented approach to such questions, for answering them requires, in my view, not a general European-wide survey or analysis, but rather an examination of particular industries and, if possible, particular firms. I have chosen to concentrate on the construction of a mechanized textile industry in Norway, a development which began in earnest in approximately 1845, and which was an important component of Norwegian industrialization at that time. Norway was then, as to some extent it remains, a small, marginal, peripheral European economy. It is therefore remarkable that as early as the 1840s it was able to deploy and operate, in the textile industry, what might now be called 'state of the art' technologies. How was this possible? In attempting to answer this question, the focus of this study is not on the Norwegian industry as a whole, but rather on ten firms engaged in various aspects of textile production (spinning, weaving, sail-cloth making, etc.), with a particular emphasis on one firm, a large integrated spinning and weaving establishment. This large firm was the Hjula Weavery, run by an important Norwegian entrepreneur, Halvor Schou. On the British side, the focus is wider for, as I shall show, these Norwegian firms acquired technology through business relationships with several hundred British enterprises engaged directly or indirectly in technology supply. My objective is essentially to describe the process of technology acquisition by the large integrated firm, Hjula Weavery, with reference to other firms where appropriate and possible. The primary sources for this study, which are described fully in the bibliography, are taxation records, fire insurance records (which

¹⁰ *Second Report From the Select Committee on Machinery*, 7 (1841), p. 277.

give an insight into the changing nature of the capital stocks of the firms), and firms' correspondence and invoice archives. The invoice records enable us to relate changing capital stocks to sources of technology acquisition. The correspondence archives, which in the case of Hjula Weavery are unusually complete, permit a detailed insight into the number of British machine makers or suppliers active in the small Norwegian market, the nature of their activities, and the technological problems with which they and their Norwegian customers dealt. The central theme of this work is the scale, complexity and importance of the interaction between the Norwegian firms and the large number of British textile engineering firms and machinery-supplying agents who supplied the technology on which Norwegian textile industrialization was based. On the basis of the empirical study, two broad arguments are advanced.

1 Mechanization of the Norwegian textile industry was a process of direct technological diffusion. Underlying the possibility of this diffusion were two major internal economic transitions. In Norway, there was the emergence and consolidation of a capitalist economy, with a high proportion of national income entering foreign trade and an outward-looking entrepreneurial class. In Britain there was a transition of a different kind, essentially a structural change within an already solidly established market economy; in the early nineteenth century an important division developed between final-output producing sectors of the economy, and a capital goods industry producing the means of production for the former. In particular the emergence of a machine-making industry in Britain was an event of critical importance. For Britain, this development institutionalized process changes in technology as the province of a particular specialized industry. For Norway, and for other European industrializers, it altered the nature of technology acquisition, particularly after 1843. This is, perhaps, the key point of the study – that outward-looking, market seeking activity by British textile engineering firms and machinery suppliers went a long way towards solving the problems of acquiring the new industrial technologies for countries such as Norway. These British engineering firms, I shall show, played a key role, indeed a decisive role, in Norwegian textile industrialization. This leads me to argue that the literature on European industrialization has not differentiated sharply enough between two stages in the spread of industrialization. In the first stage the agent of international diffusion was the individual craftsman, artisan, engineer or entrepreneur. In the second stage, relatively neglected within European historiography, the vehicle was the machine manufacturing enterprise.

2 The diffusion of textile industrialization to Norway should not be understood in terms of *imitation* of British practice. This is because imitation – a frequently used concept in the history of industrialization and also in the

economics of technological change – seems to me to imply a degree of autonomy in the imitator. That is, it implies replication of the British experience with domestic resources. Now Norway certainly replicated British technical practice, as I shall show, but it did so on the basis of technological ‘packages’ supplied directly from Britain by British textile engineering firms. The contribution of these firms was very great indeed. They provided flows of technical information; they acquired or supplied machinery and shipped it; they supplied ancillary equipment; they supplied construction expertise; they recruited and supplied skilled British operative and managerial labour for Norwegian firms (and frequently paid the families of such workers, on behalf of emigré operatives, during their periods of work in Norway). Sometimes these ‘packages’ were put together by British agents of Norwegian firms who also operated as important channels of diffusion. It follows that Norwegian textile industrialization was not so much an imitation as an *extension* of British developments following the development of a differentiated capital goods industry in the UK. More precisely, I suggest that the key concept should not be imitation but *interaction*, between a Norwegian entrepreneurial class who, though possessing commercial and marketing skills, in many cases lacked relevant technical and engineering skills, and British textile engineers whose search for markets provided the techniques and equipment which Norwegian entrepreneurs put to work.

After a consideration of the relevant literature, the following chapters will describe the internal changes in the British and Norwegian economies in the first half of the nineteenth century, and then go on to analyze the multifarious aspects of the process of technological diffusion which these changes made possible. The diffusion of textile technology to Norway will be discussed under the following headings:

- 1 the flow of technological information,
- 2 the acquisition and sources of capital equipment,
- 3 the roles of British textile engineers and machinery-supplying agents in the transfer of technology to Norway,
- 4 the roles of British workers and managers in the Norwegian textile industry,
- 5 interrelations among Norwegian firms in the diffusion of British technology.

Clearly it is impossible to draw general conclusions from an examination of a small number of firms in one small European economy. However there are indications from the sources used for this study that its propositions concerning the demiurgic role of British machinery suppliers may be of wider application, and of wider relevance to the study of European industrialization. That is to say, the experience of these Norwegian firms may well be representative of a more general European experience. Certainly it is a simple matter to show that technology exports from Britain to Norway were but a minor part of a major export effort by British textile engineers, and there are

small but suggestive links between the Norwegian firms studied here and their counterparts elsewhere. This wider export activity will be described in the final chapter. The question of whether the comprehensive technological input to Norwegian firms by British engineers was replicated elsewhere must remain open, but the general impression which emerges from the Norwegian material is that this was a standard, probably routine business procedure of British textile engineering firms. It seems to me therefore very likely that the Norwegian experience is indeed representative, in which case this study suggests questions about our understanding of the technological basis of European industrialization as a whole, as well as perhaps signposting some routes for further research. The central questions which emerge from this study all concern the role of the British capital goods industry. Was the emergence of this industry the key to the extension of British industrial methods to Europe? Did it supply, in other countries and perhaps other industries, the same all-inclusive technological packages which it offered to the Norwegian textile industry? If so, then we will have made an important step in understanding how the technologies of British industrialization spread so rapidly throughout Europe. But we can only know the answer to such questions through detailed studies of firms and industries, by looking at the economic history of technological change from the perspective of the firm. Paul Uselding has remarked that: 'The promise of the unification of business and technological history is that it can illuminate the large and central questions of capitalistic evolution by marshalling relevant evidence on how the prime institution of that system, the business firm, originates and manages elements of novelty, i.e. technology.'¹¹ It is to this task that this book aims to contribute.

¹¹ P. Uselding, 'Business history and the history of technology', *Business History Review*, 54 (1980), p. 443.