

# Great Transformations

*Economic History and the History of Technology*

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## Abstract

This chapter discusses the changing relationship between economic history and the history of technology in the Netherlands over the past 100 years, dividing this into three phases: interconnectedness until the 1950s, growing estrangement in the 1960s and 1970s and gradual rapprochement from the early 1980s. The separation in the mid-twentieth century is ascribed to the increased influence on Dutch economic historians of macro-economic theory and the paradigm of the French Annales School, which created an unfavourable environment for the study of the history of technology. The author argues that the turnaround in the 1980s was due to great transformations in both economic history and the history of technology. Economic historians studying the development of the Netherlands between around 1815 and the First World War went back to analyses at the meso and micro level, which made them more sensitive to the relevance of studying technological innovation. The history of technology in the Netherlands meanwhile came of age as a separate discipline. Historians of technology expanded their view to include technology in practice and the wider context of technological change. The final section of this chapter analyses the differences and common elements in present-day economic history and the history of technology, focussing on covering concepts such as 'modernisation' and 'technological leadership' and the shared interest in subjects such as the consumer side of innovation, the 'software' of technology and infrastructures of knowledge.

**Keywords:** economic history, history of technology, the Netherlands, 20th century

## Introduction

The relationship between economic history and the history of technology in the Netherlands over the past hundred years is a story of divergence and convergence. A phase of interconnectedness up to the 1950s was followed

by a period of estrangement in the 1960s and 1970s, which gave way to a gradual rapprochement from the early 1980s onwards. Of course, this ordering scheme is suggestive of a loose, Whiggish construction. Economic history was after all not a monolithic entity throughout the twentieth century. It branched out in a number of sub-disciplines, notably general economic history, business history and entrepreneurial history. History of technology hardly existed as a separate field in the Netherlands before the 1970s. In contrast with Britain, Germany and the United States, a specialised journal for this field of study did not appear in the Netherlands until 1984.<sup>1</sup> R.J. Forbes, who held a special chair in the history of applied sciences and technology at the University of Amsterdam since 1947, earned a great international reputation as a historian of technology but he did not create much of a following in the Netherlands itself.<sup>2</sup>

Subjects in the history of technology were studied, even though the field had not yet become an acknowledged academic discipline and those studies were in various ways and to varying degrees connected with research on the development of the economy. For all their anachronistic connotations, labels such as 'economic history' and 'history of technology' are still helpful devices to generate questions about the context, focus and outcome of research activities that actually occurred. What aspects of the history of technology in the Netherlands were investigated and how? In what respects did the relationship with the study of economic development change over time and why? What perspectives on technological change did these investigations produce? These questions form the subject of this chapter.

1 B.C. van Houten, 'Techniek-geschiedenis; een historiografische beschouwing', *Jaarboek voor de Geschiedenis van Bedrijven Techniek*, 3 (1986) 13-42, A.L. van Schelven, 'Geschiedenis van de techniek, ook een vak apart', *Jaarboek voor de Geschiedenis van Bedrijven Techniek*, 1 (1984) 19-24. The *Transactions of the Newcomen Society* in Britain appeared since 1920, *Technik-geschichte* in Germany since 1933, *Technology and Culture* in the United States since 1959. The *Jaarboek voor de Geschiedenis van Bedrijven Techniek* in the Netherlands was founded in 1984. Although 'technology' figured in the title of the *Tijdschrift voor de Geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek*, published since 1978, this journal in fact hardly devoted attention to the subject at all.

2 Forbes supervised six PhD students, see H.W. Lintsen and E. Homburg, 'Techniekgeschiedenis in Nederland', in: H.W. Lintsen et al. (eds.), *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890*, Vol. VI (Zutphen 1995) 255-266, 299-301, 299.

## Pioneers

In the introductory chapter of the first general overview of technology in the Netherlands in the nineteenth century, H. Lintsen and W.J. Wolff declared in 1992 that the historiography of technology initially strongly focused on inventions, discoveries, pioneers and high achievers. Researchers in this field were at first primarily interested in the frontiers of technical development.<sup>3</sup> This statement, up to a point, also holds true for writings on the development of technology in the Netherlands. The foremost student of the subject in the 1940s and 1950s, G. Doorman, was almost exclusively concerned with making an exhaustive inventory of patents and reconstructing in detail the nature and origins of iconic Dutch inventions. He devoted in-depth studies to inventors such as Cornelis Willemsz. Muys, Cornelis Cornelisz. van Uitgeest and Willem Beukelsz. van Biervliet, who had (reputedly) made seminal contributions to the technologies of dredging, sawing and the curing of herrings.<sup>4</sup> Doorman, an engineer by training who was a long-standing member of the Netherlands Patent Office, mostly concentrated on the history of artefacts and the handling of materials. Other engineers or trained scientists who published on the history of technology, such as F. Muller, J.J. Blanksma and A. Tutein Nolthenius,<sup>5</sup> showed a similar preference in their subjects. Similar to pioneers in the field in Britain and Germany, these early practitioners in the Netherlands were mainly preoccupied with the 'hardware' of technology. They were captivated by nuts and bolts.

However, the approach exemplified by Doorman's work was not the only way in which the history of technology in the Netherlands was studied before the 1960s. There was another strand of inquiry, which was likewise concerned with the hardware of technology, but was much less centred on

3 W.J. Wolff and H.W. Lintsen, 'Inleiding en verantwoording', in: Lintsen et al. (eds.), *Geschiedenis van de techniek*, Vol. VI (Zutphen 1992) 13.

4 See e.g. G. Doorman, (ed.), *Octrooien voor uitvindingen in de Nederlanden uit de 16<sup>e</sup> – 18<sup>e</sup> eeuw* (The Hague 1940), idem (ed.), *Het Nederlandsch octrooiwezen en de techniek der 19<sup>e</sup> eeuw* (The Hague 1947), idem, 'Hollandsche oude baggermolens', *De Ingenieur*, 63 (1951 A), 413-418, idem, 'Cornelis Dircksz. Muys, de uitvinder van de Amsterdamsche moddermolen', *De Ingenieur*, 64 (1952 A) 83-85, idem, 'Cornelis Cornelisz. van Uitgeest en de hollandse uitvindingen op het einde van de 16e eeuw', in: *Gedenknummer Octrooiwet 1912-1952* (The Hague 1952), 92-100, idem, *De middeleeuwse brouwerij en de gruit* (The Hague 1955), idem, 'Het haringkaken en Willem Beukelsz.', *Tijdschrift voor Geschiedenis*, 69 (1956) 371-386.

5 E.g. F. Muller, 'De eerste stoom-machines van ons land', *De Ingenieur*, 41 (1937) 11-21, J.J. Blanksma, 'Steenkool als brandstof omstreeks 1600', *Chemisch Weekblad*, 28 (1931) 210-213, 314-316, idem, 'Over kwik, kwikoxyden, kwiksulfiden, cinnabar, vermiljoen', *Chemisch Weekblad*, 44 (1948) 456-464, A. Tutein Nolthenius, 'Getijmolens', *Tijdschrift Koninklijk Nederlandsch Aardrijkskundig Genootschap*, 71 (1954) 186-199.

the history of artefacts and materials per se. Economic historians such as N.W. Posthumus and Z.W. Sneller, who arguably were the principal founders of the tradition of research on Dutch industry in the Early Modern Period, had a keen eye for the role of technology in economic development and stimulated a similar interest among a host of pupils and followers. Apart from their own ground-breaking studies on, notably, cloth manufacture, cotton spinning and cotton weaving,<sup>6</sup> which paid due attention to materials and equipment, Posthumus and Sneller – based at the University of Amsterdam and the Rotterdam School of Commerce – supervised a number of PhD dissertations on different sectors of Dutch industry between the late fifteenth and early nineteenth centuries.

Except for C. Visser's comparative study on a variety of processing industries (brewing, distilling, malt making, sugar refining and white-lead production) in Rotterdam in the second half of the eighteenth century,<sup>7</sup> these dissertations typically took the form of case studies that offered a comprehensive analysis of the development of a particular branch of industry (calico printing, bleaching, textile dyeing, distilling, etc.) over an extended period of time. They dealt with a range of factors on both the supply and the demand side, including labour, capital, materials, technologies and entrepreneurship, as well as business organisation, government policies and national and international markets.<sup>8</sup> Inventions formed part of the story, but they did not take centre stage. Failure to change was considered as interesting as successful innovation. What the Posthumus-Sneller school of economic history set out to do was not to illuminate the achievements of the Golden Age by focusing on cutting-edge production methods or by featuring

6 N.W. Posthumus, *Geschiedenis van de Leidse lakenindustrie*, 3 vols. (The Hague 1908-1939), Z.W. Sneller, 'De opkomst der Nederlandsche katoenindustrie', *Bijdragen voor de Vaderlandsche Geschiedenis en Oudheidkunde*, 6<sup>de</sup> reeks, 4 (1926) 237-274, 5 (1927) 101-113, idem, 'Een mechanische katoenspinnerij in Nederland in het laatst der 18<sup>e</sup> eeuw', *Bijdragen voor de Vaderlandsche Geschiedenis en Oudheidkunde*, 7<sup>de</sup> reeks, 1 (1931) 167-188.

7 C. Visser, *Verkeersindustrieën in Rotterdam* (Rotterdam 1927).

8 W.J. Smit, *De katoendrukkerij in Nederland tot 1813* (Rotterdam 1928), S.C. Regtdoorzee Grup-Roldanus, *Geschiedenis der Haarlemmer bleekerijen* (The Hague 1936), P.J. Dobbelaar, *De branderijen in Holland tot het begin der negentiende eeuw* (Rotterdam 1930), W.L.J. de Nie, *De ontwikkeling der Noord-Nederlandsche textielververij van de 14<sup>e</sup> tot de 18<sup>e</sup> eeuw* (s.a. 1937). Later studies in the same vein include: W.J. Diepeveen, *De verving van Delfland en Schieland tot het einde der zestiende eeuw* (Leiden 1950) and S.G. van Kampen, *De Rotterdamsche particuliere scheepsbouw in de tijd van de Republiek* (Assen 1952). Pioneering studies on the history of technology in the nineteenth century in this period were M.G. De Boer, *Leven en bedrijf van Gerhard Moritz Roentgen* (Groningen 1923), J.A.P.G. Boot, *De Twentse katoenijverheid 1830-1873* (Amsterdam 1935) and J.C. Westerman, *Geschiedenis van de ijzer- en staalgietery in Nederland* (Utrecht 1948).

game-changing feats of entrepreneurial bravado, but to understand the development of the Dutch economy in the Early Modern Period by means of theory-informed, empirical studies on an industry-by-industry basis. Further, even though these Dutch economic historians seldom published abroad, their work was certainly up to prevailing international standards.

## Separate ways

Economic historians from the late 1950s onwards paid much less attention to technology than their predecessors. Textbooks and monographs dealing with the late Middle Ages or the Early Modern Period duly referred to the works by Doorman, Posthumus, Sneller, Visser *e tutti quanti*, but barely added to the existing stock of knowledge about technology in industry.<sup>9</sup> A few engineers continued to follow in Doorman's footsteps.<sup>10</sup> In addition, some innovative work on agrarian techniques and implements was being carried out by historians at Wageningen University, notably J.M.G. van der Poel and H. K. Roessingh.<sup>11</sup> The growing body of literature on the economic development of the Netherlands in the nineteenth century, more specifically on the question of the 'retarded' industrialisation,<sup>12</sup> was little concerned with understanding technological innovation, however. Or to put it more precisely: innovations were regarded as 'given' entities, which required no further examination. Artefacts were treated as fixed items, which needed no closer study. The steam engine was simply *there*.<sup>13</sup> The really interesting questions were supposed to relate to the growth of

9 Joh. de Vries, *De economische achteruitgang van de Republiek in de achttiende eeuw* (Amsterdam 1959), W. Jappe Alberts and H.P.H. Jansen, *Welvaart in wording. Sociaal-economische geschiedenis van Nederland van de vroegste tijden tot het einde van de middeleeuwen* (The Hague 1964), J. Hovy, *Het voorstel van 1751 tot instelling tot instelling van een beperkt vrijhavenstelsel in de Republiek* (Groningen 1966), J.G. van Dillen, *Van rijkdom en regenten. Handboek tot de economische en sociale geschiedenis van Nederland tijdens de Republiek* (The Hague 1970).

10 See e.g. J.H. de Vlieger, 'Historische verfschetsen', *Verfkroniek*, 26 (1953) 202-205, 229-233, 255-257, 287-290, 316-318, J.M. Dirkzwager, *Dr. B.J. Tideman 1834-1883. Grondlegger van de moderne scheepsbouw in Nederland* (Leiden 1970) and K. Van der Pols, 'De introductie van de stoommachine in Nederland', in: *Ondernemende geschiedenis. 22 opstellen geschreven bij het afscheid van mr. H. van Riel als voorzitter van de Vereniging het Nederlandsch Economisch-Historisch Archief* (The Hague 1977) 183-198.

11 J.M.G. van der Poel, *Honderd jaar landbouwmechanisatie in Nederland* (Wageningen 1967), H.K. Roessingh, *Inlandse tabak. Expansie en contractie van een handelsgewas in de 17<sup>e</sup> en 18<sup>e</sup> eeuw in Nederland* (Wageningen 1976) chapter 3.

12 See the essay on the debate on the Dutch economy in the nineteenth century in this issue.

13 Cf. Lintens and Homburg, 'Techniekgeschiedenis in Nederland', 257.

'modern' industry, i.e. the rise of mechanised, factory-based production: When and where did it start? How could the spread of modern industry (or the lack of it) be explained? The magisterial work by J. A. de Jonge on the industrialisation of the Netherlands between 1850 and 1914, for example, contained much data on the use of steam power and new machines in a variety of industries, as well as a brief analytical overview of 'changes in the technology of the production process', but it did not discuss technologies as such. Technological change in industry was conceived as 'the application of new production functions'.<sup>14</sup>

This growing aloofness of economic historians with regard to the history of technology was not merely a Dutch phenomenon, although it went further in the Netherlands than in the Anglo-American world. Leading economic historians in Britain and the United States such as D.C. Coleman, P. Matthias, J. Nef, D. Landes and H.J. Habakkuk did take a keen interest in technology. Landes contributed a long chapter on technological change and industrial development after 1750 to the *Cambridge Economic History of Europe*, which, once transformed into a monograph, quickly became a classic in its field. Habakkuk compared the adoption of labour-saving inventions in Britain and the United States in the nineteenth century.<sup>15</sup> Coleman, Matthias and Nef wrote on subjects at the interface of economic history and the history of technology in the period before the Industrial Revolution.<sup>16</sup>

In the Netherlands, however, economic historians increasingly took their bearings from other traditions of research, where technology hardly figured as a topic of interest at all. First, they started to make more systematic use of insights from economic theory. In the introduction to a reader of state-

14 J.A. de Jonge, *De industrialisatie van Nederland tussen 1850 en 1914* (Nijmegen 1968), 239-245, 493-496; cf. also I.J. Brugmans, *Paardenkracht en mensenmacht. Sociaal-economische geschiedenis van Nederland 1795-1940* (The Hague 1961).

15 David S. Landes, *The unbound Prometheus. Technological change and economic development in Western Europe from 1750 to the present* (Cambridge 1969), H.J. Habakkuk, *American and British technology in the nineteenth century* (Cambridge 1962).

16 E.g. D.C. Coleman, *The British paper industry 1495-1860* (Oxford 1958), idem, 'An innovation and its diffusion: the "New Draperies"', *The Economic History Review*, 22 (1960) 417-429, P. Matthias, *The brewing industry in England 1700-1810* (Cambridge 1959), idem, 'Skills and the diffusion of innovations from Britain in the eighteenth century', *Transactions of the Royal Historical Society*, 5th. Series, 25 (1975) 93-113, J.U. Nef, 'The progress of technology and the growth of large-scale industry in Britain, 1540-1640', *The Economic History Review*, 5 (1934) 3-24, idem, *The conquest of the material world. Essays in the coming of industrialism* (Chicago 1964). Cf. also D.C. Coleman's review of Vol. III of the *History of Technology* edited by Charles Singer et al., 'Technology and economic history, 1500-1750', *The Economic History Review*, New Series, 11 (1959) 506-514.

of-the-art essays by Dutch economic historians on growth and stagnation in the economy of the Netherlands, P.W. Klein stressed that all authors had in common that they tried 'in a deductive or inductive manner to formulate statements on tendencies of change, which – they claimed – had a general validity' and that they attempted to do this in an exact, problem-oriented way rather than in a tentative, narrative fashion. Another hallmark of this new approach, was that different activities in the economy (such as trade, industry and agriculture) were no longer treated as separate entities but as parts of an integrated whole.<sup>17</sup> Klein criticised J.G. van Dillen's textbook on the early modern Dutch economy, published in 1970, as old-fashioned because it lacked these very qualities.<sup>18</sup>

Second, a growing number of Dutch economic historians looked to the French Annales School as their model. Annales historians (up to the 1970s) were concerned with studying relationships between changes in population and changes in production, prices, wages, rents and social structures in the very long term and at a regional level. Their research mostly dealt with the period before the Industrial Revolution. Dutch historians inspired by the Annales School likewise conducted in-depth studies on demography, economic cycles and social structures in a regional framework.<sup>19</sup>

Neither economic science nor the Annales School offered a very auspicious environment for making economic historians sensitive to developments in technology. Economists had long regarded the level and change of technology as lying outside the purview of economic science. These matters were simply considered as a *datum*. Even J. Schumpeter, whose attention to the importance of technological innovation in economic change was second to none, never paused to investigate the development of technology as such. Analysis of technological change only gradually became a regular subject of economic theorising from the 1960s onwards.<sup>20</sup> The Malthusian approach of the Annales School did not set much store by the study of technological

17 P.W. Klein, 'Ter inleiding en verantwoording', in: idem (ed.), *Van stapelmarkt tot welvaartsstaat. Economisch-historische studiën over groei en stagnatie van de Nederlandse volkshuishouding 1600-1970* (Rotterdam 1970) 1-8, 2, B.H. Slicher van Bath, 'Theorie en praktijk in de economische en sociale geschiedenis', in: idem, *Geschiedenis: Theorie en praktijk* (Utrecht/Antwerpen 1978) 81-258, 104, 154.

18 Van Dillen, *Van rijkdom en regenten*; P.W. Klein, 'Een nieuw handboek voor de economische en sociale geschiedenis van de Republiek', *Tijdschrift voor Geschiedenis*, 85 (1972) 550-554.

19 E.g. B.H. Slicher van Bath, *Een samenleving onder spanning. Geschiedenis van het platteland in Overijssel* (Assen 1957), A.M. van der Woude, *Het Noorderkwartier. Een regionaal-historisch onderzoek in de demografische en economische geschiedenis van westelijk Nederland van de late middeleeuwen tot het begin van de negentiende eeuw* (Wageningen 1972), J.A. Faber, *Drie eeuwen Friesland. Economische en sociale ontwikkelingen van 1500 tot 1800* (Wageningen 1973).

20 A. Heertje, *Economie en technische ontwikkeling* (Leiden 1973) 126-127, 328-329.

change either. Tellingly, the *Algemene Geschiedenis der Nederlanden* which in 1980 presented a state-of-the-art overview of the early modern history of the Low Countries moulded on the paradigm of the Annales, reserved a mere six pages for ‘technical developments’, consisting solely of an ‘elevator pitch’ on ‘great’ discoveries and inventors between 1500 and 1800.<sup>21</sup>

Nevertheless, the convergence between economic history and economic science that had been pioneered at American universities after the late 1950s, supported by the increased application of quantitative methods, also sowed the seeds for a regeneration of the interest in technology in economic history. B.H. Slicher van Bath observed in 1969 that some of the most promising work in the New Economic History in the United States was being done on investments in human capital and technological innovations. He singled out work by Theodore Schultz on capital formation by education, by Paul David on the mechanisation of reaping and by Zvi Griliches on the introduction of hybrid corn.<sup>22</sup> However, it would take some time before their examples would also be followed in the Netherlands.

## Great transformations

The overtures between economic history and the history of technology in the Netherlands, which became manifest from the 1980s onwards, were the result of transformations on both sides. Both the practice of economic history and the historiography of technology changed in such a way that exchange and co-operation became easier than before.

Economic historians studying the development of the Netherlands between about 1815 and the First World War went, in a double sense, back to basics. The debate on the ‘retarded industrialisation’ took a new turn when a new generation of historians reframed the key question as the timing and explanation of ‘economic growth’ instead of ‘industrialisation’, and began to undertake a systematic examination of primary sources to get the figures correct.<sup>23</sup> What exactly was the rate and composition of economic

21 J.A. Brongers, ‘Technische ontwikkelingen’, in: D.P. Blok et al. (eds.), *Algemene Geschiedenis der Nederlanden*, Vol. 7 (Bussum 1980) 356-362.

22 Slicher van Bath, ‘Theorie en praktijk’, 157-178; his survey of research in the U.S. first appeared in 1969.

23 Joel Mokyr, *Industrialization in the Low Countries 1795-1850* (New Haven/London 1976), Richard T. Griffiths, *Industrial retardation in the Netherlands 1830-1850* (The Hague 1979), J.M.M. De Meere, *Economische ontwikkeling en levensstandaard in Nederland gedurende de eerste helft van de negentiende eeuw. Aspecten en trends* (The Hague 1982).

growth, especially in the period before 1850? This was the first issue that had to be resolved.<sup>24</sup>

Economic historians also went back to basics in the sense that they shifted the scale of analysis from the macro to the meso or micro level. They reasoned that answers to the question of why change occurred (or failed to occur), and why it happened at a particular time, could best be found by analysing market conditions and relative prices of production factors at the level of regions, industries and firms.<sup>25</sup> Similar to the Posthumus-Sneller school for the Early Modern Period, albeit with the aid of a more sophisticated toolkit of theoretical concepts and quantitative methods, the new generation of historians conducted detailed studies based on extensive archival research, covering a range of industries, such as cotton spinning, cotton weaving, coalmining and machine making in different parts of the Netherlands in the nineteenth and early twentieth centuries.<sup>26</sup>

This move towards a more concrete level of analysis not only gave a massive boost to business history, but also brought economic history, once again, face to face with technology. Technological change was no longer merely taken for granted as 'the application of new production functions'. The factor prices approach suggested a way to find an empirical answer to the question of *why* new production functions were actually applied. Why did technological innovation in fact take place? Why was a given new technology at a particular time in a particular place adopted or not? The recipe for historians was to make a cost-benefit analysis of the use of different technologies – for example steam power or wind power – at the level of a region, an industry or a firm in a particular period of time. The emphasis in this approach lay heavily on understanding decision making by entrepreneurs. Except for a group at the University of Groningen led by E.H.P. Baudet, who pioneered the study of consumer reactions to novelties

24 This line of research culminated in the 'National accounts' project carried out by Jan Luiten van Zanden and others at the VU University Amsterdam and the universities of Groningen and Utrecht between 1987 and 2000, see Jan Pieter Smits, Edwin Horlings and Jan Luiten van Zanden, *Dutch GNP and its components, 1800-1913* (Groningen 2000), Jan Luiten van Zanden and Arthur van Riel, *The strictures of inheritance. The Dutch economy in the nineteenth century* (Princeton 2004); see also the contribution on the economy of the Netherlands in the nineteenth century in this special issue.

25 Landmark studies include: R.W.J.M. Bos, 'Techniek en industrialisatie: Nederland in de negentiende eeuw, in: *AAG Bijdragen* 22 (1975) 59-88, idem, 'Factorprijzen, technologie en marktstructuur: de groei van de Nederlandse volkshuishouding 1815-1914', *AAG Bijdragen* 22 (1975) 109-137, E.J. Fischer, *Fabriqueurs en fabrikanten. Twente, Borne en de katoennijverheid 1800-1930* (Utrecht 1983).

26 See especially the essays collected in issue 5 (1988) of the *Jaarboek voor de Geschiedenis van Bedrijven Techniek* and Fischer, *Fabriqueurs en fabrikanten*.

in the late nineteenth century (such as the bicycle, the light bulb and the cinema),<sup>27</sup> economic historians at that time paid no heed to the role of consumer demand in the shaping and adoption of innovations.

These changes in the practice of economic history nicely coincided with a fundamental transformation in the historiography of technology. It was this happy conjunction that permitted the 'technological turn' in economic history to move beyond the point reached in the time of Posthumus and Sneller and to help the history of technology break away from its traditional fixation on inventions and high achievers. Economic historians deepened their understanding of why technological innovation occurred and historians of technology expanded their view to include technology-in-practice and the wider context of technological change.

In the 1970s and 1980s, the history of technology in the Netherlands finally came of age as a separate discipline. The field acquired its own identity via textbooks, chairs, organisations and journals. The Polytechnic in Twente created a lectureship in the 'historical aspects of technology and society' in 1973. The first incumbent, A.L. van Schelven, took the initiative for the formation of a national Study Group for the History of Technology, which convened twice a year after 1975.<sup>28</sup> A study group *Techniek, Technologie en Samenleving* founded at the University of Leiden in 1977, started to teach a course on the history of technology at the Polytechnic in Delft, which expanded into a fully-fledged textbook on the 'social history of three Industrial Revolutions' a few years later.<sup>29</sup> Baudet (from Groningen) was appointed to a newly-created chair in the history of the relationships between humans and products in 1981. In 1990, the Polytechnics in Eindhoven and in Delft both established a professorship in the history of technology; the incumbent was H. Lintsen. The Royal Institute of Engineers (*Koninklijk Instituut van Ingenieurs*, KIVI) sponsored the foundation of a national study group on industrial heritage, which was concerned with the description and conservation of 'monuments of enterprise and technology'. The KIVI was

27 E.H.P. Baudet, 'Mensen en dingen. Inleiding tot een historisch onderzoek van consumentengedrag', *Tijdschrift voor Geschiedenis*, 82 (1969) 250-269, E.H.P. Baudet, J.W. Drukker, P. Kooij and H. van der Meulen, 'Innovation and consumer demand: A new approach to the history of consumption', *Maandschrift Economie*, 38 (1973-1974), 562-593, 612-638.

28 Lintsen and Homburg, 'Techniekgeschiedenis', 259, Van Schelven, 'Geschiedenis van de techniek'.

29 Maarten Pieterse (ed.), *Het technisch labyrint. Een maatschappijgeschiedenis van drie industriële evoluties* (Meppel 1981) 7-8. J.M. Dirkszwaager acted as a guest lecturer in the history of technology between 1970 and 1974. The first Dutch reader on the history of technology to appear in print was E.J. Fischer (ed.), *Geschiedenis van de techniek. Inleiding, overzicht en thema's* (The Hague 1980).

also at the inception of an umbrella organisation for researchers working in the history of technology, the *Stichting Historie der Techniek* established in 1988. The national study groups, in turn, were behind the foundation of two new periodicals, a bulletin on industrial heritage in 1981 and a yearbook for the history of business and technology (*Jaarboek voor de Geschiedenis van Bedrijven Techniek*) in 1984.<sup>30</sup>

The flourishing of the new specialty had both external and internal causes. After the 1960s, technology lost its sacrosanct status and engineers could no longer take for granted that their expertise would be deferentially acknowledged. Given the manifest damage that technological 'achievements' could inflict on society and the natural environment (ranging from environmental pollution and the spread of weapons of mass destruction to 'de-skilling', 'alienation' and the perfection of means of surveillance and oppression), the critique of technological 'progress', which had simmered on the margins ever since the nineteenth century,<sup>31</sup> now swelled to a noisy chorus. The rise of mass higher education was of course also a relevant factor in the upswing of this critical mood. The growth of this counter-movement, which also had a following among students at the Polytechnics of Delft, Twente and Eindhoven, led to much soul-searching and reflection among engineers and social scientists, which ushered in an increased appreciation of the uses of history. On the one hand, the history of technology appeared to be an excellent means to reduce the perceived lack of understanding between technicians and laymen. The gap supposedly could more easily be bridged if historical study could demonstrate in detail how present-day technology had emerged and how it had left an enduring mark on the fabric of daily life and on the evolution of society at large. On the other hand, historical research was also expected to lead to a better understanding of technology and its social consequences, by uncovering the interrelationships between technology, science and society through time.<sup>32</sup>

30 Lintsen and Homburg, 'Techniekgeschiedenis', Van Schelven, 'Geschiedenis van de techniek', P. Nijhof, 'Industrieel erfgoed in Nederland', in: Lintsen et al. (eds.), *Geschiedenis van de techniek*, Vol. VI, 241-253, Erik Nijhof en Henk Weevers, 'Tussen afschuw en nostalgie: het industrieel erfgoed in Nederland als barometer van een nieuwe tijd', in: Erik Nijhof and Peter Scholliers (eds.), *Het tijdperk van de machine. Industrie cultuur in België en Nederland* (Brussels 1996) 183-200, 188-194.

31 Cf. J.H.J. van der Pot, *Die Bewertung des technischen Fortschritts. Eine systematische Übersicht der Theorien* (Assen 1985), especially 2. Hauptteil.

32 W.J. Wolff, 'Woord vooraf', in: Lintsen et al. (eds.), *Geschiedenis van de techniek*, Vol. I, 11, Wolff and Lintsen, 'Inleiding en verantwoording', 15, Lintsen and Homburg, 'Techniekgeschiedenis', 259.

Changes in the historiography of technology also had causes peculiar to the field itself. Historians of technology in the Netherlands could draw inspiration from innovations in America, where historical research on the technological past had developed into a separate discipline from the late 1950s onwards. Faced with the refusal of the History of Science Society and its journal *Isis* to make room for history of technology, scholars interested in technology founded their own association, the Society for the History of Technology (SHOT) in 1958, and started their own journal (*Technology and Culture*) in 1959. The title of the new journal reflected the ambition of its editors and SHOT to take a broad view of the subject, which would integrate the study of technology as such with research on the wider context in which the development of technology occurred. 'Culture' included not just cultural factors in a narrow sense, but also an array of factors of an economic, social or political nature. This innovative approach required the development of a new set of concepts and methodologies, which would be 'contextual' rather than purely 'internalist' or 'externalist' in style. In his classic *Technology's storytellers*, J. Staudenmaier showed that SHOT and *Technology and Culture* indeed succeeded in acquiring a distinct intellectual identity, albeit slowly and not without a struggle. The proportion of articles of a contextual style rose from 41 per cent in the first seven years of the journal's existence, through 53 per cent between 1967 and 1973, to 59 per cent between 1974 and 1980.<sup>33</sup> By the mid-1980s, the arsenal of the historians of technology had been enriched by powerful new instruments such as the theory of technological systems and technological momentum, network theory and the social construction of technology approach. The contextual approach, which had been pioneered in the U.S. offered a useful template for historians, and sociologists or engineers turned historians in the Netherlands, who started to practise the historiography of technology from the 1980s onwards. Some of them also made significant contributions to these innovative approaches in their own right.<sup>34</sup>

The flagship of the fledgling discipline was the newly founded *Jaarboek voor de Geschiedenis van Bedrijven Techniek*. The yearbook brought together economic and business historians who were aware of the importance of

33 John M. Staudenmaier, *Technology's storytellers. Reweaving the human fabric* (Cambridge Mass. 1985) 208 table 14.

34 See e.g. Wiebe E. Bijker, Thomas P. Hughes and Trevor Pinch (eds.), *The social construction of technological systems. New directions in the sociology and history of technology* (Cambridge Mass. 1987), a collective volume of papers of a conference held at the Polytechnic Twente in July 1984, and Wiebe Bijker, 'De sociale constructie van netwerken en technische systemen: nieuwe perspectieven voor de techniekgeschiedenis', *Jaarboek voor de Geschiedenis van Bedrijven en Techniek*, 4 (1987) 7-24.

technology in historical change, and engineers who were sensitive to the economic and social contexts of technology. The distribution of the articles by period reflected the shift in attention of research from the pre-industrial era to the nineteenth and twentieth centuries. Of the 143 articles that appeared in the yearbook during the ten years of its existence, about 80 per cent were concerned with topics covering the period after 1800, against some 10 per cent dealing with subjects in the Middle Ages and the Early Modern Era, with the remainder largely devoted to discussions about theoretical and historiographical matters. Many of the contributors to the yearbook were also involved in two massive collective book projects in the history of technology that were launched in the late 1980s, the six-volume *Geschiedenis van de Techniek in Nederland. De wording van een moderne samenleving 1800-1890*, published between 1992 and 1995, and its follow-up, the seven-volume *Techniek in Nederland in de twintigste eeuw* which appeared between 1998 and 2003. The powerhouses of these projects – informally known as TIN-19 and TIN-20 – were the *Stichting Historie der Techniek* and the departments of technology and society at the Polytechnics of Eindhoven and Twente. The initiators moreover managed not only to mobilise massive support from scholars at other universities in the Netherlands, but also to attract substantial funding from the business community, the Ministry of Economic Affairs and the national organisation for scientific research. History of technology had evidently established a solid reputation in academia and in society at large. While of course differences of opinion arose about interpretations, methodological choices and points of detail, TIN-19 and TIN-20 together offered something no community of historians anywhere else had yet been able to produce: a nearly comprehensive, state-of-the-art overview of the history of technology in a single country covering the entire nineteenth and twentieth centuries.<sup>35</sup>

Meanwhile, research on the history of technology before 1800 also continued inside and outside academia, although the number of people working in this field remained much smaller than of those studying the more recent periods. R. Unger, A. Wegener Sleswijk, P. van Dam and others carried out meticulous studies on the development of shipbuilding, brewing,

35 H.W. Lintsen et al. (eds.), *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890*, 6 Vols (Zutphen 1992-1995), J.W. Schot et al. (eds), *Techniek in Nederland in de twintigste eeuw*, 7 Vols. (Zutphen 1998-2003). See for reviews e.g. Joel Mokyr, 'High technology in the Low Countries', *Technology and Culture*, 42 (2001) 133-137 and the debates in the *NEHA-Jaarboek voor Economische, Bedrijfs- en Techniekgeschiedenis*, 58 (1995), 27-110, the *Tijdschrift voor Sociale en Economische Geschiedenis*, 1 (2004) 149-160 and the *Bijdragen en Mededelingen betreffende de Geschiedenis der Nederlanden*, 120 (2005) 48-79.

herring fishing, textile making, mill construction, hydraulic equipment and navigation technology in their social contexts.<sup>36</sup> This tradition of scholarship culminated in a new wide-ranging synthesis by the present author, published in 2008: *The rise and decline of Dutch technological leadership. Technology, economy and culture in the Netherlands, 1350-1800*.<sup>37</sup>

## Perspectives on technological change

Economic historians and historians of technology in the Netherlands nowadays communicate more than they used to in the quarter of a century before the 1980s. There is more common ground between them today than in the past. Practitioners of these disciplines now share an interest in technology in a wider context and they view technology in a broader sense than a mere assemblage of nuts and bolts. Nevertheless, they usually approach the field from somewhat different directions and tend to ask different types of questions.

Economic historians are mostly interested in the contribution of technological change to economic growth. They are concerned about the timing, diffusion and impact of innovations and, in common with American pioneers in this field such as P. David and Z. Griliches, prefer to digest their material in a quantitative form. Patent statistics, productivity figures and data on factor costs are frequently used. The historians examine whether inventions consisted of incremental improvements to existing techniques

36 See e.g. Richard W. Unger, *Dutch shipbuilding before 1800. Ships and guilds* (Assen 1978), idem, *A history of brewing in Holland 900-1900. Economy, technology and the state* (Leiden 2001), idem, 'Dutch herring, technology and international trade in the seventeenth century', *Journal of Economic History*, 40 (1980) 253-279, André Wegener Sleeswijk, *De Gouden Eeuw van het fluitschip* (Franeker 2003), A.J. Hoving and A.A. Lemmers, *In tekening gebracht. De achttiende-eeuwse scheepsbouwers en hun ontwerpmethoden* (Amsterdam 2001), Judith H. Hofenk-de Graaff, *Geschiedenis van de textieltechniek* (s.l. 1992), W. Dobber et al., *Cornelis Cornelisz van Uitgeest. Uitvinder aan de basis van de Gouden Eeuw* (Zutphen 2004), Alan Lemmers, *Techniek op schaal. Modellen en het technologiebeleid van de Marine 1725-1885* (Amsterdam 1996), Petra van Dam, 'Ecological challenges, technological innovations: The modernization of sluice building in Holland, 1300-1600', *Technology and Culture*, 43 (2002) 500-520, Siger Zeischka, *Minerva in de polder. Waterstaat en techniek in het hoogheemraadschap van Rijnland (1500-1856)* (Amsterdam 2007), Karel Davids, *Zeewezen en wetenschap. De wetenschap en de ontwikkeling van de navigatietechniek in Nederland tussen 1585 en 1815* (Amsterdam/Dieren 1986), Willem F.J. Morzer Bruyns, *Schip Recht door Zee. De octant in de Republiek in de achttiende eeuw* (Amsterdam 2003).

37 Karel Davids, *The rise and decline of Dutch technological leadership. Technology, economy and culture in the Netherlands, 1350-1800*, 2 vols. (Leiden 2008). See also : idem, 'De technische ontwikkeling van Nederland in de vroegmoderne tijd. Literatuur, problemen en hypothesen', *Jaarboek voor de Geschiedenis van Bedrijven Techniek*, 8 (1991) 9-37.

(micro inventions) or technological breakthroughs that opened up an entire new range of production possibilities (macro inventions). They examine the structure of incentives for invention, for example in the form of patents, and sometimes – along the lines of J. Mokyr – they probe into the question of what types of knowledge were embodied in inventions, where this knowledge came from and how it came to be transformed into new technology.<sup>38</sup>

Historians of technology, by contrast, concentrate on the dynamics of technological development itself. Innovation is not seen as a process with discrete phases, but as a kind of continuum in which new ideas (whether major breakthroughs or minor improvements) are continuously selected, moulded and adapted to different circumstances under the impact of the actions of different groups with different demands and interests. The social construction of technology approach has even claimed that artefacts do not exist outside the interactions of the relevant groups that assign meanings to that artefact. ‘Everything is social’ – the slogan went.<sup>39</sup> However, actors themselves, historians of technology argue, operate in a context that is also shaped by other forces that follow their own patterns and rules. Large technological systems (complexes of physical artefacts, organisations and institutional arrangements such as electricity systems), notably, are both ‘socially constructed and society shaping’; they acquire a momentum of their own.<sup>40</sup> Regions or nations may develop a distinct style of technology, which can persist for ages. The ‘technological style’ of the Netherlands, for example, is said to consist of small-scale production, small-scale use of energy and versatility of techniques.<sup>41</sup> Technological development can also

38 See e.g. Jan Pieter Smits, Herman de Jong and Bart van Ark, *Three phases of Dutch economic growth and technological change, 1815-1997* (Research Memorandum GD-42 Groningen 1999), Ben Gales, *Ondergronds bovengronds. Techniek en markt van de Limburgse steenkolenmijnbouw gedurende de achttiende en negentiende eeuw* (Nijmegen 2002), Karel Davids, ‘Patents and patentees in the Dutch Republic, 1580-1720’, *History and Technology*, 16 (2000) 263-283, idem, *Rise and decline*, 400-416, 478-482, 499-500, 505-506, 511-512; cf. Joel Mokyr, *The lever of riches. Technological creativity and economic progress* (New York 1990) and idem, *The gifts of Athena. Historical origins of the knowledge economy* (Princeton 2002).

39 D. van Lente, H.W. Lintsen, M.S.C. Bakker, E. Homburg, J.W. Schot, G.P.J. Verbong, ‘Techniek en modernisering’, in: Lintsen et al., *Geschiedenis van de techniek*, Vol. I, 19-36, 27-28, Bijker, ‘Sociale constructie’, 17.

40 Bijker, ‘Sociale constructie’, 10-13, Thomas H. Hughes, ‘The evolution of large technological systems’, in: Bijker, Hughes and Pinch (eds.), *Social construction*, 51-82.

41 H.W. Lintsen, *Een revolutie naar eigen aard. Technische ontwikkelingen en maatschappelijke verandering in Nederland* (Delft 1990) 27-30; cf. Joachim Radkau, *Technik in Deutschland vom 18. Jahrhundert bis zur Gegenwart* (Frankfurt am Main 1989) 21-58. Some caveats were put in by J.W. Schot, ‘Innoveren in Nederland’, in: Lintsen et al., *Geschiedenis van de techniek*, Vol. VI, 217-239, 235-236.

be shown to have some resemblance to evolutionary processes. The growth of 'niches', in which incipient new technologies can be nurtured, has been suggested as an example of this pattern.<sup>42</sup>

Both the TIN-19 and 20 projects and the *Rise and decline* book proposed ways to combine perspectives and questions from different disciplines by using a single, overarching concept to organise the varied historical material. The umbrella concepts employed in the TIN-19 and TIN-20 books were 'modernisation' and 'contested modernisation'. 'Modernisation' was taken as a generic term, covering a whole cluster of fundamental changes in society, including demographic transition, industrialisation, urbanisation, democratisation, the growth of government bureaucracies and the increased mobility of people of ideas. The expected benefits of using this concept were that it suggested a convenient criterion to distinguish relevant themes from less important ones, that it drew attention to underlying relations between innovations in technology and other processes in society and that it facilitated the making of international comparisons.

On the basis of the 'modernisation' concept, the authors decided to focus research on those fields of technological activities they deemed crucial in bringing about fundamental transformations. Hence, the project included for example case studies on railways and waterways, building, public health, gas and electric lighting, printing, paper manufacture and communications. By taking the state of affairs at around 1800 as a starting point and then tracing the evolution of innovations onwards, the authors tried to avoid the pitfalls of Whiggish history, which lie in wait for anyone who dares to bring the notion of modernisation into play. International comparisons would help to get around another danger inherent in the concept of modernisation: the assumption that the experience of a particular country (for example Britain or the United States) represents a kind of fixed standard against which the performance of all other countries has to be measured.<sup>43</sup>

The notion of 'contested modernisation', which made its appearance in the TIN-20 project, was meant to stress on the one hand that 'modernity' in the twentieth century in the eyes of elites continued to be an ideal worth striving for and, on the other hand that the rate and direction of change was also a bone of contention between different groups in society.<sup>44</sup> Modernisation was not a neutral category.

42 Schot, 'Innoveren in Nederland', 230-233.

43 Van Lente et al. 'Techniek en modernisering', 19-36.

44 J.W. Schot, H.W. Lintsen and A. Rip, 'Betwiste modernisering', in: Schot et al. (eds.), *Techniek in Nederland*, Vol. I (Zutphen 1998) 17-37, 20.

Similar to 'modernisation', the concept of 'technological leadership' has been around in international historiography for quite some time. It has been applied to industrial firms as well as to socio-geographical entities such as cities, regions and countries, mostly for the period following the Industrial Revolution.<sup>45</sup> In the *Rise and decline of Dutch technological leadership*, which dealt with the period before 1800, the concept was conceived in the sense that a given country, region, town or cluster of towns plays an initiating role in the development of new technologies in a wide variety of fields.<sup>46</sup> 'Technological leadership' can be shown to shift over time from one location to another, without any shift being determined in advance; it resided for a while in the Netherlands during the seventeenth and much of the eighteenth centuries and it then moved to England.<sup>47</sup> The concept of technological leadership was thus assumed to be free from finalist connotations and to act as a powerful stimulus for making interregional comparisons. Under this umbrella, *Rise and decline* first examined long-term changes in the transfer of technology, in perceptions of contemporary observers and in relative levels of productivity in the Netherlands in a wide range of economic activities. It then went on to ask questions about the adoption of innovations in market and non-market contexts as well as about the emergence and origins of technological innovations. The latter part included an analysis of the culture and politics of 'openness of knowledge', of institutional arrangements for the protection and remuneration of inventive activities, of the infrastructure of knowledge and of the process of knowledge creation (and its limits) itself.

Moreover, economic historians and historians of technology not only share the same covering concepts, up to a point, but also more and more often find themselves working side by side on the same type of subjects. What increasingly holds the interest of both groups are topics such as the consumer side of innovation, the 'software' of technology and infrastructures of knowledge.

The pioneering work of the Baudet group in the 1970s was finally followed-up in the late 1990s. Historians and social scientists from various

45 See e.g. E. Ames and N. Rosenberg, 'Changing technological leadership and industrial growth', *Economic Journal*, 73 (1963) 13-31, D.S.L. Cardwell, *Turning points in Western technology* (New York 1972) 190, 206, Richard R. Nelson and Gavin Wright, 'The rise and fall of American technological leadership: the post-war era in historical perspective', *Journal of Economic Literature*, 30 (1992), 1931-1964.

46 Davids, *Rise and decline*, 3.

47 Karel Davids, 'Shifts of technological leadership in early modern Europe', in: Karel Davids and Jan Lucassen (eds.), *A miracle mirrored. The Dutch Republic in European perspective* (Cambridge 1995) 338-366.

backgrounds started to make a thorough exploration of the rise of Dutch consumer society in the twentieth century, and more particularly of the spread of a whole range of new consumer products, such as cars, TV sets, washing machines, central heating and kitchen appliances. A guiding question in these inquiries was how and to what extent new actors, such as women's associations, and new institutions, such as government safety regulations, were instrumental in shaping new products and technologies for consumption. In this perspective, a household represents an equally important location for innovation as a factory and consumers are as equally relevant a party as producers.<sup>48</sup>

Economic historians and historians of technology also developed a joint interest in questions concerning the notion of 'knowledge' itself. Knowledge has become a focus of attention in research on both the pre-industrial and the industrial periods. Historians of technology today are not just interested in artefacts or materials, but also in the formal or tacit knowledge and the manual or mental skills that are brought to bear to master or manipulate nature. 'Software' has become as crucial as 'hardware', information techniques as critical as instruments and machines.<sup>49</sup> Economic historians are equally interested in these topics from the perspective of human capital formation. 'I propose to treat education as an investment in man and to treat its consequence as a form of capital. Since education becomes a part of the person receiving it [...] I shall refer to it as human capital', Theodore W. Schultz wrote in 1960.<sup>50</sup> This notion has been applied fruitfully in recent research in the Netherlands on long-term changes in literacy, numeracy and vocational skills. Understanding human capital formation is now – partly

48 Wiebe Bijker and Karin Bijsterveld, 'Women walking through plans: Technology, democracy and gender identity', *Technology and Culture*, 41 (2000) 485-515, R. Oldenziel (ed.), 'Huishouden' in: Schot et al. (eds.), *Techniek in Nederland*, Vol. IV (Zutphen 2001) 11-151, Adri de la Bruhèze and Onno de Wit (eds.), *De productie van consumptie*, special issue *Tijdschrift voor Sociale Geschiedenis*, 28 (2002) no. 3, Adri de la Bruhèze and Ruth Oldenziel (eds.), *Manufacturing technology, manufacturing consumers. The making of Dutch consumer society* (Amsterdam 2009), 13. A foundational text for much of this research is Ruth Schwartz Cowan, 'The consumption junction: A proposal for research strategies in the sociology of technology', in: Bijker, Hughes and Pinch (eds.), *Social construction*, 261-280.

49 Cf. the distinction in Alexander J. Field, 'French optical telegraphy, 1793-1855: Hardware, software, administration', *Technology and Culture*, 35 (1994) 315-347; Davids, *Zeewezen en wetenschap*, 69-264, idem, *Rise and decline*, 434-454, 502-512, D. van Lente (ed.), 'Papier, druk en communicatie', in: Lintsen et al. (eds.), *Geschiedenis van de techniek*, Volume II (Zutphen 1993), 175-281, J. van den Ende (ed.), 'Kantoor en informatietechnologie', in: Schot et al. (eds.), *Techniek in Nederland*, Vol. I, 209-248.

50 Theodore W. Schultz, 'Capital formation by education', *Journal of Political Economy*, 68 (1960) 571-583, 571.

due to the seminal work by Joel Mokyr – viewed as key in explaining the emergence of a ‘knowledge economy’ and hence, the genesis of economic growth in the long term.<sup>51</sup> Finally, historians of technology and economic historians are also curious about the infrastructures that underpin the transmission and creation of knowledge. Early modern historians study institutions such as craft guilds, navigation schools, learned societies and publishing houses, whilst twentieth-century historians examine innovation systems and their components such as laboratories, universities, research stations and network relationships between firms.<sup>52</sup>

## Epilogue

Historians of technology in the Netherlands today are at the forefront of international research. The TIN-19 and TIN-20 group hosted the 2004 Annual Meeting of SHOT in Amsterdam and this formed the heart of a newly-built network of hundreds of young and senior scholars from all of Europe (and the United States), who are busily studying the role of technology as an agent of change in Europe between 1850 and 2000. A major result of this *Tensions of Europe* project is the six-volume work *Making Europe*, which started to appear in 2013.<sup>53</sup> Co-operation between historians of technology, business historians and historians of entrepreneurship has been institutionalised in the BINT project, which aims to produce a new history of business in

51 See e.g. P. Baggen, J. Faber and E. Homburg, ‘Opkomst van een kennismaatschappij’, in: Schot et al. (eds.), *Techniek in Nederland*, Vol. VI, 141-173, Jan Luiten van Zanden, ‘De timmerman, de boekdrukker en het ontstaan van de Europese kenniseconomie. Over de prijs en het aanbod van kennis vóór de Industriële Revolutie’, *Tijdschrift voor Sociale en Economische Geschiedenis*, 2 (2005) 105-120, Tine de Moor en Jan Luiten van Zanden, ‘Van fouten kan je leren. Een kritische benadering van de mogelijkheden van “leeftijdstapelen” voor sociaal-economisch onderzoek naar gecijferdheid in het pre-industriële Vlaanderen en Nederland’, *Tijdschrift voor Sociale en Economische Geschiedenis*, 5 (2008) 55-86, Janneke Tump, *Ambachtelijk geschoold. Haarlemse en Rotterdamse ambachtlieden en de circulatie van technische kennis, ca.1400-1720* (PhD Dissertation . VU University Amsterdam 2012).

52 Davids, *Rise and decline*, 416-434, 482-502, Jasper Faber, ‘Het Nederlandse Innovatie Systeem, 1870-1990’, *NEHA-Jaarboek voor Economische, Bedrijf- en Techniekgeschiedenis*, 66 (2003) 208-232, Arjan van Rooij, Eric Berkers, Mila Davids and Frank Veraart, ‘National innovation systems and international knowledge flows: an exploratory investigation with the case of the Netherlands’, *Technology Analysis and Strategic Management*, 20 (2008) 149-168, Mila Davids et al., ‘Knowledge circulation in innovation networks in the twentieth century: Its importance for innovations in small and large companies in the Netherlands’, in: Paloma Fernández Pérez and Mary B. Rose (eds.), *Innovation and entrepreneurial networks in Europe* (London 2010) 184-204.

53 [www.tensionsofeurope.eu](http://www.tensionsofeurope.eu), [www.makingeurope.eu](http://www.makingeurope.eu).

the Netherlands in the twentieth century.<sup>54</sup> The only cloud on the horizon is possibly the institutionalist turn among general economic historians that has taken place in recent years. One of the by-products of the focus on institutions seems to be a blind spot for the role of technology.<sup>55</sup>

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54 [www.bintproject.nl](http://www.bintproject.nl); the project includes a volume on knowledge and innovation.

55 A recent overview by Jan Luiten van Zanden and Maarten Prak of social and economic history of the Netherlands in the past 1000 years, inspired by institutional economics, entirely ignores the TIN 19 and TIN 20 projects, see *Nederland en het poldermodel* (Amsterdam 2013).