

Knie, Andreas

**Book Part — Digitized Version**

## Yesterday's decisions determine tomorrow's options: the case of the mechanical typewriter

**Provided in Cooperation with:**

WZB Berlin Social Science Center

*Suggested Citation:* Knie, Andreas (1992) : Yesterday's decisions determine tomorrow's options: the case of the mechanical typewriter, In: Meinolf Dierkes, Ute Hoffmann (Ed.): New technology at the outset: social forces in the shaping of technological innovations, ISBN 0-8133-8620-9, Campus, Frankfurt/M. ; New York, NY, pp. 161-172

This Version is available at:

<https://hdl.handle.net/10419/112218>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



## WZB-Open Access Digitalisate

## WZB-Open Access digital copies

---

Das nachfolgende Dokument wurde zum Zweck der kostenfreien Onlinebereitstellung digitalisiert am Wissenschaftszentrum Berlin für Sozialforschung gGmbH (WZB). Das WZB verfügt über die entsprechenden Nutzungsrechte. Sollten Sie sich durch die Onlineveröffentlichung des Dokuments wider Erwarten dennoch in Ihren Rechten verletzt sehen, kontaktieren Sie bitte das WZB postalisch oder per E-Mail:

Wissenschaftszentrum Berlin für Sozialforschung gGmbH  
Bibliothek und wissenschaftliche Information  
Reichpietschufer 50  
D-10785 Berlin  
E-Mail: [bibliothek@wzb.eu](mailto:bibliothek@wzb.eu)

The following document was digitized at the Berlin Social Science Center (WZB) in order to make it publicly available online.

The WZB has the corresponding rights of use. If, against all possibility, you consider your rights to be violated by the online publication of this document, please contact the WZB by sending a letter or an e-mail to:

Berlin Social Science Center (WZB)  
Library and Scientific Information  
Reichpietschufer 50  
D-10785 Berlin  
e-mail: [bibliothek@wzb.eu](mailto:bibliothek@wzb.eu)

---

Digitalisierung und Bereitstellung dieser Publikation erfolgten im Rahmen des Retrodigitalisierungsprojektes **OA 1000+**. Weitere Informationen zum Projekt und eine Liste der ca. 1 500 digitalisierten Texte sind unter <http://www.wzb.eu/de/bibliothek/serviceangebote/open-access/oa-1000> verfügbar.

This text was digitizing and published online as part of the digitizing-project **OA 1000+**. More about the project as well as a list of all the digitized documents (ca. 1 500) can be found at <http://www.wzb.eu/en/library/services/open-access/oa-1000>.

## Yesterday's decisions determine tomorrow's options: The case of the mechanical typewriter

---

*Andreas Knie*

### THE ESTABLISHMENT OF A "GOLDEN STANDARD": PERSPECTIVES ON THE GENERATION OF TECHNICAL KNOWLEDGE

Popular ideologies of technological change usually equate technological development with technological progress: the technical solutions prevailing on the market rank as the "better solution", the "better product." Here "better" means optimized functioning and performance to please the user. In the case of the mechanical typewriter, a central office appliance well into the 1970s, however, it is evident that this assumption needs to be revised. An analysis focusing on the creation phase of the mechanical typewriter provides a better understanding of the driving and constituting forces behind technical development.<sup>1</sup>

The most striking difference between the first mechanical writing machine—the writing ball (Fig. 1) designed by the Danish cleric Malling-Hansen in the 1870s—and today's typebar machine is the solid design of the latter: it guarantees exact performance at any time and any place as often as desired. Friedrich Nietzsche, one of the first and most famous owners of a writing ball, soon found out that he could not rely on his writing machine. On a trip to Italy he complained: "The weather is dull

---

<sup>1</sup> Here I draw on the findings of an ongoing study (see Knie 1991b) that is part of a larger project on technological development in organizational contexts (*Technikgenese in organisatorischen Kontexten*). The research is being done by the Social Science Research Center Berlin (WZB) and the Department of Sociology at the Technical University Berlin. A part of the "Verbund Sozialwissenschaftliche Technikforschung", the project is funded by the Federal Minister for Research and Technology.

and cloudy, hence humid. The ribbon also becomes humid and sticky so that the stencils get stuck and none of my writing can be seen" (in *Die fröhliche Wissenschaft* [1882], quoted from Kittler 1986: 301). This impaired the machine to such an extent that he finally gave up using his writing ball.

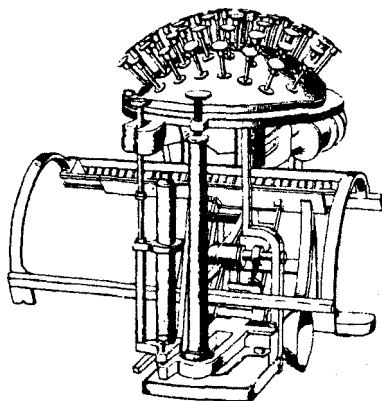


Figure 1. Writing Ball

Nietzsche and his contemporaries could choose from a great variety of writing machines ranging from typebar machines with segment shift, typeball machines and writing balls, to cheap singlebar machines (see Pfeiffer 1923; Müller 1986; Adler 1973; Baggenstoss 1977). Customers could choose between the "Universal" keyboard (which is the one still in use today), the "Ideal" keyboard, keyboards with bars for each capital and small letter, and keyboards featuring one or even two shiftkeys. This wide variety matched the different needs and desires of professional and non-professional users.

Around the turn of the century, however, typewheel and typeball machines were displaced from the market and the typebar machine established itself as the dominant technique in mechanical design, even though typing with the typebar machine was hard work (Kunzelmann 1979: 169).<sup>2</sup> The "mechanical character" of the typewriter, i.e. reliable performance regardless of time and place, was developed and preserved over the past one hundred years, but only at the expense of qualities like

---

<sup>2</sup> Typewheel and typeball machines became available again with the advent of electromechanical designs.

comfort and handling. During the process of construction and industrial production priority was given to securing this stable, mechanical character rather than to the users' particular needs. In other words, criteria other than the user-friendliness which is usually quoted in this regard have informed the process of generating and implementing technological knowledge. Why, then, are users of typewriters still being offered mechanical machines that after many decades of industrial maturing are still miserable to handle? This is one of the questions a research project concerned with the reconstruction of the development of the mechanical typewriter must address.

The increasing number of cases of occupational illness among typists has in the past brought harsh criticism and sometimes words of condemnation on the mechanical typewriter (see Holtgreve 1989; Davies 1979; Frevort 1979; Fritz 1982; Srole 1987). Since 1974, the mechanical typewriter has had its place in the research program on Improvement in the Quality of Working Life (*Humanisierung der Arbeitswelt*) set up by the Federal Minister of Research and Technology (BMFT). A number of—for the most part ergonomic—investigations have been undertaken. They always centered on "optimizing energetic work" and, therefore, were only able to offer recommendations concerning different key and keyboard parameters—like measurements and surface design—as well as optical and acoustic signalling (see Menzel and Schilling 1920; IG Metall 1984; Rohmert and Haider 1982).

Concepts designed to minimize strain on body and health very soon became measures of a compensatory nature. They could not alter the character of the machine, which was determined by early but far-reaching constructive decisions. Investigations geared towards reducing stress on the body obviously paid too much respect to the "normative power" of the given technique and were guided by the widespread assumption that the realized technical solution must be the "correct solution." This assumption has since been subjected to vehement criticism, and has increasingly given way to the notion of technological development as a social process that needs to be reintegrated into its economic, political, and cultural context (Bijker et al. 1987; Weingart 1989). The following description of the history of the mechanical typewriter has been informed by this new perspective. It puts forward the thesis that technical appliances are "coined" early in their process of creation, certain attributes becoming irreversible. The generation of a new technology can be described as a process of closing and consolidation which is concluded in the definition of a "golden standard" (*Stand der Technik*).

In German law the term "Stand der Technik" serves as a reference point for the state-controlled regulation of technological practice. I use this term in a slightly different sense, however, to denote the dominant--and necessary--guidance for the generation of technological knowledge in the innovation process. The outcomes of technological practice demand for an absolute inherent consistency to fulfill the promise to realize a predictable procedure. Construction and development engineers, therefore, are in need of a stable fundament for planning and implementation.<sup>3</sup> They tend to minimize the risk of poorly developed modes of function through recourse to approved principles and elements that guarantee the degree of certainty necessary for complex constructive tasks. It is this particular feature of technical construction work that lends significance to the "Stand der Technik" and explains both the quest of technological practitioners for, and their readiness to agree on a "golden standard."

The establishment of a "golden standard" signifies that a new technique or artifact is socially and institutionally anchored and can itself be the point of departure for new developments. Above all, a "consensus of consolidation" needs to be initiated, promoted, and pushed forward in order to benefit from the emerging cognitive, social, and economic advantages of a "golden standard." Engineers, firms, research institutions, professional associations, and committees are involved in this process. A technical solution selected in this way is not necessarily the functionally "best" technique or the "best" appliance offering the greatest handling comfort. It is simply a construction for which a lasting "consensus of consolidation" has been achieved at an early stage of development and which embodies the most favourable cognitive, social, and economic conditions (see Knie 1991b).

#### TYPEWRITER DESIGN IN THE CONTEXT OF MASS PRODUCTION

During the 18th and 19th century a great number of models for the mechanization of writing were created all over the world, mostly by individual inventors with a great deal of imagination but only little mechanical competence. At the end of the 1860s a group of inventors in

---

<sup>3</sup> This need has not, however, been sufficiently taken into consideration by new approaches to the social study of technology (Lohmann 1953/54: 601f.; Hellige 1984: 276f.; Pahl and Beitz 1986).

Milwaukee set out to find a construction for a typewriter. Testing various models they discarded those with more complex mechanical designs. The resultant model was a construction borrowed from the piano with a hammer mechanism and a bar for every single letter and symbol. During this "closing" process the group did not pay attention to qualities like originality or handling comfort. Instead, the focus was on finding a sturdy, less complex construction suitable for serial production.

The group contacted several companies but did not arouse much interest in spite of the group's industry-oriented ideas. Finally, in December 1872 "E. Remington & Sons"--a producer of agricultural machinery--responded. This well-established company was suffering from a drastic fall in the demand for weapons at the end of the civil war (1865) and was forced to find possibilities of diversification. "The search of diversity carried them into many curious corners of industry. They made everything from cotton gins to fire engines" (Hatch 1956: 68). The primary interest of the company was to fully utilize production capacities rather than to improve their new product. "Remington" carried out no market analysis, nor did they take the time to check on other systems for their suitability. Since the company's entry into the sewing-machine business had not been very successful they were now more concerned with limiting the risks of this undertaking. They managed to persuade the Milwaukee group to prefinance production to the tune of \$ 10,000 and to organize distribution of the machines. The head of the sewing-machine department, a man "who could not get away from environmental influence, and made his product look like a sewing-machine" (Hatch 1956: 151), was in charge of further development which aimed at quickly securing the constructive stability of the former basic construction. This resulted in mostly minor improvements, largely by using metal as a new material. Thus constructive decisions made in Milwaukee were taken over, fixed, and socially "hardened".

The first series of industrially produced typewriters, offered for sale in April 1874, did not provoke much enthusiasm among potential customers. Despite the high price of \$ 125 per piece these first series machines were still not at all satisfactory when it came to comfort or reliability. Machines of this type could only print capital letters. In addition they could not consistently produce straight lines and were noisy. The keyboard--originally arranged in alphabetic order--had now to be altered because letters that were frequently used kept getting stuck. This constructive defect was eliminated through a new arrangement--the QWERTY keyboard which still serves as a standard for today's PCs (David 1985: 332f.).

## THE EMERGENCE OF THE AMERICAN TYPEWRITER INDUSTRY

Since the new product did not sell very well little further attention was paid to the production of typewriters. They remained the "unloved child" of the Remington company. Two years after entering the market, the small typewriter-production department with its thirty employees had produced only 550 machines. When the financial situation of Remington became ever more critical in the mid-1880s, the department was finally sold. Wyckhoff, Seamens & Benedict, the company of a former employee, acquired, at a price of \$ 197.000, the new owner of equipment, stock and exclusive rights. Under a new name--"Remington Typewriter Company"--they took over production and distribution of the machines (Hoke 1984: 220; Current 1954: 111; Hatch 1956: 175; Pirker 1962: 33).

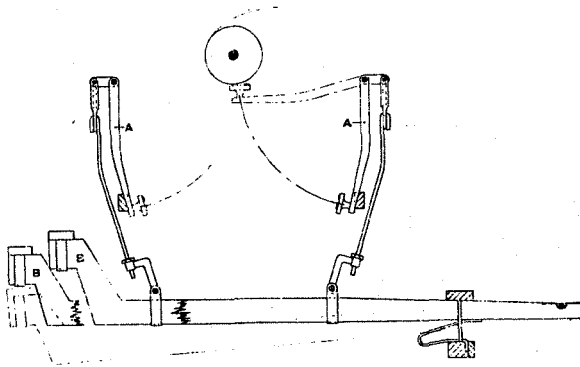


Figure 2. Remington

Very low sales and the harsh critique of customers again failed to induce technicians and construction engineers to question basic construction principles. The particular *Unteraufschlag* typebar technique (see Fig. 2) was not given up, "closing" decisions were not revised. Manufacturers had obviously reached a stage of knowledge that enabled them to operate on a well-structured technical basis and they therefore avoided any far-reaching, costly changes to the basic construction. Not until the late 1880s did sales increase thanks to an extensive advertisement campaign.

Soon other inventors who had previously produced typewriters in their homes were now offering their products on a new market expected



to expand by the optimistic voice of the trade press. Mostly equipped with a precision-mechanics shop, several small companies were set up by amateur inventors in cooperation with a sponsor. Independent of the "Remington technique" they tried to realize very different basic construction systems. Despite the fact that they were ten years behind Remington in manufacturing technique, the "Hall" model, a singlebar machine for domestic use with a few more intermediate steps in handling, could be produced at a low price and in a sturdy quality.

The models "Crandall" (Fig. 3a) and "Hammond" (Fig. 3b) were the first machines to appear on the market that featured the ingenious type-wheel or typecylinder techniques. This feature provided added comfort in writing but this was not enough to make up for mechanical deficiencies such as the irregular typeface after a few months in operation. These machines that had been developed along new paths of construction without relying on the consolidated typebar technique or production routines, did not reach the same popularity among customers as did a "Remington" or "Calligraph" machine with their mature, but far from optimal system of construction.

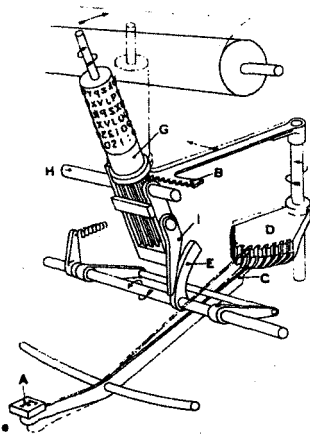


Figure 3a. "Crandall"

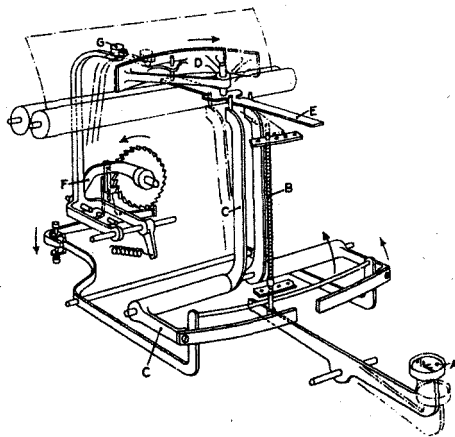


Figure 3b. "Hammond"

By this time the person buying and the person using a typewriter were often not one and the same (Specht 1896: 270; Hoffmann 1985: 131). We can safely assume that an office manager would always prefer one of the sturdy, lasting typewriters instead of the ones that were more comfortable to use but always in danger of breaking down and in need of

repair. The "Ideal" keyboard which would have represented an alternative and improvement to the complicated "Remington" keyboard appeared on the market too late to meet acceptance. On a convention in 1888 typists decided to stick to the "Remington" keyboard in order to avoid experiments and possibly having to adapt to changing arrangements of the bars. In any case, the "Ideal" keyboard soon disappeared from the market and was replaced by the "Remington" keyboard, named "Universal" (Pfeiffer 1923: 123; Martin 1981: 516).

Although the standard set by Remington in the 1880s remained unchallenged for about ten years and was itself the reference point for further development, it can still not be considered a "golden standard" for typewriters. Various other basic systems were still being promoted on the market. There existed no understanding among manufacturers and users about how to relate which system to which segment of the market and there was also no authority, going beyond the single institutional context, laying down rules and regulations or organizing training in order to structure and formally establish the hitherto existing pool of knowledge.

#### THE ECONOMIC AND TECHNICAL CONSOLIDATION OF THE TYPEWRITER INDUSTRY

The wide variety of technical systems and manufacturing and distribution firms did not run parallel to an increasing demand for typewriters. This led to overproduction, provoking a drastic decline in prices followed by a "war between companies" (Pirker 1962: 36). First initiatives to introduce an entrepreneurial and technical consolidation were taken at the end of 1892. This rigid framework was to induce an even more rigid process of constructive "closing". All the larger typewriter companies, all manufacturers of typebar machines, merged in 1893 in the "Union of Typewriter Company of America." What is remarkable about this trust of the still new typewriter industry is not so much that it tried to stabilize prizes, but that out of it came the "Standard Remington" as an industry-wide and "golden standard." The economic power concentrated in the trust was able to present this typewriter as the universal construction system. This standard was guarded and secured so that there was no chance for suggestions and contributions by the still considerable number of independent technicians and engineers to be heard. Companies outside the trust could not successfully compete on the market, because

they lacked the necessary economic resources and could not rely on the same consolidated level of knowledge. The trust rejected contributions to solve the noise problem in favour of investment in a joint production plant, which was supposed to reduce production costs (Beeching 1974: 14; Martin 1981: 466).

When the "birth-defect" of the typebar-technique—the type printed on the bottom of the plate was not visible for the operator—was solved through the ingenious front-strike technique (see Fig. 4), it finally became the worldwide dominant system (Morschheuser et al. 1987: 183f.). This improvement, which could only be achieved through an extended mechanical interlinking, made the machine harder to handle because more force needed to be applied for operation, but it did offer an increase in typing speeds (Pfeiffer 1921: 183f.).

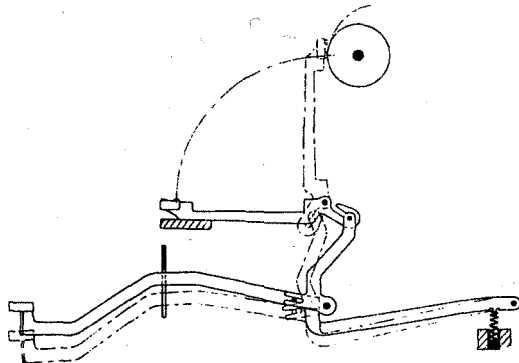


Figure 4. Wagner/Underwood

The case of the Royal Typewriter Company founded in 1904 illustrates how far-reaching the acceptance of this "golden standard" for typewriters—the first series was offered by the Underwood company—had been within the trade. E. B. Hess, a former tradesman in textiles with a technical inclination and owner of a small shop, "was not an engineer, and some of his favorite ideas were enough to drive engineers mad, but he was fortunate in having as a colleague, a small, quiet, disciplined, conservative technician, Lewis C. Meyers" (Bliven 1954: 90). Soon W. C. Ryan, a famous millionaire, broker, and sponsor of other daring industrial projects joined the group and enabled the small company to start without financial worries. Hess and Meyers identified considerable con-

structive deficiencies in the standard typewriter: In spite of segment shift control the typeface remained unstable and the visibility of the printed letters was still hampered by bows, strips, and springs. Overall the machine appeared to be unnecessarily complicated, thus raising the costs of manufacture and repair. The greatest criticism however was still the heavy strike. During a day's work on a modern typewriter a typist had to expend a considerable amount of energy (Bundesanstalt für Arbeitsschutz 1986: 18). Despite this critical analysis the conclusions drawn by the company were quite moderate. They did not follow the example given by alternative modes of construction like the typecylinder and typeball machines, but instead they accepted the typebar system as the basic construction.

The process of consolidation was continued, although the operation of this particular machine had proved to be quite uncomfortable. This financially secure company did not search for technical concepts to satisfy particular needs, but they searched for a way to make a stage of knowledge adaptable to higher demands. The new product, a machine that came out much flatter and appears modern by today's standard, was equipped with the typebar and front-strike systems and a new mechanism to accelerate movement of the bars, allowing a somewhat lighter strike. By relying on technical elements of the "golden standard", which had already been labeled as fail-safe, the Royal Typewriter Company managed to grow into the leading manufacturer of typewriters next to the Underwood company.

Developing modes of construction off the "beaten path" apparently meant taking too much of a risk, even as early as a few years after the turn of the century. By this time the unification of the trade had occurred to an extent that even suppliers had adjusted their products accordingly. The technical skills and knowledge of the qualified technicians and engineers hired by the Royal Typewriter Company represented the "golden standard" as well. Their interest in unconventional solutions was undoubtedly limited (Bliven 1954: 92f). A formally established and institutionalized group for technicians, possibly developing their own ideas concerning a technical standard independent of the industry did not exist at this point. It was not until much later that the scientific attention paid to technical construction in general was brought to the construction of typewriters. In Germany, for example, the first lectures on precision mechanics were held in a technical college in 1828 (Petzold 1985: 172). It was considered "beneath an engineer's dignity" (Reindl 1930: 157) to show a professional interest in sewing-machines and typewriters.

Reconsidering this short survey on the history of the typewriter, one fact, in particular, seems noteworthy: in the initial phase of industrial development a diversity of constructions to mechanize writing can be observed. This diversity soon disappears giving room to a long lasting and stable phase of standardization. The applications of the typewriter followed the opposite trend. In the early days, the intended purposes and application areas of the typewriter were far from being clear and it proved difficult to open up a market. Later on—after the transition to a modern office organization—the typewriter had established itself in all public and private areas of word-processing. The wide range of application of the typewriter together with particular needs of different user groups was not met by a constructive diversity in typewriter design.

By the end of World War I only one basic system of construction for typewriters remained. Mechanical stability of these machines had been achieved and secured during the trade-wide process of closing and consolidation, but only at the expense of constructive diversity. Yet manufacturers have always showed interest in integrating the needs and wishes of users when developing new models. Claims such as "designed to fit your needs 100%" (Schmitt 1937: 40) were made, but a closer look reveals that these offers were limited to marginal aspects such as additional symbols, one- or multicoloured ribbons, or number of copies.

The early phase of industrial development already shows that companies were primarily interested in securing the mechanical system and only secondly in criteria defined by the users' needs. The later phases show that new manufacturers entering the market adapted previously tested, basic constructions to their needs, instead of taking risks with a completely new development. The formation, acceptance, and securing of a "golden standard" was the more attractive the more companies could be bound to it. The process of unification was settled fairly quickly because industry's interest in the typewriter was only limited, being based on short-sighted considerations of diversification. Yet, these companies—through the typebar machine—managed to bring about a technical reality that other companies set up exclusively for the purpose of developing and manufacturing typewriters would not venture to ignore, the less so since they wanted their machines to be competitive at the price level. It was too late for entrepreneurial or constructive creativity at a time when the typebar technique had become a trade-wide technical standard that, for its fixed rules of construction and favourable

conditions for production, represented cognitive, social, and economic advantages. The selection patterns invisibly embedded in the typebar design were perpetuated and applied also to new tasks confining the generation of technical knowledge to a very narrow framework.

The creation phase, thus, is of special importance in the overall process of technological development. The specific economic, technical, and political conditions of this phase, once incorporated in a "golden standard", incessantly shape technology—possibly beyond their "expiry date". As can be seen from the case of the QWERTY keyboard, a "golden standard" can act as stabilizing force comparable to institutions. The QWERTY keyboard is still featured on modern PCs tormenting today's users. Although the technical preconditions of this type of keyboard arrangement became irrelevant a long time ago, alternative options that have been given up in the process of consolidation and closure cannot be taken up again at will when the economic and technological circumstances have changed. The risk of breaking up the established technical configuration of the typewriter prevented constructive efforts beyond the correction of minor details. Attempts to introduce an "ideally" arranged keyboard were doomed to failure, just as endeavours to provide the typebar construction with a lighter strike or to abolish its hammering sound never materialized. Other systems than the typebar design—swept away early by the constituting forces of a "golden standard"—would have offered better opportunities for such improvements.

Hence, the idea of technological progress should not be governed by the assumption that a long phase of technical development and market selection assure a perfect outcome for users. Instead, technological development is largely dominated by the "internal" needs of clear and systematic structures that enable the creation of stable modes of functioning in a narrowly "technical" sense and meet user's needs only secondarily. In this way, yesterday's decisions determine tomorrow's options.

## References

---

- Abernathy, W. J. and Utterbeck, J. M. 1978. "Patterns of industrial innovation," *Technology Review* 80: 41-47.
- ACARD (Advisory Council for Applied Research and Development) 1980. *Biotechnology: Report of a Joint Working Party* (The Sphinx Report). London: HMSO.
- Adams, W. and Brock, J. W. 1983. "Integrated monopoly and market power: System selling, compatibility standards, and market control," *Quarterly Review of Economics and Business* 22/4: 29-42.
- Adler, F. 1987. "Flexible Automatisierung und sozialer Fortschritt - Untersuchungsergebnisse und Forschungsprobleme," *Informationen zur soziologischen Forschung in der DDR* No. 5: 25-37.
- Adler, M. H. 1973. *The Writing Machine*, London: Allen & Unwin.
- Aiken, M., Bacharach, S. B., and French, J. L. "Organizational structure, work process, and proposal making in administrative bureaucracies," *Academy of Management Journal* 23: 631-652.
- Akrich, M. 1990. "The description of technical objects," in J. Law and W. Bijker, eds. 1990.
- Akrich, M. (forthcoming). "Essay of technosociology: A gasogene in Costa Rica," in *The Arbitrariness of Technological Choices*, P. Lemonnier, ed. London: Routledge.
- Albach, H. ed. 1989. *Organisation - Mikroökonomische Theorie und ihre Anwendungen*. Wiesbaden: Gabler.
- Allen, D. 1988. "New telecommunications services. Network externalities and critical mass," *Telecommunications Policy* 12: 257-71.
- Altmann, N., Bechtle, G., and Lutz, B. 1978. *Betrieb - Technik - Arbeit. Elemente einer soziologischen Analytik technisch-organisatorischer Veränderungen*. Campus: Frankfurt/M.
- Altmann, N., Deiß, M., Döhl, V., and Sauer, D. 1986. "Ein 'Neuer Rationalisierungstyp' - neue Anforderungen an die Industriesoziologie," *Soziale Welt* 37: 191-206.
- Altmann, N., Köhler, Ch., and Meil, P. eds. 1991. *Technology and Work in German Industry*. London: Routledge.
- "The Anatomy of the Development and Diffusion of New Technologies: The ADD-TECH Research Program, Progress Report and Planned Activities," 1990. No. 3, mimeo, Theme Technology and Social Change, Linköping University
- Andersen, H. W. 1989. *Fra det britiske til det amerikanske produksjonsideal. Forandringer i teknologi og arbeid ved Akers mek. Verksted og i norsk skipsbyggeindustri 1935-1970*. Trondheim: Tapir.
- Andersen, H. W. and Collett, J. P. 1989. *Anchor and Balance: Det Norske Veritas 1864-1989*. Oslo: Cappelen.
- Andersen, S. and Burns, T. R. 1991. *State Technocracy and Democratic Process*. Dartmouth: Aldershot.
- Aron, R. 1967. *The Industrial Society: Three Essays on Ideology and Development*. New York: Simon and Schuster.

- Arrow, K. J. 1962. "Economic welfare and the allocation of resources for invention," in *The Rate and Direction of Inventive Activity*. Princeton, NJ: Princeton University, National Bureau Committee for Economic Research.
- Arthur, W. B. 1984. "Competing technologies and economic prediction," *IIASA Options* 2: 10-13.
- Arthur, W. B. 1988. "Competing technologies: An overview," in G. Dosi et al. eds. 1988.
- Arthur, W. B. 1989. "Competing technologies, increasing returns, and lock-in by historical events," *Economic Journal* 99: 116-31.
- Asdonk, J. et al. 1988. "Einflussfaktoren und Steuerungspotentiale im Prozeß der Technikgenese - Eine Fallstudie in außerbetrieblichen FuE-Einrichtungen," Bielefeld (mimeo)
- Asdonk, J., Bredeweg, U., and Kowol, U., 1990. "Technikgenese im Kontext von Hersteller-Anwender-Beziehungen," in R. Tschiedel, ed. 1990, 107-19.
- Asdonk, J., Bredeweg, U., and Kowol, U., 1991. Innovation als rekursiver Prozeß. Zur Theorie und Empirie der Technikgenese am Bereich der Produktionstechnik", *Zeitschrift für Soziologie* 20: 290-304.
- Aspe, C. 1988. *Des eaux d'égouts et des couleurs. Le traitement des eaux usées par les collectivités locales*. Marseille: CRES.
- Axelrod, R. 1984. *The Evolution of Cooperation*. New York: Basic Books.
- Baethge, M. et al. 1974. *Produktion und Qualifikation*. Hannover
- Baethge, M. and Oberbeck, H. 1986. *Zukunft der Angestellten - Neue Technologien und berufliche Perspektiven in Büro und Verwaltung*. Frankfurt/M.: Campus.
- Baethge, M. and Oberbeck, H. 1990. "Systemische Rationalisierung von Dienstleistungsarbeit und Dienstleistungsbeziehungen - Eine neue Herausforderung für Unternehmen und wissenschaftliche Analyse," in *Strukturwandel der Dienstleistungsrationalisierung*, R. Rock, R. Ulich, and F. Witt, eds. Frankfurt/M.: Campus, 149-75.
- Baggenstoss, A. ed. 1977. *Von der Bilderschrift zur Schreibmaschine*. Zürich.
- Barley, S. R. 1986. "Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments," *Administrative Science Quarterly* 31: 78-108.
- Barraque, B. and Beyeler, C. 1989. *Normes et innovations dans le domaine de l'eau potable, de l'assainissement et des déchets*. Paris: LATTIS.
- Barras, R. 1986. "Towards a theory of innovation in service," *Research Policy* 15: 161-73.
- Baumgartner, T. and Burns, T. R. 1984. *Transitions to Alternative Energy Systems: Entrepreneurs, New Technologies and Social Change*. Boulder: Westview.
- Baumgartner, T., Burns, T. R., and Deville, P. 1986. *The Shaping of Socio-Economic Systems. The Application of the Theory of Actor-Systems Dynamics to Conflict, Social Power, and Institutional Innovation in Economic Life*. New York: Gordon & Breach.
- Beck, Th. 1899. *Beiträge zur Geschichte des Maschinenbaus*. Düsseldorf: VDI.
- Becker, M. H. 1970. "Sociometric location and innovativeness: Reformulation and extension of the diffusion model," *American Sociologist* 35: 276-82.
- Beeching, W. 1974. *Century of the Typewriter*. London: Heinemann.
- Bell, D. 1973. *The Coming of Post-Industrial Society. A Venture in Social Forecasting*. New York: Basic Books.
- Beniger, J. 1986. *The Control Revolution. Technological and Economic Origins of the Information Society*. Cambridge, MA: Harvard Univ. Press.
- Benoit, S. 1991. *De la houille verte à la houille blanche*. Paris: Hachette.
- Berger, P. 1991. *Gestaltete Technik. Die Genese der Informationstechnik als Basis einer politischen Gestaltungsstrategie*. Frankfurt/M.: Campus.
- Berger, J. and Offe, C. 1980. "Die Entwicklungsdynamik des Dienstleistungssektors," *Leviathan* 8: 41-75.



- Berry, M. 1983. *Une technologie invisible? L'impact des instruments de gestion sur l'évolution des systèmes humains*. Paris: École Polytechnique, CRG.
- Bertho-Lavenir, C. 1989. "The telephone in France 1879 to 1979: National characteristics and international systems," in R. Mayntz and T. Hughes, eds. 1989, 155-77.
- Bertolini, G. 1983. *Eau, déchets et modèles culturels*. Paris: Édition Entente.
- Besen, S. and Saloner, G. 1989a. "Compatibility standards and the market for telecommunication services," in R. W. Crandall and K. Flamm, eds. 1989.
- Besen, S. M. and Saloner, G. 1989b. "The economics of telecommunications standards," in R. W. Crandall and K. Flamm, eds. 1989, 177-220.
- Biervert, B., Monse, K., and Hilbig, M. 1989. "Integrierte und flexibilisierte Dienstleistungen durch neue Informations- und Kommunikationstechniken". In *Informations- und Kommunikationstechniken im Dienstleistungssektor*, B. Biervert and M. Dierkes, eds. Wiesbaden: Gabler.
- Biervert, B., Monse, K., Behrendt, E., and Hilbig, M. 1991. *Informatisierung von Dienstleistungen - Entwicklungskorridore und Technikfolgen für die privaten Haushalte*. Opladen: Westdeutscher Verlag.
- Biervert, B. and Monse, K. eds. 1990. *Wandel durch Technik? Institution, Organisation, Alltag*. Opladen: Westdeutscher Verlag.
- Bijker, W. E., Hughes, Th. P., and Pinch, T. J. eds. 1987. *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technology*. Cambridge, MA: MIT Press.
- Bliven, B. 1954. *The Wonderful Writing Machine*. New York: Random House.
- Blumtritt, O. 1986. *Zur Genese der elektromagnetischen Feldtheorie. Eine wissenschaftshistorische Studie zur Entstehung der Maxwellschen Gleichungen*. Hildesheim: Gerstenberg.
- Bohm, J. et al. 1979. "Der Telefaxdienst der Deutschen Bundespost," *Jahrbuch der Deutschen Bundespost* 29: 172-227.
- Bolenz, E. 1987. *Technische Normung zwischen Markt und Staat: Untersuchungen zur Funktion, Entwicklung und Organisation verbandlicher Normung in Deutschland*. Bielefeld: Kleine.
- Boltanski, L. and Thévenot, L. 1987. "Les économies de la grandeur," *Cahiers du Centre d'Études de l'Emploi*. Paris: PUF.
- Bouchut, Y. and Jacot, H. 1988. "Technologie, organisation et gestion de la production," in *Traité d'Économie Industrielle*, J. de Brandt, ed. Paris: Economica.
- Boyd, R. and Richerson, P. J. 1985. *Culture and the Evolutionary Process*. Chicago: Univ. of Chicago Press.
- Boyer, R. and Mistral, J. 1983. *Accumulation, Inflation, Crises*. Paris: P.U.F. (2nd ed.)
- Boyer, R. and Schmeder, G. 1989. "Division du travail, changement technique: un retour à Adam Smith," *Revue française d'économie* V/1.
- Brady, T. 1990. "In-house development and the growth of the software industry," *CICT Working Paper No. 12*, SPRU University of Sussex, Brighton.
- Brandt, G. et al. 1978. *Computer und Arbeitsprozeß*. Frankfurt/M.: Campus
- Braun, I. 1991. "Geflügelte Saurier - Systeme zweiter Ordnung: ein Verflechtungsphänomen großer technischer Systeme," *WZB discussion paper FS II 91-501*, Berlin.
- Braunstein, Y. M. and White, L. J. 1985. "Setting technical compatibility standards: An economic analysis," *The Antitrust Bulletin* (Summer): 337-55.
- Braverman, H. 1974. *Labor and Monopoly Capital. The Degradation of Work in the Twentieth Century*. New York: Monthly Review Press.
- Bresnahan, T. and Chopra, A. 1990. "The development of the local area network market as determined by user needs," *Economics of Innovation and New Technology* 1: 97-110.
- Brighton Women and Science Group. 1980. *Alice Through the Microscope: the Power of Science over Women's Lives*. London: Virago.

- Brock, G. 1975. "Competition, standards and self-regulation in the computer industry," in *Regulating the Product*, R. E. Caves and M. J. Roberts, eds. Cambridge, MA: Ballinger, 75-96.
- Brödner, P. 1985. *Fabrik 2000 - Alternative Entwicklungspfade in die Zukunft der Fabrik*. Berlin: edition sigma.
- Bruce, M. 1988. "New product development strategies of suppliers of emerging technologies: A case-study of expert systems," *Journal of Marketing Management*, Spring.
- Bruce, M. 1990. "Home interactive telematics-technology with a history," in *Concerning Home Telematics*, F. van Rijn and R. Williams, eds. Amsterdam: North-Holland.
- Bull, A.T., Holt, G., and Lilly, M.D. 1982. *International Trends and Perspectives in Biotechnology*. Paris: OECD.
- Brundenius, C. and Zimbalist, A. 1989. *The Cuban Economy: Measurement and Analysis of Socialist Performance*. Baltimore: John Hopkins Univ. Press.
- Bundesanstalt für Arbeitsschutz (1986). *Vom Stehpult zum Computer*. Dortmund.
- Burns, B. 1988. "New technology and job design: The case of CNC," *New Technology, Work and Employment* 3/2: 100-11.
- Burns, T. R. 1985. *Technological Development with Reference to Hydro-Power, Nuclear and Alternative Energy Technologies*. Berlin: Wissenschaftszentrum.
- Burns, T. R. and Dietz, T. 1991. "The theory of sociocultural evolution," Uppsala. (mimeo)
- Burns, T. R., DeVille, P., and Meeker, D. 1991. "The social theory of human interaction and games." (mimeo)
- Burns, T. R. and Flam, H. 1987. *The Shaping of Social Organization*. London: Sage.
- Burns, T. R. and Ueberhorst, R. 1988. *Creative Democracy: Systematic Conflict Resolution and Policymaking in a World of High Science and Technology*. New York: Praeger.
- Burrichter, C. and Zimmerli, W. 1990. "Wissenstypen im technologischen Wandel," (project proposal) Erlangen/Bamberg
- Buschmann, E. et al. 1989. "Der Software-Markt in der Bundesrepublik Deutschland," *GMD-Studien* No. 167. St. Augustin, Oct.
- Business Week 1990. "R&D Scorecard," June 15.
- Callon, M. 1986. "Some elements for a sociology of translation: Domestication of the scallops and the fishermen of St. Brieuc Bay," in *Power, Action and Belief: A New Sociology of Knowledge?* J. Law, ed. London: Routledge, 196-233.
- Callon, M. 1987. "Society in the making: The study of technology as a tool for sociological analysis," in W. E. Bijker et al. eds. 1987, 83-103.
- Callon, M. 1990. "Réseaux technico-économiques et irréversibilité," in *Figures de l'irréversibilité en économie*, R. Boyer, ed. Paris: EHESS.
- Campagnac, E. and Tabarly, Y. 1979. *Transfers de modes de vie et habitat ouvrier, Laboratoire d'aménagement régional et urbain*. Villeneuve d'Ascq.
- Campbell, D. T. 1965. "Variation and selective retention in sociocultural evolution," in *Social Change in Developing Areas: A Reinterpretation of Evolutionary Theory*, H. R. Barringer, G. I. Blankstein, and R. W. Mack, eds. Cambridge, MA: Schenkman.
- Carlton, D. W. and Klamer, J. M. 1983. "The need for coordination among firms, with special reference to network industries," *University of Chicago Law Review* 50: 446-65.
- Caron, F. 1989. "The evolution of the technical system of railways in France from 1832 to 1937," in R. Mayntz and T. Hughes, eds. 1989, 69-103.
- Chanaron, J. J., Perrin, J., and Ruffieux, B. 1988. "Les liaisons enseignement/recherche/industrie dans les pôles technologiques français," *Culture Technique* N° 18.
- Chandler, A. D. Jr. 1962. *Strategy and Structure*. Cambridge, MA: MIT Press.
- Chandler, A. D. Jr. 1977. *The Visible Hand*. Cambridge, MA: MIT Press.
- Chandler, A. D. Jr. 1989. *Scale and Scope*. Cambridge, MA: Harvard Univ. Press.
- Chevalier, D. 1989. "Le programme savoir-faire et techniques," *Terrain*, N° 12, avril.

- Chevalier, J. M., Barbet, Ph., and Benzoni, L. 1986. *Économie de l'Énergie*. Paris: Presses de la fondation nationale des sciences politiques et Dalloz.
- Child, J. 1984. "Microelectronics and employment in the service sector," in *New Technology and the Future of Work and Skills*, P. Marstrand, ed. Pinter: London.
- Childs, G. H. L. 1982. "Chances for a worldwide videotex standard," in *Bildschirmtext Kongress 1982*, Diebold Deutschland GmbH, ed. Frankfurt/M: Selbstverlag, 51-62.
- Clark, P. and Staunton, N. 1989. *Innovation in Technology and Organization*. London: Routledge.
- Clark, R. 1981. "International technical standards," in *Viewdata in Action - A Comparative Study of Prestel*, R. Winsbury, ed. London: McGraw Hill, 71-81.
- Clarke, L. 1985. "The origins of nuclear power: A case of institutional conflict," *Social Problems* 32: 474-87.
- CNRS 1986. *Programme Science, Technologie, Société du CNRS, 1980-1985*. Paris: CNRS.
- Cockburn, C. 1983. *Brothers: Male Dominance and Technological Change*. London: Pluto.
- Cockburn, C. 1985. *Machinery of Dominance: Men, Women and Technical Know-how*. London: Pluto.
- Codding, G. A. and Rutkowski, A. M. 1982. *The International Telecommunication Union in a Changing World*. Dedham, MA: Artech House.
- Colletis, G. 1990. "Les grandes infrastructures de recherche en France et en Allemagne: quelle inscription territoriale?," Séminaire international *La grande technologie entre l'État et le marché, politiques publiques comparées*, 8-9 Nov. CERAT, Université des sciences sociales de Grenoble.
- Collins, H. M. 1990. *Artificial Experts: Social Knowledge and Intelligent Machines*. Cambridge, MA and London: MIT Press.
- Coombs, R., Saviotti, P. and, Walsh, V. 1987. *Economics and Technological Change*. Basingstoke: Macmillan.
- Cornwall-Jones, K. 1990. "The commercialisation of artificial intelligence," unpubl. PhD thesis, Sciences Policy Research Unit, Sussex University, Brighton.
- Cornu, R. 1982. "De la boîte à outils à la boîte à idées: jalons pour une étude des savoir-faire et de la créativité ouvrière," Colloque national d'ethnologie française, Isle d'Abeau, mai.
- Coy, W. 1990. "Von QUERTY zu WYSIWYG. Texte, Tastatur und Papier," in *Computerwelten - Alltagswelten. Wie verändert der Computer die soziale Wirklichkeit?* W. Rammert, ed. Opladen: Westdeutscher Verlag, 91-101.
- Cowan, R. S. 1983. *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave*. New York: Basic Books.
- Cowan, R. 1990. "Nuclear power reactors: A study in technological lock-in," *Journal of Economic History* 50 (Sept.).
- Cowan, R. 1991. "Tortoises and hares: Choice among technologies of unknown Merit," *Economic Journal* 101 (July).
- CPE 1983. "Rapport sur l'état de la technique, la révolution de l'intelligence," *Science et Technique*, numéro octobre.
- Crandall, R. W. and Flamm, K. eds. 1989. *Changing the Rules. Technological Change, International Competition, and Regulation in Communications*. Washington, DC: The Brookings Institution.
- Crane, R. J. 1979. *The Politics of International Standards*. Norwood, NJ: Ablex.
- Current, R. 1954. *The Typewriter and the man who made it*. Urbana: Univ. of Illinois Press.
- Daft, R. L. and Becker, S. W. 1978. *The Innovative Organization*. New York: Elsevier.
- Damenpour, F. 1987. "The adoption of technological, administrative, and ancillary innovations: Impact of organizational factors," *Journal of Management* 13/4: 675-688.
- Damenpour, F. and Evan, W. M. 1984. "Organizational innovation and performance: The problem of organizational lag," *Administrative Science Quarterly* 29: 392-409.

- Dangelmaier, W. and Warnecke, H.-J. 1990. "Von der Produktionssteuerung zur Produktionsregelung kommen," *Handelsblatt*, 2 May.
- Dankbaar, B. and van Tulder, R. 1989. "The construction of an open standard. Process and implications of specifying the Manufacturing Automation Protocol (MAP)," NOTA. The Hague, The Netherlands.
- David, P. A. 1985. "Clio and the economics of QWERTY," *American Economic Review* 75: 332-37.
- David, P. A. 1987. "Some new standards for the economics of standardization in the information age," in *Economic Policy and Technological Performance*, P. Dasgupta and P. Stoneman, eds. Cambridge: Cambridge Univ. Press.
- David, P. A. and Bunn, J. A. 1988. "The economics of gateway technologies and network evolution. Lessons from electricity supply history," *Information Economics and Policy* 3: 165-202.
- David, P. A. and Greenstein, S. 1990. "The economics of compatibility standards: An Introduction to recent research," *Economics of Innovation and New Technology* 1: 3-41.
- Davies, M. W. 1979. "Woman's place is at the typewriter: The feminization of the clerical workers and changes in clerical work in the United States," PhD thesis, Brandeis University.
- De Bernardy, M. and Boisgontier, P. 1988. *Grains de technopole*. Grenoble: PUG.
- Debeir, J. C., Deleage, J. P. and Hemery, D. 1986. *Les servitudes et la Puissance. Une histoire de l'énergie*. Paris: Flammarion.
- Delbecq, A. L., Van de Ven, A. H. and Gustafson, D. H. 1975. *Group Techniques for Program Planning*. Glenview, Ill.: Scott, Foresman.
- DePay, D. 1989. "Die Organisation von Innovationen - Die Anwendung des Dekompositionsprinzips von Williamson," in *Organisation - Mikroökonomische Theorie und ihre Anwendung*, H. Albach, ed. Wiesbaden: Gabler.
- Deiß, M., Döhl, V., and Sauer, D. (with Altmann, N.) 1990. *Technikerherstellung und Technik-anwendung im Werkzeugmaschinenbau - Automatisierte Werkstückhandhabung und ihre Folgen für die Arbeit*. Frankfurt/M.: Campus.
- Dertouzos, M. and Moses, J. eds. 1980. *The Computer Age: A Twenty Year View*. Cambridge, MA: MIT Press.
- Deters, M. and Helten, F. 1990. "Die soziale Konstruktion von Technik. Zur Bedeutung interaktiver und kommunikativer interpersoneller Beziehungen für Technikentwicklung," Inst. f. Soziologie, TU Berlin. (mimeo)
- Dierkes, M. 1987. "Technikgenese als Gegenstand sozialwissenschaftlicher Forschung - Erste Überlegungen," *Mitteilungen des Verbunds Sozialwissenschaftliche Technikforschung* No. 1: 166-83.
- Dierkes, M. 1988. "Organisationskultur und Leitbilder als Einflussfaktoren der Technikgenese - Thesen zur Strukturierung eines Forschungsfeldes," *Mitteilungen des Verbunds Sozialwissenschaftliche Technikforschung* No. 3: 49-62.
- Dierkes, M. 1989. "Technikgenese in organisatorischen Kontexten - Neue Entwicklungslinien sozialwissenschaftlicher Technikforschung," *WZB discussion paper* FS II 89-104, Berlin.
- Dierkes, M. 1990a. "Technische Entwicklung als sozialer Prozeß. Chancen und Grenzen einer sozialwissenschaftlichen Erklärung der Technikgenese," *Naturwissenschaften* 77: 214-20.
- Dierkes, M. 1990b. "Technikgenese: Einflussfaktoren der Technisierung jenseits traditioneller Technikfolgenforschung," in B. Biervert and K. Monse, ed. 1990, 311-32.
- Diesel, R. 1893 (Reprint 1986). *Theorie und Konstruktion eines rationellen Wärmemotors zum Ersatz der Dampfmaschinen und der heute bekannten Verbrennungsmotoren*. Düsseldorf: VDI.
- Dietz, T. and Burns, T. R. 1991. "Human agency in evolutionary theory," in *Agency in Social Theory*, B. Wittrock, ed. London: Sage.

- Dietz, T., Burns, T. R., and Buttler, F. 1990. "Evolutionary theory in sociology: An examination of current thinking," *Sociological Forum* 5: 155-71.
- Dietz, T., Frey, R. S. and Rosa, E. A. 1992. "Risk, technology, and society," in *Handbook of Environmental Sociology*, R. E. Dunlap and W. Michaelson, eds. Westport, Conn.: Greenwood Press (forthcoming).
- DiMaggio, P. J. and Powell, W. W. 1983. "The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields," *American Sociological Review* 48: 147-60.
- D'Iribarne, A. 1990. "La gestion de l'organisation et des ressources humaines comme facteur stratégique de la production et de la diffusion de l'innovation," *Revue d'économie industrielle* N° 51.
- D'Iribarne, A. and Linhart, D. 1989. "L'activité du PIRTEM, de 1984 à 1988, premier bilan scientifique," *Cahier du PIRTEM*. Paris: CNRS.
- D'Iribarne, Ph. 1989. *La Logique de l'Honneur*. Paris: Le Seuil.
- D'Iribarne, Ph. 1990. "Modernisation technique des entreprises françaises," Colloque *Technologie et Compétitivité*, 24-27 June, OCDE, Paris.
- Döhl, V. 1989. "Die Rolle von Technikanbietern im Prozeß systemischer Rationalisierung," in B. Lutz, ed. 1989, 147-66.
- Döhl, V., Altmann, N., Deiß, M., and Sauer, D. 1989. *Neue Rationalisierungsstrategien in der Möbelindustrie I - Markt und Technikeinsatz*. Frankfurt/M.: Campus.
- Dodgson, M. 1989. *Technology Strategy and the Firm - Management and Public Policy*. Glasgow: Bell and Bain Ltd.
- Dosi, G. 1982. "Technological paradigms and technological trajectories: A suggested interpretation of the determinants of technological change," *Research Policy* 11: 147-62.
- Dosi, G. and Orsenigo, L. 1988. "Coordination and transformation: An Overview of structures, behaviours and change in evolutionary environments," in G. Dosi et al. eds. 1988.
- Dosi, G., Freeman, C., Nelson, R., Silverberg G., and Soete, L. eds. *Technical Change and Economic Theory*. London: Pinter.
- Doyal, L. et al. 1983. *Cancer in Britain: The Politics of Prevention*. London: Pluto.
- DTI/PA Consultants Group, 1990. *Manufacturing into the 1990s*. London: HMSO.
- Düll, K. and Lutz, B. eds. 1989. *Technikentwicklung und Arbeitsteilung im internationalen Vergleich*. Frankfurt/M.: Campus
- Dupuy, G. and Knaebel, G. 1982. *Assainir la ville hier et aujourd'hui*. Paris: Dunod.
- Durand, C. 1979. "Avant-propos," *Sociologie du travail* N° 1.
- Edge, D. 1988. "The social shaping of technology," *Edinburgh PICT Working Paper* No. 1, Edinburgh University.
- Edquist, C. and Edqvist, O. 1979. *Social Carriers of Techniques for Development*. Stockholm: SAREC.
- Effelsberg, W. and Fleischmann, A. 1986. "Das ISO-Referenzmodell für offene Systeme und seine sieben Schichten - Eine Einführung," *Informatik-Spektrum* 12: 280-299.
- Ehn, P. 1988. *Work-Oriented Design of Computer Artifacts*. Stockholm: Swedish Center for Working Life
- Ekardt, H.-P., 1978. "Entwurfsarbeit. Organisations- und handlungstheoretische Analyse der Arbeit von Bauingenieuren im Tragwerkentwurfsbereich," (unpubl. doctoral thesis) Darmstadt.
- Elam, M. 1990. "Puzzling out the post-fordist debate: Technology, markets and institutions," *Economic and Industrial Democracy* 2/1.
- Ellul, J., 1964. *The Technological Society*. New York: Knopf (first Paris 1954).
- Ellul, J. 1977. *Le Système Technicien*. Paris: Calman Lévy.
- Elster, J., 1983. *Explaining Technical Change*. Cambridge: Cambridge Univ. Press.
- Elzen, B., Enserink, B., and Smit, W. A. 1990. "Weapon innovation: Networks and guiding principles," *Science and Public Policy* 17: 171-93.

- Elzinga, A. 1975. "Objectivity and partisanship in science," *Ethnos* 40: 406-27.
- Elzinga, A. 1980. "Science policy in Sweden: Sectorization and adjustment to crisis," *Research Policy* 9: 116-46.
- Elzinga, A. 1985. "Research, bureaucracy, and the drift of epistemic criteria," in *The University Research System*, B. Wittrock and A. Elzinga, ed. Stockholm: Almqvist & Wiksell International, 191-220.
- Etzkowitz, H. 1984. "Solar versus nuclear energy: Autonomous or dependent technology," *Social Problems* 31: 417-34.
- European Economic Commission (EEC) 1988a. *Research on the 'Cost of Non-Europe', Basic Findings, Vol. 2, Studies on the Economies of Integration*. Luxembourg: Commission of the European Communities.
- European Economic Commission (EEC) 1988b. *Research on the 'Cost of Non-Europe', Basic Findings, Vol. 10, Telecommunications Equipment and Services*, Luxembourg: Commission of the European Communities.
- Evan, W. M. and G. Black. 1967. "Innovation in business organizations: Some factors associated with success or failure," *Academy of Management Journal* 40: 519-530.
- Farrell, J. and Saloner, G. 1986. "Standardization and variety," *Economics Letters* 20: 71-74.
- Farrell, J. and Saloner, G. 1987. "Competition, compatibility and standards: The economics of horses, penguins and lemmings," in *Product Standardization and Competitive Strategy*, H. Landis Gabel, ed. Amsterdam: North-Holland, 1-21.
- Farrell, J. and Saloner, G. 1988. "Coordination through committees and markets," *Rand Journal of Economics* 19: 235-52.
- Farrell, J. and Saloner, G. 1989. "Converters, compatibility, and the control of interfaces," Cambridge, MA: MIT-Working Paper, 3106-90.
- Faulkner, W. 1986. "Linkage between industrial and academic research: The case of biotechnological research in the pharmaceutical industry," unpubl. D.Phil. thesis, University of Sussex.
- Faulkner, W. and Arnold, E. 1985. *Smothered by Invention*. London: Pluto.
- Feickert, D. 1979. "Of Men and Minos," *Computing Europe*, 22 November.
- Feldman, S. P. 1989. "The broken wheel: The inseparability of autonomy and control in innovation within organizations," *Journal of Management Studies* 26/3: 83-102.
- Fennell, M. L. and Warnecke, R. B. 1988. *The Diffusion of Medical Innovations: An Applied Network Analysis*. New York: Plenum.
- Fincham, R., Fleck, J., Procter, R., Scarbrough, H., Tierney, M., and Williams, R. (forthcoming). *Expertise and Innovation*.
- Finne, H. et al. 1989. *Automatisering og organisasjonsutvikling*. Trondheim: IFIM.
- Finon, D. 1989. *L'échec du surgénérateur*. Grenoble: PUG.
- Fleck, J. 1988a. "Innofusion or diffusion," *Edinburgh PICT Working Paper No. 7*, Edinburgh University.
- Fleck, J. 1988b. "The development of information integration: Beyond CIM?" *Edinburgh PICT Working Paper No. 9*, Edinburgh University
- Fleck, J., Webster, J., and Williams, R. 1990. "The dynamics of IT implementation: A reassessment of paradigms and trajectories of development," *Futures* 22: 618-40.
- Fleischmann, G., 1989. "Alternative Technikkonzeptionen in Unternehmen", in G. Fleischmann and J. Esser, eds. 1989, 137-55.
- Fleischmann, G. and Esser, J. eds. 1989. *Technikentwicklung als sozialer Prozeß*. Frankfurt/M.
- Foray, D. 1989. "Les Modèles de compétition technologique: Une revue de la littérature," *Revue d'Economie Industrielle* N° 48.
- Foray, D. 1990. "Exploitation des externalités de réseau versus évolution des normes: Les formes d'organisation face au dilemme de l'efficacité, dans le domaine des technologies de réseau," *Revue D'Economie Industrielle* 51/1: 113-40.

- Forester, T. 1987. *High Tech-Society. The Story of the Information Technology Revolution*. Cambridge, MA: MIT Press.
- Forester, T., ed. 1980. *The Microelectronics Revolution*. Cambridge, MA: MIT Press.
- Forrest, J. E. 1988. "The management of technological innovation: Strategic alliances in the new biotechnology industry," unpubl. PhD thesis, UWC of Cardiff.
- Fourastié, J. 1954. *Die große Hoffnung des 20. Jahrhunderts*. Köln.
- Fransman, M. 1989. "Cooperation, competition and international competitiveness: The case of Japanese central office switches," *Edinburgh PICT Working Paper No. 16*, Edinburgh University.
- Fransman, M. 1990. *The Market and Beyond: Cooperation and Competition in Information Technology in the Japanese System*. Cambridge: Cambridge Univ. Press.
- Fransman, M. 1990a. "Controlled competition in the Japanese telecommunications equipment industry: The case of central office switches," *Edinburgh PICT Working Paper No. 20*, Edinburgh University.
- Freeman, C. 1984. *The Economics of Innovation*. London: Penguin.
- Freeman, C. 1988. "The factory of the future: The productivity paradox, Japanese just-in-time and information technology," *PICT Policy Research Paper No. 3*, London, Economic and Social Research Council, Programme on Information and Communications Technologies.
- Freeman, C., Clarke, J., and Soete, L. 1982. *Unemployment and Technical Innovation: A study of Long Waves in Economic Development*. London: Pinter.
- Freeman C. and Perez, C. 1988. "Structural crises of adjustment, business cycles and investment behaviour," in G. Dosi et al. eds. 1988.
- Frevort, U. 1979. "Vom Klavier zur Schreibmaschine - Weiblicher Arbeitsmarkt und Rollenzuweisung am Beispiel der weiblichen Angestellten in der Weimarer Republik," in *Frauen in der Geschichte I*, A. Kuhn and G. Schneider, eds. Düsseldorf: Schwaborn.
- Frey, H. 1990. "Bestandsaufnahme der Einführung von CIM-Installationen durch Generalunternehmen und Analyse möglicher Auswirkungen auf die Abhängigkeit mittelständischer Unternehmen," Paper commissioned by the Federal Ministry of Research and Development, Köln.
- Freyssenet, M. 1990. "Les formes sociales d'automatisation," *Cahiers de Recherche du GIP-MI N° 37*, Paris.
- Friedman, A. with Cornford, D. 1989. *Computer Systems Development: History, Organisation and Implementation*. Chichester: John Wiley & Sons.
- Fritz, H.J. 1982. *Menschen in Büroarbeitsräumen*. München: Heinz Moos.
- Fuentes, A. and Ehrenreich, B. 1983. *Women in the Global Factory*, Institute for New Communications.
- Gabor, D. 1946. "Theory of communication," *Journal of IEE* 93, III.
- Gaffard, J. L. and Perrin, J. 1990. *Technopoles et Développement*. Sophia-Antipolis: LATAPSES-CNRS.
- Gardell, B. 1971. *Produktionsteknik och arbetsglädje*. Stockholm: Personaladministrativa rådet.
- Gateway 1985-89. The MAP Reporter. Industrial Technology Institute, Michigan, various issues.
- Gaudin, T. 1979 "Pour une analyse des interactions objets/société," *La Revue de l'Entreprise*, 26 March.
- Gehlen, A. 1957. *Die Seele im technischen Zeitalter*. Reinbek b. Hamburg: Rowohlt.
- Geistdörfer, A. 1976. "Description des techniques," *Techniques et Cultures* N° 1.
- Genschel, Ph. and Werle, R. 1991. (forthcoming). "From hierarchical coordination to international standardization in telecommunications," In *Trans-Border Aspects of Large-Scale Technical Systems: Development, Deployment, Standardization and Regulation*. S. Salsbury, ed.

- Gershuny, J. 1981. *Die Ökonomie der nachindustriellen Gesellschaft*. Frankfurt/M.: Campus.
- Gille, B. 1978. *Histoire des Techniques*. Paris: Gallimard, La Pléiade.
- Gittins, J. C. and Jones, D. M. 1979. "A dynamic allocation index for the discounted multi-armed bandit problem," *Biometrika* 66.
- Glimell, H. 1990. "Kunskapsintressen i svensk arbetslivsforskning," in *Makten över forskningspolitiken. Särintressen, nationell styrning och internationalisering*, W. Agrell, ed. Lund: Lund Univ. Press, 133-60.
- GMD (Gesellschaft für Mathematik und Datenverarbeitung mbH), 1989. "Der Software-Markt in der Bundesrepublik Deutschland," *GMD-Studien* No. 167, Sankt Augustin.
- Godelier, M. 1982. *Les sciences de l'homme et de la société en France. - Rapport au Ministère de la Recherche et de l'Industrie*. Paris: La Documentation Française.
- Göranzon, B. 1984. *Datautvecklingens filosofi*. Stockholm: Carlssons.
- Göranzon, B. 1990. *Det praktiska intellektet*. Stockholm: Carlssons.
- Goffman, E. 1973. *La mise en scène de la vie quotidienne, 1. La présentation de soi*. Paris: Editions de Minuit.
- Golding, A. M. 1972. "The semiconductor industry in Britain and the United States: A case study in innovation, growth and the diffusion of technology," D. Phil. Thesis: University of Sussex.
- Goldstine, H. H. 1972. *The Computer from Pascal to von Neumann*. Princeton: Univ. Press.
- Gonod, P. 1988. "La technologie générale: Projet d'encyclopédie systémique des techniques," *Analyse des Systèmes* XIX/4.
- Goodman, P.S., Sproull, L. S., and Associates. eds. 1990. *Technology and Organizations*. San Francisco: Jossey-Bass.
- Green, K. 1990. "Shaping technologies and shaping markets: Creating demand for biotechnology," Paper presented to conference on *Firm Strategy and Technical Change*, Manchester University, 27-28 September.
- Green, K. and Yoxen, E. 1990. "The greening of european industry: What role for biotechnology?" *Futures* 22: 475-95.
- Green, E., Owen, J., Pain, D., and Stone, I. (forthcoming). "Gender, skill and the making of software," in Murray and Woolgar.
- GREMI 1989. "Milieux innovateurs et réseaux transnationaux? Vers une nouvelle théorie du développement spatial", *Actes du colloque GREMI-EADA*. Paris: GREMI.
- Grossman, J. B. 1970. "The Supreme Court and social change," *American Behavioral Scientist* 13/4: 535-531.
- Grossman, R. 1980. "Women's place in the integrated circuit," *Radical America*, Jan./Feb.
- Guillermé, J. 1984. "Les liens du sens dans l'histoire de la technologie," *Cahier STS N° 2*.
- GUIR/IRI (Government-University-Industry Roundtable/Industrial Research Institute). 1991. *Industrial Perspectives on Innovation and Interaction with Universities: Summary of Interviews with Senior Industrial Officials*. Washington, DC: National Academy Press.
- Gustavsen, B. 1983. "Some aspects of the development of social science work research in Scandinavia," *WZB discussion paper* IIVG 83-209, Berlin.
- Gustavsen, B. 1990a. *Workplace Development Programs in Scandinavia as Exemplified by the Swedish Program on Leadership, Organisation and Codetermination*. Stockholm: Swedish Center for Working Life.
- Gustavsen, B. 1990b. *A Preliminary Evaluation and Summary of the LOM Program*. Stockholm: Swedish Center for Working Life.
- Habermas, J. 1968. *Technik und Wissenschaft als 'Ideologie'*. Frankfurt/M.: Suhrkamp.
- Hack, L. 1988. *Vor Vollendung der Tatsachen. Die Rolle von Wissenschaft und Technologie in der dritten Phase der Industriellen Revolution*. Frankfurt/M.: Fischer.



- Hack, L. 1989. "Determinationen/Trajekte vs. Konfigurationen/Projekte. Sozioökonomische und soziokulturelle Strukturveränderungen als Resultat der bewußten Gestaltung technischer Innovationen," in G. Fleischmann and J. Esser, eds. 1989, 71-105.
- Hack, L. and Hack, I. 1985. *Die Wirklichkeit, die Wissen schafft. Zum wechselseitigen Begründungsverhältnis von 'Verwissenschaftlichung der Industrie' und 'Industrialisierung der Wissenschaft'*. Frankfurt/M.: Campus.
- Hacker, S. 1990. *Doing It the Hard Way: Investigations of Gender and Technology*. Winchester, MA: Unwin Hyman.
- Häusler, J. 1990. "Zur Gegenwart der Fabrik der Zukunft - Forschungsaktivitäten im bundesdeutschen Maschinenbau," *Max-Planck-Institut für Gesellschaftsforschung discussion paper 90/1*, Köln.
- Hagberg, J.-E. 1986. "Tekniken i kvinnornas händer. Hushållsarbete och hushållsteknik under tjugo- och trettio-talet," *Linköping Studies in Arts and Science* No. 7.
- Hagemeyer, F.-W. 1979. "Die Entstehung von Informationskonzepten in der Nachrichtentechnik. Eine Fallstudie zur Theoriebildung in der Technik in Industrie- und Kriegsforschung," unpubl. doctoral thesis, Free University Berlin.
- Hales, M. 1988. *Women - The Key to Information Technology*. London: London Strategic Policy Unit.
- Halfmann, J. 1984. *Die Entstehung der Mikroelektronik. Zur Produktion des technischen Fortschritts*. Frankfurt/M.: Campus.
- Hansen, W. 1982. "Technologische Entwicklungstrends der Werkstoffe," in *Technologieforum Berlin '82. Proceedings*. Berlin: VDE-Verlag, 49-91.
- Harbor, B. 1989. "Technological divergence in the development of military and civil communications systems: The case of Ptmigan and Systems X," Paper presented to ESRC PICT National Workshop, Brunel University, Uxbridge, 17-19 May.
- Hård, M. 1989. "History of technology in Sweden: A field with a future!?" *Polhem* 7: 164-82.
- Hård, M. 1992. "Beyond harmony and consensus: A social conflict approach to technology," *Science, Technology, and Human Values* (forthcoming)
- Hars, A. and Scheer, A.-W. 1990. "Leitstände - ein neues Instrumentarium zur Fertigungssteuerung," in *Werkstattoffene CIM-Konzepte - Alternativen für CAD/ CAM und Fertigungssteuerung*, KfK-PFT 157, M. v. Behr and Ch. Köhler, eds. Karlsruhe, 51-78.
- Hartmann, G., Nicholas, I., Sorge, A., and Warner, M. 1984. "Consequences of CNC technology: A study of British and West German manufacturing firms," in *Microprocessors, Manpower and Society: A comparative, cross-national approach*, M. Warner, ed. Aldershot: Gower.
- Hatch, A. 1956. *Remington Arms. An American History*. New York: Rinehard & Cie.
- Haudricourt, A. 1964. "La technologie science humaine," *La Pensée* N° 115.
- Haudricourt, A. 1987. *La technologie science humaine, recherches d'histoire et d'ethnologie des techniques*. Paris: Éditions de la Maison des Sciences de l'Homme.
- Haugeland, J. 1987. *Artificial Intelligence: The Very Idea*. Hamburg: McGraw-Hill.
- Heims, St. J. 1980. *John von Neumann and Norbert Wiener. From Mathematics to the Technologies of Life and Death*. Cambridge, MA: Harvard Univ. Press.
- Heintz, B. 1990. "Das 'Fließband im Kopf'. Computer und Rationalisierung," in *Schweiz im Wandel. Studien zur neueren Gesellschaftsgeschichte*, S. Brändli et al. eds. Basel: Helbig and Lichtenbahn, 117-47.
- Heintz, B. 1991. "Modernisierungsstrategien und Computerarchitekturen," in *Wissenschaft - Technik - Modernisierung*, B. Joerges, ed. Berlin. WZB discussion paper FS II 91-503.
- Hellige, H.D. 1984. "Die gesellschaftlichen und historischen Grundlagen der Technikgestaltung als Gegenstand der Ingenieurausbildung," *Technikgeschichte* 51/4: 276-91.
- Hellwig, H.-E. and Hellwig, U. 1986. "CIM-Konzepte und CIM-Bausteine," *VDI-Z* 128/18.

- Henderson, R. M. and Clark, K. B. 1990. "Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms," *Administrative Science Quarterly* 35: 9-30.
- Hertog, J. F. den and Schröder, P. 1989. "Social research for technological change: Lessons from national programs in Europe and North America," *Merit* 89-028, Maastricht Economic Research Institute on Innovation and Technology.
- Heys, F. A. 1981. "International videotex standards: How will they affect the user?" *Viewdata 81*. Northwood Hills: Online, 417-37.
- Hildebrandt, E. and Seltz, R. eds. 1987. *Managementstrategien und Kontrolle. Eine Einführung in die Labour Process Debate*. Berlin: edition sigma.
- von Hippel, E. 1988. *The Sources of Innovation*. New York: Oxford Univ. Press.
- Hirschhorn, L. 1984. *Beyond Mechanization. Work and Technology in a Postindustrial Age*. Cambridge, MA: MIT Press.
- Hirsch-Kreinsen, H. 1986. "Technische Entwicklungslinien und ihre Konsequenzen für die Arbeitsgestaltung," in H. Hirsch-Kreinsen and R. Schultz-Wild, eds. 1986, 13-48.
- Hirsch-Kreinsen, H. 1988. "Die Entwicklung der NC-Steuerungen von Werkzeugmaschinen - ein Vergleich zwischen den USA und den deutschsprachigen Ländern," *Mitteilungen des Verbunds Sozialwissenschaftliche Technikforschung* No. 3: 25-39.
- Hirsch-Kreinsen, H. 1989. "Entwicklung einer Basistechnik - NC-Steuerungen von Werkzeugmaschinen in den USA und der Bundesrepublik," in K. Düll and B. Lutz, eds. 1989. Frankfurt/M., 161-211.
- Hirsch-Kreinsen, H. and Lutz, B. 1987. "Soziale Einflußgrößen fertigungstechnischer Entwicklung," *ZwF* 82/9: 538-43.
- Hirsch-Kreinsen, H. and Schultz-Wild, R. eds. 1986. *Rechnerintegrierte Produktion - Zur Entwicklung von Technik und Arbeit in der Metallindustrie*. Frankfurt/M.: Campus.
- Hirsch-Kreinsen, H., Schultz-Wild, R., Köhler, Ch., and Behr, M. v. 1990. *Einstieg in die rechnerintegrierte Produktion - Alternative Entwicklungspfade der Industriearbeit im Maschinenbau*. Frankfurt/M: Campus.
- Hodges, A. 1983. *Alan Turing: The Enigma*. London: Burnett Books.
- Hoffmann, U. 1985. "Die wundervolle Schreibmaschine," in *Geldwelt*, Vol. 1, *Zur Geschichte der Bankangestellten*, U. Hoffmann, ed. München: Hampp, 131-83.
- Hoffmann, U., 1989. "'Frauenspezifische' Zugangsweiszur (Computer-)Technik," *Technik und Gesellschaft. Jahrbuch* 5. Frankfurt/M.: Campus, 159-74.
- Hohn, H.-W. and Schneider, V. 1991. "Path-dependency and critical mass in the development of research and technology: A focused comparison," *Science and Policy* 18: 111-22.
- Hoke, D. R. 1984. "Ingenious Yankees. The rise of the American system of manufacturers in the private sector," PhD thesis, Wisconsin/Madison.
- Holtgreve, U. 1989. *Schreib-Dienst*, Marburg: SP-Verlag.
- Hourcade, J. C. and Nicolon, A. 1987. *La course d'obstacles des nouvelles énergies renouvelables: biogaz, photovoltaïque, éoliennes*, *Énergie Internationale*. Paris: Economica.
- Hourcade, J. C., Le Peltier, V., and Salles, J. M. 1990. *Ecological Economics*. (forthcoming)
- Howells, J. 1989. "A case study in the management of technical innovation: New fermented foods in Western Europe," unpubl. PhD thesis, University of Nottingham.
- Howells, J. and Hine, J. 1990. "Competitive strategy and the implementation of a new network technology: The case of electronic funds transfer at point of Sale (EFTPoS)," *Edinburgh PICT Working Paper* No. 26, Edinburgh University.
- Hughes, Th. P. 1976. "The development phase of technological change," *Technology and Culture* 17: 423-31.
- Hughes, Th. P. 1983. *Networks of Power. Electrification in Western Society 1880-1930*. Baltimore: Johns Hopkins Univ. Press.
- Hughes, Th. P. 1987. "The evolution of large technological systems," in W. E. Bijker et al. eds. 1987, 51-82.

Huws, U. 1982. *Your Job in the Eighties*. London: Pluto.

IG Metall, ed. 1984. "Büro 1880-1930, Frauenarbeit und Rationalisierung," (*Arbeitshefte der IG Metall zur Humanisierung des Arbeitslebens*). Frankfurt.

Ingelstam, L. and Schiller, B. 1981. *Teknik och social förändring*. Lund: Liber.

Irmer, T. 1990. *CCITT after the IXth Plenary Assembly - A Review, and a Preview, on its Standardization Activities* (Mimeo).

Jacot, J. H. 1984. *Travailleur collectif et relations science-production*. Paris: CNRS.

Jacot, J. H. 1989. "Du Fordisme au Toyotisme? Les voies de la modernisation du système automobile en France et au Japon," *Études et Recherches, Commissariat au Plan N°7-8*.

Jamison, A. 1982. *National Components of Scientific Knowledge: A Contribution to the Social Theory of Science*. Lund: Research Policy Institute.

Jamison, A. and Annerstedt, J. eds. 1988. *From Research Policy to Social Intelligence*. London: MacMillan.

Jeantet, A. and Tiger, H. 1988. "Quelle automatique dans les industries manufacturières," AFCET, Congrès automatique, Grenoble, Oct.

Jenkins, R. V. 1976. *Images and Enterprize: Technology and the American Photographic Industry, 1839-1925*. Baltimore: John Hopkins Univ. Press.

Jewkes, J., Sawers, D., and Stillerman, R. 1959. *The Sources of Invention*. New York: St. Martin's Press.

Joerges, B. 1989. "Soziologie und Maschinerie - Vorschläge zu einer 'realistischen' Techniksoziologie," in P. Weingart, ed. 1989, 44-89.

Johansson, B. 1988. "Ny teknik och gamla vanor. En studie om mikrovägsgugnens introduktion," *Linköping Studies in Arts and Science* No. 28.

Jones, B. 1983. "Machinist or technician programming of CNC," in *Systems Design: By, for and with the User*, U. Briefs et al. eds. Amsterdam: North-Holland.

Jones, B. 1988. "Work and flexible automation in Britain: A review of developments and possibilities," *Work, Employment and Society* 2/4, 451-86.

Jones, V. C. 1988. *MAP/TOP Networking. A Foundation for Computer-Integrated Manufacturing*. New York: McGraw-Hill.

Jokisch, R. ed. 1982. *Techniksoziologie*. Frankfurt/M.: Suhrkamp.

Joly, P.B. 1989. *Dynamique de l'industrie des semences*. Grenoble: INRA.

Jürgens, U. and Naschold, F. 1984. *Arbeitspolitik. Materialien zum Zusammenhang von politischer Macht, Kontrolle und betrieblicher Organisation der Arbeit*. Opladen: Westdeutscher Verlag.

Kahneman, D., Slovic, P. and Tversky, A. 1982. *Judgement under Uncertainty: Heuristics and Biases*. Cambridge: Cambridge Univ. Press.

Kaiser, A. 1986. "Stadens ljus. Etableringen av de första svenska gasverken," *Linköping Studies in Arts and Science* No. 4.

Kaluzny, A. D. and Hernandez, R. 1988. "Organizational change and innovation," in *Health Care Management*, S. M. Sjprte and A. D. Kaluzny, eds. 1988. New York: John Wiley & Sons. (2nd ed.)

Kanter, R. 1988. "When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organizations," in *Research in Organizational Behavior*, Vol. 10, B. M. Staw and L. L. Cummings, eds. Greenwich, CT: JAI Press.

Katz, M. L. and Shapiro, C. 1986. "Product compatibility choice in a market with technological progress," *Oxford Economic Papers* 38: 146-65.

Katz, M. L. and Sahapiro, C. 1985. "Network externalities, competition and compatibility," *American Economic Review* 75.

- Karpik, L., Callon, M. and Jancovice, E. 1972. "Science, rationalité et industries," *Sociologie du Travail* N° 1.
- Keck, O. 1981. *Policymaking in a Nuclear Program*. Lexington, MA
- Kern, H. and Schumann, M., 1984. *Das Ende der Arbeitsteilung?* München: Beck.
- Kimberly, J. R. 1981. "Managerial innovation," in *Handbook of Organizational Design*, Vol. 1, P. C. Nystrom and W. H. Starbuck, eds. New York: Oxford Univ. Press, 84-104.
- Kimberly, J. and Evanisko, M. 1981. "Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations," *Academy of Management Journal* 24: 689-713.
- Kindleberger, Ch. P. 1983. "Standards as public, collective and private goods," *Kyklos* 36: 377-96.
- Kitschelt, H. 1980. *Kernenergiepolitik. Arena eines gesellschaftlichen Konflikts*. Frankfurt/M.: Campus.
- Kitschelt, H. 1984. *Der ökologische Diskurs. Eine Analyse von Gesellschaftskonzeptionen in der Energieidebatte*. Frankfurt/M.: Campus.
- Kittler, F. A. 1986. *Grammophon, Film, Typewriter*. Berlin: Brinkmann und Bose.
- Kleinaltenkamp, M. 1990. "Der Einfluss der Normung and Standardisierung auf die Diffusion technischer Innovationen," Sonderforschungsbereich 187 working paper, Ruhr Universität Bochum.
- Klemm, F. 1983. *Geschichte der Technik*. Reinbek b. Hamburg: Rowohlt.
- Klepper, G. 1990. "Entry into the market for large transport aircraft," *European Economic Review* 34: 775-803.
- Knie, A. 1989. "Das Konservative des technischen Fortschritts - Zur Bedeutung von Konstruktionstraditionen, Forschungs- und Konstruktionsstilen in der Technikgenese," *WZB discussion paper FS II 89-11*, Berlin
- Knie, A. 1990. "Was leistet Technikgenese-Forschung?" in R. Tschiedel, ed. 1990, 91-105.
- Knie, A. 1991a. *Diesel - Karriere einer Technik. Genese und Formierungsprozesse im Motorenbau*. Berlin: edition sigma.
- Knie, A. 1991b. "'Generierung' und 'Härtung' technischen Wissens: Die Entstehung der mechanischem Schreibmaschine," *Technikgeschichte* 58/2: 101-26.
- Knight, K. 1967. "A descriptive model of the intra-firm innovation process," *Journal of Business* 40: 478-496.
- Kobayashi, H. 1981. "Stand und Trend der Automatisierung im Maschinenbau in Japan," paper presented to AWF-Congress *Fertigungsautomatisierung*, Böblingen.
- König, W. 1990. *Massenproduktion und Technikkonsum - Entwicklungslinien und Triebkräfte der Technik zwischen 1880 und 1914. Propyläen Technikgeschichte*, Vol. 4.2. München
- König, W. 1991. "Nutzungswandel, Technikgenese und Technikdiffusion. Ein Essay zur Frühgeschichte des Telefons in den Vereinigten Staaten und Deutschland," in *Fern-Sprechen*, J. Becker, ed. Stuttgart.
- Knorr-Cetina, R. 1988. "Das naturwissenschaftliche Labor als Ort der 'Verdichtung' von Gesellschaft," *Zeitschrift für Soziologie* 17: 85-101.
- Krämer, S. 1988. *Symbolische Maschinen. Die Idee der Formalisierung in geschichtlichem Abriss*. Darmstadt: Wiss. Buchgesellschaft.
- Kraft, Ph. 1977. *Programmers and Managers: The routinisation of computer programming in the United States*. New York: Springer.
- Krohn, W. and Rammert, W. 1985. "Technologieentwicklung: Autonomer Prozeß und industrielle Strategie," in *Soziologie und gesellschaftliche Entwicklung. Verhandlungen des 22. Deutschen Soziologentags in Dortmund 1984*, B. Lutz, ed. Frankfurt/M.: Campus, 411-33.
- Krohn, W. and Weyer, J. 1990. "Die Gesellschaft als Labor. Risikotransformation und Risikokonstitution durch moderne Forschung," in *Risikante Entscheidungen und Katastrophenpotentiale*, J. Halfmann and K. Japp, eds. Opladen: Westdeutscher Verlag, 89-122.

- Kubicek, H. and Rolf, A. 1985. *Mikropolis. Mit Computernetzen in die "Informationsgesellschaft."* Hamburg: VSA.
- Küffner, G. 1987. *Spitzentechnik in Deutschland. Von der Forschung zur Anwendung.* Wiesbaden: Gabler.
- Kunzmann, R. W. 1979. *Hundert Jahre Schreibmaschine im Büro.* Rinteln: Merkur.
- Lahner, M. and Ulrich, E. 1969. "Analyse von Entwicklungsphasen technischer Neuerungen," *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* 2/6.
- LaPorte, T. 1988. "The United States air traffic system: Increasing reliability in the midst of rapid growth," in R. Mayntz and Th. P. Hughes, eds. 1988, 215-44.
- LaPorte, T. ed. 1991. *Social Responses to Large Technical Systems: Control or Anticipation.* Dordrecht/Boston: Kluwer
- Latour, B. 1987a. "Give me a laboratory and I will raise the world," in *Science Observed*, K. Knorr-Cetina and M. Mulkey, eds. 1987. London: Sage, 141-70.
- Latour, B. 1987b. *Science in Action: How to Follow Scientists and Engineers Through Society.* Milton Keynes: Open Univ. Press.
- Latour, B. 1990. "Where are the missing masses? Sociology of a few mundane artefacts," in J. Law and W. Bijker, eds. 1990.
- Law, J. 1988. "The anatomy of a sociotechnical struggle: The design of the TSR 2," In *Technology and Social Process*, B. Elliott, ed. Edinburgh: Edinburgh Univ. Press, 44-69.
- Law, J. and Bijker, W. eds. 1990. *Constructing Networks and Systems.* Cambridge, MA: MIT Press.
- Lazonick, W. H. 1979. "Industrial relations and technical change: The case of the self-acting mule," *Cambridge Journal of Economics* 3: 231-62.
- Lebas, Ch. 1978. *Les innovations technologiques induites, une analyse critique.* Grenoble: CRI.
- Lebas, Ch. and Mercier, Ch. 1983. "Les savoir-faire ouvriers enjeu des changements techniques," *Économie et Humanisme* N°269.
- Lennerlöf, L. 1986. "Psychology at work. Behavioural science in work environment research," *International Review of Applied Psychology* 35: 77-99
- Leroi-Gourhan, A. 1980. *Hand und Wort. Die Evolution von Technik, Sprache und Kunst.* Frankfurt/M.: Suhrkamp.
- Lévy-Leboyer, M. 1989. "The French electrical power system: An inter-country comparison," in R. Mayntz and T. Hughes, eds. 1989, 254-62.
- Lifchus, I. M. 1986. "Standards and innovation: The hidden synergy," in *Telecommunications and Equity: Policy Research Issues*, J. Miller ed. Amsterdam: Elsevier Science Publishers, 179-84.
- Liff, S. 1990. "Gender and Information Technology: Current research priorities, strengths, gaps and opportunities," Paper presented to Second PICT Workshop on Gender and IT, Nov./Dec. 1989.
- Lindblom, C. E. 1977. *Politics and Markets.* New York: Basic Books.
- Linde, H. 1982. "Soziale Implikationen technischer Geräte, ihrer Entstehung und Verwendung," in R. Jokisch, ed. 1982, 1-31.
- Lindgren, M. 1987. "Glory and Failure: The Difference Engines of Johann Müller, Charles Babbage and Georg and Edvard Scheutz," *Linköping Studies in Arts and Science* No. 9.
- Lindqvist, S. 1990. "History of technology as an academic discipline," in *Swedish Research in a Changing Society: The Bank of Sweden Tercentenary Foundation 1965-1990*, K. Hårnqvist and N.-E. Svensson, eds. 1990. Hedemora: Gidlungs, 411-31.
- Linhart, R. 1978. "Procès de travail et division de la classe ouvrière," *La Division du Travail, colloques de Dourdan.* Paris: Galilée.
- Lohmann, H. 1953/54. "Die Technik und ihre Lehre," *Wissenschaftliche Zeitschrift der Technischen Hochschule Dresden* 3: 601-29.

- Lutz, B. 1969. "Produktionsprozeß und Berufsqualifikation," in *Spätkapitalismus oder Industriegesellschaft?* Th. W. Adorno, ed. Stuttgart: Enke.
- Lutz, B. 1976. "Bildungswesen und Beschäftigungsstruktur in Deutschland und Frankreich. Zum Einfluß des Bildungssystems auf die Gestaltung betrieblicher Arbeitskräftestrukturen," *Betrieb - Arbeitsmarkt - Qualifikation*, ISF, ed. München, Frankfurt/M.: Campus.
- Lutz, B. 1986. "Einführung. Qualifikationsentwicklung in der mechanischen Fertigung - zur Fragestellung eines sozialwissenschaftlichen Forschungsprojekts," in H. Hirsch-Kreinsen and R. Schultz-Wild, eds. 1986, 5-11.
- Lutz, B. ed. 1987. *Technik und sozialer Wandel. Verhandlungen des 23. Deutschen Soziologentages in Hamburg 1986*. Frankfurt/M.: Campus.
- Lutz, B. 1988. "Gibt es einen Zusammenhang zwischen der Ausbreitung der Informatik und der Verschulung von beruflicher Qualifizierung?" *Mitteilungen des Verbunds Sozialwissenschaftliche Technikforschung* No. 3: 67-77.
- Lutz, B. ed. 1989. *Technik in Alltag und Arbeit. Beiträge der Tagung des Verbunds Sozialwissenschaftliche Technikforschung, Bonn 29./30.5.1989*. Berlin: edition sigma.
- Lutz, B. 1990. "Technikforschung und Technologiepolitik: Förderstrategische Konsequenzen eines wissenschaftlichen Paradigmenwechsels," *WSI-Mitteilungen* No. 10: 614-22.
- Lutz, B. and Hirsch-Kreinsen, H. 1987. "Vorläufige Thesen zu gegenwärtigen und zukünftigen Entwicklungstendenzen von Rationalisierung und Industriearbeit," *Mitteilungen des Verbunds Sozialwissenschaftliche Technikforschung* No. 1: 158-65.
- Lutz, B. and Veltz, P. 1989. "Maschinenbauer versus Informatiker - Gesellschaftliche Einflüsse auf die fertigungstechnische Entwicklung in Deutschland und Frankreichs," in K. Düll and B. Lutz, eds. 1989, 213-85.
- MacKenzie, D. 1989. "The influence of the Los Alamos and Livermore national laboratories on the development of supercomputing," *Edinburgh PICT Working Paper* No. 13, Edinburgh University.
- MacKenzie, D. 1990a. *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance*. Cambridge, MA.: MIT Press.
- MacKenzie, D. 1990b. "Economic and sociological explanations of technical change," *Edinburgh PICT Working Paper* No. 27, Edinburgh University.
- MacKenzie, D. 1991. "Notes toward a sociology of supercomputing," in T. R. La Porte, ed. 1991, 159-75.
- MacKenzie, D. and Wajcman, J., eds. 1985. *The Social Shaping of Technology: How the Refrigerator Got Its Hum*. Milton Keynes: Open Univ. Press.
- McLaughlin, P. 1988. "Essentialism, population thinking, and the environment," *Environment, Technology, and Society* 52: 4-7.
- Macpherson, A. 1990. *International Telecommunication Standards Organizations*. Boston: Artech House.
- Mairesse, J. and Cuneo, P. 1985. "Recherche-Développement et performances des entreprises," *Revue Économique* 36/5.
- Mangematin, V. 1990. "La normalisation, prolongement de la Recherche-Développement," colloque *Le management de la technologie*, Grenoble, Oct.
- Mansfield, E. P. 1968. *Industrial Research and Technological Innovation*. New York: Norton.
- March, J. G. and Spoull, L. S. 1990. "Technology, management, and competitive advantage," in P. S. Goodman, L. S. Sproull and Associates, eds. 1990, 144-73.
- Marglin, S. 1974. "What do bosses do? The origins and functions of hierarchy in capitalist production," *Review of Radical Political Economics* No. 6, Summer.
- Marti, B. 1982. "Efforts toward a European standard," in *Bildschirmtext Kongress 1982*, Diebold Deutschland GmbH ed. Frankfurt/M.: Selbstverlag, 35-50.
- Martin, E. 1981. *Die Schreibmaschine und ihre Entwicklungsgeschichte*. Aachen: Basten.

- Martin, J. M. 1988. "L'avenir du marché pétrolier, sous l'abondance pétrolière retrouvée, le changement caché des structures et des technologies," *Futuribles*, June.
- Matschoß, C. 1908. *Die Geschichte der Dampfmaschine*. Berlin.
- Maurice, M. 1980. "Le déterminisme technologique dans la sociologie du travail, 1955-1980, un changement de paradigme?," *Revue de Sociologie du Travail*, Jan.
- Maurice, M. 1986. "Sociologie du travail et progrès technique," Séminaire *Les changements techniques dans l'industrie*, CNRS, INRA, MRT, Lille.
- Maurice, M., Sellier, F. and Silvestre, J. J. 1979. "La production de hiérarchie dans l'entreprise: Comparaison France-Allemagne," *Sociologie du travail* N° 2.
- Mayntz, R. 1986. "Corporate actors in public policy: Changing perspectives in political analysis," *Norsk Statsvitenskapelig Tidsskrift* 3: 7-25.
- Mayntz, R. 1988. "Zur Entstehung technischer Infrastruktursysteme," in *Differenzierung und Verselbständigung. Zur Entwicklung gesellschaftlicher Teilsysteme*, R. Mayntz et al. Frankfurt/M.: Campus, 233-59.
- Mayntz, R. 1990. "Entscheidungsprozesse bei der Entwicklung von Umweltstandards," *Die Verwaltung* 23: 137-51.
- Mayntz, R. and Hughes, Th. P. eds. 1988. *The Development of Large Technical Systems*. Frankfurt/M.: Campus; Boulder: Westview Press.
- Mayntz, R. and Schneider, V. 1988. "The dynamics of system development in a comparative perspective: Interactive videotex in Germany, France, and Britain," in R. Mayntz and Th. P. Hughes, eds. 1988, 263-98.
- Meyer, J. W. and Rowan, B. 1977. "Institutionalized organizations: Formal structure as myth and ceremony," *American Journal of Sociology* 83: 340-363.
- Mayr, O. 1986. *Authority, Liberty, and Automatic Machinery in Early Modern Europe*. Baltimore: John Hopkins Univ. Press.
- McCorduck, P. *Machines Who Think. A Personal Inquiry into the History and Prospects of Artificial Intelligence*. San Francisco: Freeman.
- Ménard, C. 1990. *L'Économie des Organisations*. Paris: La Découverte.
- Mensch, G. 1971. "Zur Dynamik des technischen Fortschritts," *Zeitschrift für Betriebswirtschaft* 41: 295-314.
- Mensch, G. 1976. *Gemischtwirtschaftliche Innovationspraxis*. Göttingen: Schwartz.
- Mensch, G. 1977. *Das technologische Patt. Innovationen überwinden Depression*. Frankfurt/M.: Fischer.
- Menzel, M. and Schilling, A. 1920. "Beiträge zur Psychotechnik der Schreibmaschine und ihrer Bedienung," *Praktische Psychologie* 2: 269f.
- Meyer-Abich, K. M. and Schefold, B. eds. 1981. *Wie möchten wir in Zukunft leben? Der sanfte und der harte Weg*. München: Beck.
- Mickler, O. 1981. *Facharbeit im Wandel*. Frankfurt/M.: Campus.
- Midler, C. 1984. *Les concepts au concret. Réflexions sur les liens entre systèmes techniques et systèmes de gestion dans l'industrie automobile*. Paris: CRG, École Polytechnique.
- Miles, I. 1990. *Home Telematics: Information Technology and the Transformation of Everyday Life*. London: Pinter.
- Miles, I. and Thomas, G. 1990. *Telematics in Transition*. London: Longman.
- Mintzberg, H. 1979. *The Structuring of Organizations*. Englewood Cliffs, NJ: Prentice-Hall.
- Mitter, S. 1986. *Women in the Global Economy*. London: Pluto.
- Molina, A. 1989. *The Social Basis of the Microelectronics Revolution*. Edinburgh: Edinburgh Univ. Press.
- Molina, A. 1989a. "Managing economic and technological competitiveness in the US semiconductor industry: Short- and long-term strategies," *International Journal of Technology Management* No. 2: 157-75.
- Molina, A. 1989b. "The transputer constituency: Building up UK/European capabilities in information technology," *Edinburgh PICT Research Report* No. 1, Edinburgh University.

- Molina, A. 1989c. "Transputers and parallel computers: Building technological capabilities through sociotechnical constituencies," *PICT Policy Research Paper* No. 7, Swindon, ESRC.
- Molina, A. 1990a. "The development of public switching systems in the UK and Sweden: The weight of history," *Edinburgh PICT Working Paper* No. 19, Edinburgh University.
- Morschheuser, F. and Wagner, F. X. 1987. *Erfinder der Typenhebel-schreibmaschine*. Koblenz: Landesmuseum.
- Mowery, D. C. 1990. "Technology and organizations: An economic/institutional analysis," in P. S. Goodman, L. S. Sproull and Associates, eds. 1990, 200-31.
- Müller, J. 1986. *Schreibmaschinen*. Hannover: Verlag der Papierzeitung.
- Mumford, E. 1983. *Designing Secretaries*. Manchester: Manchester Business School Publications.
- Mumford, L. 1964. *The Myth of the Machine. Vol. 1, Technics and Human Development*. New York: Harcourt, Brace and Jovanovich.
- Mumford, L. 1970. *The Myth of the Machine. Vol. 2, The Pentagon of Power*. New York: Harcourt, Brace and Jovanovich.
- Mumford, L. 1980. "Autoritäre und demokratische Technik," *Technologie und Politik*, No. 16, Reinbek b. Hamburg: Rowohlt, 12-22
- Murray, F. with Knights, D. 1990. "Competition and control: The strategic use of IT in a life insurance company," in *Case Studies in Information Technology*, K. Legge, C. W. Clegg, and N. J. Kemp, eds. Oxford: Blackwell.
- Murray, F. and Woolgar, St. eds. (forthcoming) *Critical Perspectives on Software Development*, Boston, MA: MIT Press.
- Nelson, R. and Winter, S. 1977. "In search of a useful theory of innovation," *Research Policy* 6: 36-76.
- Noble, D. F. 1979. "Social choice in machine design: The case of automatically controlled machine tools," in *Case Studies on the Labour Process*, A. Zimbalist, ed. New York: Monthly Review Press, 18-50.
- Noble, D. F. 1984. *Forces of Production - A Social History of Industrial Automation*. Alfred A. Knopf: New York.
- Noguchi, T. 1983. "High technology and industrial strategies in Japan," *Labour Society* 8/4: 383-92.
- Nora, S. and Minc, A. 1980. *The Computerization of Society*. Cambridge, MA: MIT Press.
- Nyberg, A. 1989. "Tekniken - kvinnornas befriare? Hushållsteknik, köpevaror, gifta kvinnors hushållsarbets-tid och förvärvsdeltagande 1930-talet - 1980-talet," *Linköping Studies in Arts and Science* No. 45.
- Oakey, R., Faulkner, W., Cooper S., and Walsh, V. 1990. *New Firms in the Biotechnology Industry*. London: Pinter.
- Offe, C. 1984. "Das Wachstum der Dienstleistungsarbeit - Vier soziologische Erklärungsansätze," in *Arbeitsgesellschaft - Strukturprobleme und Zukunftsperspektiven*, C. Offe, ed. Frankfurt/M.: Campus.
- OECD. 1985. *The Semiconductor Industry: Trade Related Issues*. Paris: OECD
- OECD/ICCP. 1987. *Standards in Information and Communication Technology*. Paris: OECD.
- Orsenigo, L. 1989. *The Emergence of Biotechnology*. London: Pinter.
- Pahl, G. and Beitz, W. 1986. *Konstruktionslehre*. Berlin: Springer.
- Papert, S. and Turkle S. 1990. "Epistemological pluralism: Styles and voices within the computer culture," *Signs* 16/1: 128-57.
- Pelaez, E. 1990. "What shapes software development?" *Edinburgh PICT Working Paper* No. 10, Edinburgh University.



- Pelz, D. C. 1985. "Innovation complexity and the sequence of innovating stages," *Knowledge: Creation, Diffusion, Utilization* 6/3: 261-291.
- Perez, C. 1983. "Structural change and the assimilation of new technologies in the economic and social system," *Futures* 15: 357-75.
- Perrin, J. 1988. *La production sociale des techniques*. Paris: Publisud.
- Perrin, J. 1990. "Construire une science de techniques," Journées interdisciplinaires sur la technologie, 21-22 May, Lyon.
- Perrow, C. A. 1967. "Framework for the comparative analysis of organizations," *American Sociological Review* 32: 194-208.
- Perrow, C. 1984. *Normal Accidents. Living with High-Risk Technologies*. New York: Basic Books.
- Petzold, H. 1985. *Rechnende Maschinen*. Düsseldorf: VDI Verlag.
- Pfeiffer, O. 1923. "Die Schreibmaschine bis 1900," *Beiträge zur Geschichte der Technik und Industrie* 13: 89-124.
- Picot A. and Schneider, D. 1988. "Unternehmerisches Innovationsverhalten, Verfügungsrechte und Transaktionskosten," in *Betriebswirtschaftslehre und Theorie der Verfügungsrechte*, D. Budäus, E. Gerum, and G. Zimmermann, eds. Wiesbaden: Gabler.
- Pinch, T. J. and Bijker, W. E. 1984. "The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other," *Social Studies of Science* 14: 399-441.
- Pinch, T. J. and Bijker, W. E. 1987. "The social construction of facts and artefacts: Or how sociology of science and the sociology of technology might benefit each other," in W. E. Bijker et al. eds. 1987, 17-50.
- Pipe, G. R. 1989. "The ITU Plenipotentiary: Reconciling conflicting agendas," *ITU Report 1989* (August), 43-44.
- Pirker, Th. 1962. *Büro und Maschine*, Basel: Kyklos; Tübingen: Mohr.
- PIRTTEM, *Résumée du rapport d'activité 1984-1987 et des orientations 1988-1990*. Paris: CNRS.
- Plowden Report 1965. "Report of the Committee of Inquiry into the Aircraft Industry," Cmnd. 2853, HMSO.
- Poitou, J.P. 1988. *Le cerveau de l'usine. Histoire des bureaux d'études Renault de l'origine à 1980. Recherche sur les conditions de l'innovation technique*. Aix en Provence: Publications de l'Univ. de Provence.
- Poole, M. S. and Van de Ven, A. H. 1989. "Toward a general theory of innovation," in *Research on the Management of Innovation*, A. H. Van de Ven, H. L. Angle, and M. S. Poole, eds. Cambridge, MA: Ballinger.
- Popitz, H. 1989. *Epochen der Technikgeschichte*. Tübingen: Mohr.
- Porat, M. U. 1977. *The Information Economy: Definition and Measurement*. Washington: Office of Telecommunications, US Department of Commerce.
- Powell, W. W. 1987. "Review essay: Explaining technological change," *American Journal of Sociology* 93: 185-97.
- Pratten, C. F. 1971. *Economies of Scale in Manufacturing*. Cambridge: Cambridge Univ. Press.
- Radkau, J. 1983. *Aufstieg und Krise der deutschen Atomwirtschaft 1945-1975. Verdrängte Alternativen in der Kerntechnik und der Ursprung der nuklearen Kontroverse*. Reinbek b. Hamburg: Rowohlt.
- Radkau, J. 1989. *Technik in Deutschland. Vom 18. Jahrhundert bis zur Gegenwart*. Frankfurt/M.: Suhrkamp.
- Rakow, L. 1988. "Women and the telephone: The gendering of a communications technology," in *Technology and Women's Voices*, C. Kramarae ed. New York: Routledge and Kegan Paul.
- Rammert, W. 1982. "Soziotechnische Evolution: Sozialstruktureller Wandel und Strategien der Technisierung," in R. Jokisch, ed. 1982, 32-81

- Rammert, W. 1983. *Soziale Dynamik der technischen Entwicklung. Theoretisch-analytische Überlegungen zu einer Soziologie der Technik am Beispiel der 'science-based industry'*. Opladen: Westdeutscher Verlag.
- Rammert, W. 1988a. "Technikgenese. Stand und Perspektiven der Sozialforschung zum Entstehungszusammenhang neuer Techniken," *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 40: 747-61.
- Rammert, W. 1988b. *Das Innovationsdilemma. Technikentwicklung im Unternehmen*. Opladen: Westdeutscher Verlag.
- Rammert, W. 1989a. "Techniksoziologie," in *Wörterbuch der Soziologie. Vol. 3*, G. Endruweit and G. Trommsdorff, eds. Stuttgart: Enke, 724-35.
- Rammert, W. 1989b. "Der Anteil der Kultur an der Genese einer Technik: Das Beispiel des Telefons," in *Telefon und Gesellschaft*, Forschungsgruppe Telefonkommunikation, ed. Berlin: Spiess, 87-95.
- Rammert, W. 1989c. "Technisierung und Medien in Sozialsystemen - Annäherungen an eine soziologische Theorie der Technik," in P. Weingart, ed. 1989, 128-73.
- Rammert, W. 1990a. "Plädoyer für eine Technikgeneseforschung. Von den Folgen der Technik zur sozialen Dynamik technischer Entwicklungen," in B. Biervert and K. Monse, eds. 1990, 333-50.
- Rammert, W. 1990b. "Materiell-immateriell-medial: Die verschlungenen Bande zwischen Technik und Alltagsleben," *Österreichische Zeitschrift für Soziologie* 15/1: 26-39.
- Rammert, W. 1990c. "Telefon und Kommunikationskultur. Akzeptanz und Diffusion einer Technik im Vier-Länder-Vergleich," *Kölner Zeitschrift für Soziologie und Sozialpsychologie* 42: 20-40.
- Rammert, W. 1991. "Technikgenese und der Einsatz von Expertensystemen aus sozialwissenschaftlicher Sicht," *KI - Künstliche Intelligenz* No. 4: 26-30.
- Rammert, W. 1992. "Wer oder was steuert den technischen Fortschritt? Technischer Wandel zwischen Steuerung und Evolution," *Soziale Welt* 43/1.
- Rammert, W., Böhm, W. Olscha, C., and Wehner, J. 1991. *Vom Umgang mit Computern im Alltag. Fallstudien zur Kultivierung einer neuen Technik*. Opladen: Westdt. Verlag.
- Reindl, J. 1930. "Werden und Wirken der Arbeitsgemeinschaft Deutscher Betriebsingenieure," *Der Betrieb* 9: 157-59.
- Reuleaux, F. 1875. *Theoretische Kinematik. Grundzüge einer Theorie des Maschinenwesens*. Braunschweig: Vieweg.
- Ribeiro, D. 1971. *Der zivilisatorische Prozeß*. Frankfurt/M.: Suhrkamp.
- Richards, G. T. 1964. *The History and Development of the Typewriters*. London.
- Richta, R. et al. 1968. *Zivilisation am Scheideweg*. Freiburg: Verlag an der Basis.
- Riesenhuber, H. 1987. "Technik und sozialer Wandel," in B. Lutz, ed. 1987, 26-33.
- Rogan, J., Caillet, J. P., and Heger, D. 1986. "Communications for CIM: An overview of the CNMA project," paper presented to the 3rd Esprit conference 1986 (Technical Week), 29 September - 1 October 1986, Brussels.
- Rogers, R. A. 1990. "Visions Dancing in Engineers' Heads: AT&T's Quest to Fulfill the 'Leitbild' of a Universal Telephone Service," *WZB discussion paper* FS II 90-102, Berlin.
- Rohlf, J. 1974. "A theory of interdependent demand for a communications service," *Bell Journal of Economics* 5: 16-37.
- Rohmert, W. and Haider, E. 1982. "Forschungsbericht zur ergonomischen Gestaltung von Schreibmaschinentastaturen," *BMFT Forschungsbericht* DV 82-003.
- Ropohl, G. 1979. *Eine Systemtheorie der Technik. Zur Grundlegung der Allgemeinen Technologie*. München: Hanser.
- Ropohl, G. 1989. "Ein Systemmodell der technischen Entwicklung," G. Fleischmann and J. Esser, eds. 1989, 1-27.
- Ropohl, G. 1990. "Technisches Problemlösen und soziales Umfeld," in *Technik und Philosophie*, F. Rapp, ed. 1990. Düsseldorf: VDI-Verlag, 111-67.

- Roqueplo, Ph. 1975. *Incidences des rapports sociaux sur le développement scientifique et technique*. Paris: CORDES.
- Roqueplo, Ph. 1983. *Penser la technique*. Paris: Seuil.
- Roqueplo, Ph. 1988. *Pluies acides, menaces pour l'Europe*. Paris: Economica.
- Rosa, E. A. and Machlis, G. E. 1983. "Energetic theories of society: An evaluative review," *Sociological Inquiry* 53: 152-78.
- Rosanvallon, A. 1981. *Formation continue et apprentissage*. Grenoble: IREP.
- Rosen, B. N., Schnaars, S. P., and Shani, D. 1988. "A comparison of approaches for setting standards for technological products," *Journal of Product and Innovation Management* 5: 129-39.
- Rosenberg, N. 1982. *Inside the Black Box: Technology and Economics*. Cambridge: Cambridge Univ. Press.
- Rürüp, R. and Hausen, K. eds. 1975. *Moderne Technikgeschichte*. Köln: Kiepenheuer & Witsch.
- Ruffier, J. 1989. "Qui possèdent les machines," *Annales des Mines*, March.
- Russell, St. 1986. "The political shaping of energy technology: Combined heat and power in Britain," unpubl. Ph.D. thesis, Technology Policy Unit, University of Aston.
- Russell, St. and Williams, R. 1988. "Opening the black box and closing it behind you: On microsociology in the social analysis of technology," *Edinburgh PICT Working Paper No. 3*, Edinburgh University.
- Sachs, W. 1985. "Energie als Weltbild. Ein Kapitel aus der Kulturgeschichte des Produktivismus," *Technik und Gesellschaft. Jahrbuch* 5. Frankfurt/M.: Campus, 36-57.
- Sahal, D. 1981. *Patterns of Technological Innovation*. London: Addison-Wesley.
- Saglio, J. 1985. "Systèmes industriels localisés et cultures professionnelles," *Sociologie du Sud-Est* N° 41-44.
- Savage, J. G. 1989. *The Politics of International Telecommunications Regulation*. Boulder: Westview Press.
- Schaniberg, A. S. 1980. *The Environment: From Surplus to Scarcity*. New York: Oxford.
- Scharf, A. 1985. "Technologische Vermittler - Systemhäuser als Problemlöser," *Hard and Soft* No. 0.
- Scharpf, F. W. 1989. "Decision rules, decision styles and policy choices," *Journal of Theoretical Politics* 1: 149-76.
- Scharpf, F. W. 1991. "Koordination durch Verhandlungssysteme: Analytische Konzepte und institutionelle Lösungen am Beispiel der Zusammenarbeit zwischen zwei Bundesländern," *MPIfG Discussion Paper* 91/4, Köln.
- Scherer, F. M. and Ross, D. 1990. *Industrial Market Structure and Economic Performance*. Houghton Mifflin Company: Boston. (3rd ed.)
- Schmiede, R. 1983. "Abstrakte Arbeit und Automation," *Leviathan* 11/1
- Schmitt, J. 1937. "Mercedes Büromaschinenwerke AG," *Deutsche Großbetriebe* 14, Leipzig: Arnd.
- Schmookler, J. 1966. *Invention and Economic Growth*. Cambridge, MA: Harvard Univ. Press.
- Schneider, V. 1989. *Technikentwicklung zwischen Politik und Markt: Der Fall Bildschirmtext*. Frankfurt/M.: Campus.
- Schneider, V. 1991. "The governance of large technical systems: The case of telecommunications," in T. R. La Porte ed. 1991, 19-41.
- Schultz-Wild, R., Nuber, Ch., Rehberg, F., and Schmierl, K. 1989. *An der Schwelle zu CIM - Strategien, Verbreitung, Auswirkungen*. Eschborn: RKW-Verlag; Köln: Verlag TÜV-Rheinland.
- Schumm, W. and Weber, A. 1990. "Die soziale Produktion von POS-Zahlungssystemen. Möglichkeiten der Analyse von Technikgenese," (mimeo) Frankfurt/M.

- Schumpeter, J. 1950. *Capitalism, Socialism, and Democracy*. New York: Harper & Row. (3rd ed.)
- Scott, W. R. 1987. *Organizations: Rational, Natural, and Open Systems*. Englewood Cliffs, NJ: Prentice-Hall. (2nd ed.)
- Scott, W. R. 1990a. "Technology and structure: An organizational-level perspective," in P. S. Goodman, L. S. Sproull and Associates, eds. 1990, 109-43.
- Scott, W. R. 1990b. "Innovation in medical care organizations: A synthetic overview," *Medical Care Review* 47/2: 165-92.
- Seeger, P. 1988. *Der Funktionswandel der Telekommunikations-Infrastruktur und die Instrumentalisierung der Deutschen Bundespost für Innovationsstrategien*. Münster: Lit-Verlag.
- Senker, J. and Sharp, M. 1988. *The Biotechnology Directorate of the SERC: Report and Evaluation of its Achievements 1981-1987*. Brighton: Science Policy Research Unit, University of Sussex.
- Senker, P. 1987. *Towards the Automatic Factory? The Need for Training*. Bedford: IFS.
- Shannon, C. E. 1962. "The mathematical theory of communication," in *The Mathematical Theory of Communication*, C. Shannon and W. Weaver. Urbana: Univ. of Illinois Press. (9th ed., first published 1948 in *Bell System Technical Journal*)
- Shapin, St. 1982. "History of science and its sociological reconstructions," *History of Science* 20: 157-211.
- Sharp, M. 1985. *The New Biotechnology: European Governments in Search of a Strategy*. Brighton: Science Policy Research Unit, Sussex University.
- Siemens AG 1988. "CNMA conformance testing," Phase 3 of the ESPRIT Project 955.
- Sigaut, F. 1991. "Aperçus sur l'histoire de la technologie, en tant que science humaine," *Actes et communications INRA* No. 6: 67-82.
- Sigaut, R. 1990. "Les points de vue constitutifs d'une science des techniques," Journées interdisciplinaires sur la technologie, 21-22 May, Lyon.
- Silverstone, R. and Towler, R. 1983. "Progression and tradition in the job of the secretary," *Personnel Management*, May.
- Silverstone, R. and Morley, D. 1990. "Families and their technologies: Two ethnographic portraits," in *Household Choices*, T. Putnam and Ch. Newton, eds. 1990. London: Futures Publications, 74-83.
- Simon, H. 1981. *The Sciences of the Artificial*. Cambridge, MA: MIT Press. (2nd ed.)
- Sirbu, M. A. and Zwimpfer, L. E. 1985. "Standards setting for computer communications: The case of X.25," *IEEE Communications Magazine* 23: 35-45.
- Sjögren, D. ed. 1979-83. *Nyhetsblad från Snickeriprojektet*. Stockholm: Swedish Center for Working Life.
- Smith, P. 1988. "The impact of trade unionism and the market in a regional newspaper," *Industrial Relations Journal* 19: 214-21.
- Sörensen, K. H. and Espeli, T. eds. 1989. *Ny teknologi - En utfordring for samfunnsforskning*. Oslo: Norges allmennvitenskapelige forskningsråd.
- Soete, L. 1987. "The newly emerging information technology sector," in *Technical Change and Full Employment*, C. Freeman and L. Soete, eds. Basil Blackwell: Oxford.
- Sombart, W. 1916 (Revised Edition). *Der moderne Kapitalismus. Vol. I and III. 2*. München und Leipzig: Duncker und Humblot
- SOU 1990/54. *Arbetslivsforskning - inriktning, organisation, finansiering. Betänkande av tillkallad särskild utredare*. Stockholm: Allmänna Förlaget.
- Specht, F. 1896. "Die weiblichen Stenographen und Maschinenschreiber Berlins," *Zeitschrift für Staatswissenschaften* 52: 270-91.
- Spur, G. 1984. "Über intelligente Maschinen und die Zukunft der Fabrik," *DFG-Mitteilungen* No. 3.

- Srole, C. 1987. "A blessing to mankind, and especially to womankind: The typewriter and the feminization of clerical work," in *Women, Work, and Technology*, Drygulski et al. eds. Ann Arbor: Univ. Press of Michigan.
- Statistics Canada 1987. *Industrial Research and Development Statistics*. Ottawa.
- Staudenmaier, J. M. 1985. *Technology's Storytellers. Reweaving the Human Fabric*. Cambridge, MA: MIT Press
- Stoneman, P. 1976. *Technological Diffusion and the Computer Revolution: The UK Experience*. Cambridge: Cambridge Univ. Press.
- Swann, P. 1990. "Standards and the growth of a software network," in *An Analysis of the Information Technology Standardization Process*, J. L. Berg and H. Schumny, eds. Amsterdam: Elsevier Science/North-Holland.
- Swann, P. and Lamaison, H. 1988. "The growth of an IT network: A case study of personal computer applications software," *Discussion Papers in Economics*, No. 8807, Brunel University.
- Swodak, W. 1982. "Status quo und technische Entwicklung in der Chemie," *Technologieforum Berlin '82. Proceedings*. Berlin: VDE-Verlag.
- Taylor, P. 1990. "The social construction of computer hacking," research hypotheses for doctoral thesis, Edinburgh PICT, Edinburgh University. (mimeo)
- Technique et culture 1990. Rapport scientifique.*
- Teece, D. J. 1986. "Capturing value from technological innovation: Integration, strategic partnering, and licensing decisions," *Research Policy* 15: 285-305.
- Thevenot, L. 1989. "L'Économie des conventions," *Revue Économique* N° 2.
- Thomas, F. 1988. "The politics of growth: The German telephone system," in R. Mayntz and Th. P. Hughes, eds. 1988, 179-214.
- Thomas, F. 1989. "Korporative Akteure und die Entwicklung des Telefonsystems in Deutschland 1877 bis 1945," *Technikgeschichte* 56: 39-65.
- Thompson, J. 1967. *Organizations in Action*. New York: McGraw-Hill.
- Tierney, M. and Williams, R. 1990. "Issues in the black-boxing of technologies," *Edinburgh PICT Working Paper* No. 22, Edinburgh University.
- Tirole, J. 1988. *The Theory of Industrial Organization*. Cambridge, MA: MIT Press.
- Tolbert, P. S. and Zucker, L.G. 1983. "Institutional sources of change in the formal structure of organizations: The diffusion of civil service reform, 1880-1935," *Administrative Science Quarterly* 28: 22-39.
- Tolksdorf, G. 1989. "Einflüsse auf die Generierung von moderner Produktionstechnik," Bielefeld, February (mimeo)
- Treue, W. 1965. *Achse, Rad und Wagen*. München
- Trist, E. 1981. *The Evolution of Socio-Technical Systems*. Toronto: Ontario Ministry of Labour.
- Troitzsch, U. and Wohlauf, G. eds. 1980. *Technikgeschichte*. Frankfurt/M.: Suhrkamp.
- Troussier, J.F. 1981. *Travail individuel et collectif dans quelques industries*. Grenoble: IREP.
- Tschiedel, R. ed. 1990. *Die technische Konstruktion der gesellschaftlichen Wirklichkeit. Gestaltungsperspektiven der Technik - Soziologie*. München: Profil.
- Tünschel, L. 1987. "CIM-Strategien für die Fabrik mit Zukunft," in *CIM oder die Zukunft der Arbeit in rechnerintegrierten Fabrikstrukturen*, IG Metall, ed. Frankfurt/M.
- Turing, A. 1937. "On computable numbers, with an application to the Entscheidungsproblem," *Proceedings of the London Mathematical Society* 42/2. (Reprinted in German in *Alain Turing, Intelligence Service. Schriften*. B. Dotzler and F. Kittler, eds. 1987. Berlin: Brinkmann und Bose, 19-60.
- Turing, A. 1969. "Intelligent machinery," in *Machine Intelligence 5*, B. Meltzer and D. Mitchie, eds. 1969. Edinburgh.
- Ullrich, O. 1977. *Technik und Herrschaft*. Frankfurt/M.: Suhrkamp.

- Usher, A. P. 1954. *A History of Mechanical Inventions*. Cambridge, MA: Harvard Univ. Press. (Rev. ed., first 1929)
- Verman, L. C. 1973. *Standardization. A New Discipline*. Hamden: Archon Books.
- Vig, N.J. 1988. "Technology, philosophy, and the state: An overview," in *Technology and Politics*, M. E. Kraft and N. J. Vig, eds. Durham, NC: Duke Univ. Press, 1-32.
- Voelzkow, H. 1989. "Die Normung von CIM-Schnittstellen. Zielsetzungen, Besonderheiten, Probleme und Ansatzpunkte für eine sozialverträgliche Technikgestaltung," Sonderforschungsbereich 187 working paper, Ruhr Universität Bochum.
- Voelzkow, H., Hilbert, J., and Bolenz, E. 1987. "Wettbewerb durch Kooperation - Kooperation durch Wettbewerb. Zur Funktion und Funktionsweise von Normungsverbänden," in *Dezentrale Gesellschaftsteuerung: Probleme der Integration polyzentrischer Gesellschaften*, M. Glasgow and H. Willke, eds. Pfaffenweiler: Centaurus, 93-116.
- Waldén, L. 1990. "Genom symaskinens nålsöga. Teknik och social förändring i kvinnokultur och manskultur," *Linköping Studies in Arts and Science* No. 50.
- Wallenstein, G. D. 1977. "Development of policy in the ITU," *Telecommunications Policy* 1: 138-52.
- Warnecke, H. J. 1982. "Technologische Entwicklungstrends im Maschinenbau," *Technologieforum Berlin '82. Proceedings*. Berlin: VDE-Verlag, 15-34.
- Warnecke H.-J. 1986. "Fabrikautomatisierung zwischen technischen Zielvorstellungen und wirtschaftlich-sozialer Realität," in *Produktionstechnisches Kolloquium 1986*, G. Spur, ed. Berlin.
- Webb, J. 1991. "The mismanagement of innovation? Organisational factors," Paper presented at *ESRC/DTI New Technologies and the Firm Initiative, Technology Study Group Conference*, University of Stirling, 6-7 Feb.
- Webster, A. and Constable, J. 1990. "Strategic research alliances and hybrid coalitions," *Science and Public Policy*
- Webster, J. 1988a. "Theorising technology," Edinburgh PICT internal mimeo, Edinburgh University.
- Webster, J. 1988b. "Technology and social shaping," Paper presented to *Programme on Information and Communication Technologies (PICT) National Network Meeting*, Edinburgh University, Aug.
- Webster, J. 1990a. *Office Automation: The Labour Process and Women's Work in Britain*. Hemel Hempstead: Harvester Wheatsheaf.
- Webster, J. 1990b. "The shaping of software systems in manufacturing: Issues in the generation and implementation of network technologies in British industries," *Edinburgh PICT Working Paper* No. 17, Edinburgh University.
- Webster, J. (forthcoming). "From the word processor to the micro: Gender issues in the development of office IT equipment," in Green et al.
- Weingart, P. 1982. "Strukturen technologischen Wandels. Zu einer soziologischen Analyse der Technik," in R. Jokisch, ed. 1982, 112-41.
- Weingart, P. ed. 1989. *Technik als sozialer Prozeß*. Frankfurt/M.: Suhrkamp.
- Weingart, P. 1989a. "'Großtechnische Systeme' - ein Paradigma der Verknüpfung von Technikentwicklung und sozialem Wandel?" in P. Weingart, ed. 1989, 174-196
- Weiss, M. B. and Sirbu, M. A. 1989. *Technological Choice in Voluntary Standards Committees: An Empirical Analysis*. Pittsburgh (Mimeo).
- Werle, R. 1990. *Telekommunikation in der Bundesrepublik: Expansion, Differenzierung, Transformation*. Frankfurt/M.: Campus.
- Weyer, J. 1989. "'Reden über Technik' als Strategie sozialer Innovation - Zur Genese und Dynamik von Technik am Beispiel der Raumfahrt in der Bundesrepublik," in *Gesellschaft-*

- liche Steuerungsrationalität und partikulare Handlungsstrategien, M. Glagow, H. Willke, and H. Wiesenthal. eds. Pfaffenweiler: Centaurus, 81-114.
- Wiener, N. 1948. *Cybernetics or Control and Communication in the Animal and the Machine*. Cambridge, MA: The Technology Press.
- Wiener, N. 1949. *The Extrapolation, Interpolation, and Smoothing of Stationary Time Series*. New York.
- Wilkinson, B. 1983. *The Shop Floor Politics of New Technology*. London: Heinemann Educational.
- Williams, H. and Taylor, J. 1989. "ICTs, organisation and the management of territory," Paper presented to ESRC PICT National Workshop, Uxbridge, 17-19 May.
- Williams, I. D. 1989. "University-Industry relations: Their role in technological innovation: the case of biotechnology in the UK," unpubl. Ph.D. thesis, Technology Policy Unit, Aston University, Birmingham.
- Williams, R. 1984. "The formation and impact of hazard control policy: A study of the regulation of white lead paint," unpubl. PhD thesis, Technology Policy Unit, Aston University, Birmingham.
- Williams, R. 1987. "Democratising systems development: Technological and organisational constraints and opportunities," in *Computers and Democracy*, G. Bjerknes et al. eds. Avebury: Aldershot.
- Williamson, O. E. 1975. *Markets and Hierarchies*. New York: Free Press.
- Williamson, O. E. 1985. *The Economic Institutions of Capitalism. Firms, Markets, Relational Contracting*. New York: Free Press.
- Willmott, R. 1989. *Message Handling and Directories. A Progress Report*. DTI ITSU. (mimeo)
- Winner, L. 1983. "Technologies as forms of life," in *Epistemology, Methodology and the Social Sciences*, R. S. Cohen and M. W. Wartofsky, eds. Dordrecht, Netherlands: Reidel.
- Winner, L. 1985. "Do artifacts have politics?" in *The Whale and the Reactor: A Search for Limits in an Age of High Technology*, L. Winner. Chicago: Univ. of Chicago Press, 19-9.
- Winterton, J. 1985. "Computerised coal: New technology in the mines," in *Digging Deeper: Issues in the Miners Strike*, H. Beynon, ed. 1985. London: Verso.
- Wise, M.N., 1988. "Mediating machines," *Science in Context* 2/1: 77-113.
- Wood, S. ed. 1982. *The Degradation of Work? Skill, Deskilling and the Labour Process*. London: Hutchinson.
- Woodward, J. 1965. *Industrial Organization: Theory and Practice*. London: Oxford Univ. Press.
- Woolgar, St. and Russell, G. 1990. "The social basis of computer viruses," *CRICT Discussion Paper*, Brunel University, Uxbridge. Also to appear in Murray and Woolgar. (forthcoming)
- Woolgar, St. 1991. "The turn to technology in social studies of science," *Science, Technology and Human Values* 16: 20-50.
- Woronoff, D. 1989. "L'histoire de techniques en France: esquisse d'un bilan, communication au séminaire 'histoire des techniques'," Appel d'offres CNRS, INRA, MRT *Les changements techniques dans les industries liées à l'agriculture*.
- Woronoff, D. 1990. *Forges et forêts. Recherches sur la consommation proto-industrielle de bois*. Paris: EHESS.
- Wright, T. P. 1936. "Factors affecting the cost of airplanes," *Journal of the Aeronautical Sciences*, Vol. 3.
- Yates, J. 1987. "From hand copy to Xerox copy: The effects of duplicating technology on organizational communications in American firms in the nineteenth and twentieth centuries," in: *Organizational Communication: Emerging Perspectives*, Vol. 2, L. Thayer, ed. 1987. Norwood, NJ: Ablex.
- Yoxen, E. 1983. *The Gene Business: Who Should Control Biotechnology?* London and Sidney: Pan Books.

- Zaltman, G., Duncan, R., and Holbek, J. 1973. *Innovations and Organizations*. New York: Wiley.
- Zelleken, H.-J., Fontaine, J., and Braatz, F. 1989. *Zahlung per Karte*. Köln
- Zündorf, L. and Grunt, M. 1982. *Innovation in der Industrie: Organisationsstrukturen und Entscheidungsprozesse betrieblicher Forschung und Entwicklung*. Frankfurt/M.: Campus.