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We humans spend most of our waking lives working. Our work includes cultural, intellectual, managerial and emotional labour as well as physical toil. And yet, most research carried out by humanities and media scholars implicitly treats the study of work as marginal, uninteresting or as a "mere" sociological topic. Even the study of "digital practices" rarely engages with the specifics of the workplace, despite the importance of distributed micro-practices such as clickworking, filesharing and collaborative editing. Information technology continues to underpin this transformation of work today, as it has in the past.

For this reason, the contributions to the interdisciplinary conference "Computing is Work!" (Siegen, Germany, 6–8 July 2017) focused on computing as work practice, both on a local or situated and an infrastructural level. Speakers explored different kinds of computing as work, from computerised literary production to computer-based scientific research. In publishing this think piece as a part of the interdisciplinary online journal *Media in Action*, we aim to document this conference in a hybrid and productive way: so consider this think piece as a pathway to the conference talks and the conference talks as pathways to this think piece.

As conference organisers, Tom Haigh and I asked ourselves how to present the recorded videos in the most appropriate way. Rather than merely uploading them to a commercial social media platform, we opted to combine this text with the audio-visual content. The conference videos themselves are available in the Media in Action repository and as part of Siegen University's digital video platform.[1] While we acknowl-

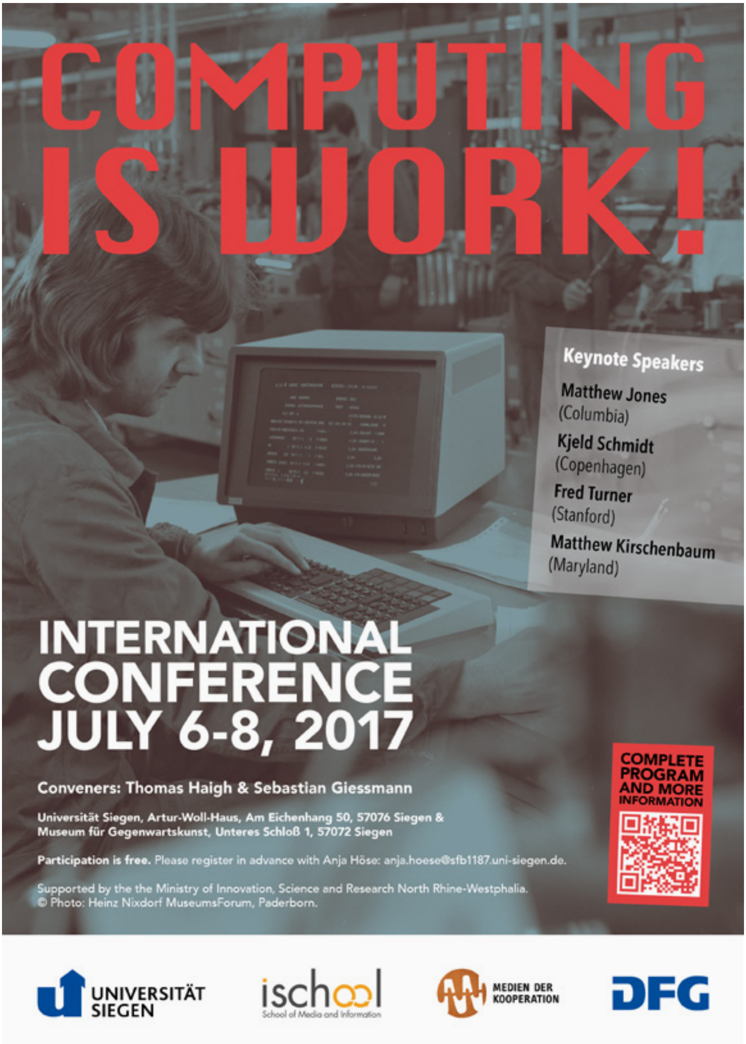

Fig. 1: Conference poster for *Computing is Work!* Graphic design by Matthias Schäfer, Siegen 2017. The photograph depicts a 1979 factory scene at Buderus company in Wetzlar, Northern Hesse. Courtesy of Heinz Nixdorf MuseumsForum, Paderborn.

edge that certain modes of online circulation may be quicker and more popular, we doubt that yet another YouTube talk is a very sustainable way of scientific publishing. We hope that you, as readers and viewers, enjoy this intermedia mode of publication, linking a think piece (instead of an introduction) with academic talks.[2]

A Very Short History of Coordinations

Within the history of infrastructural media, coordination has become a technical term for all practices of organising distributed action since the 19th century (Schüttpelz 2013: 42). The immense need for spatio-temporal coordination that arose during industrialisation is well documented – within both a general history of media and the history of computing and networking. We can draw on classical diagnoses concerning the "control revolution" in North America since the 1860s, when the challenges of distributed production and frontier spaces were met with transport technologies and telegraphic communication. James Beniger's notion of a "control revolution" (1986) and JoAnne Yates' studies concerning new corporate and bureaucratic techniques of information processing (1989; 1994) focused on the coordinative efforts that established physical transport on a wider scale. Thus, coordinative and bureaucratic efforts precede the public availability of infrastructural media innovations. Within the "back office" of railroad companies, banks, factories, publishing houses and nation states, the telegraph and telephone, filing systems, punch cards and other means of registering became coordination mechanisms and, as such, infrastructural media.

A similar development took place in terms of law and standardisation during the "second industrial revolution". Copyrights and technical norms were used as means of international coordination, as shown by Miloš Vec (2006) and Monika Dommann (2019). Florian Hoof (2019), Nadine Taha (2019) and Christine Schnaithmann (2019) were able to demonstrate how micro-coordinative practices became a key to factory floor and management, within the media laboratories of industrial research and via the architecture of office spaces. Taylorism and its variants can be understood as a way to intertwine bureaucratic coordination with the coordinated movement of skilled and unskilled workers. Colonial strategies employed similar dispositions. European colonial powers built infrastructures and created metrologies (Latour 1999) that combined communications media and military means of coordination, leading to "infrastructures of asymmetry"[3] and geopolitical oppression (Diogo/van Laak 2016). Yet, besides the obvious power asymmetries, coordinative practices and techniques of colonisation transformed *all* involved actors, as recent research in global history emphasised (van der Straeten/Hasenöhrl 2016).

Infrastructural expansion and closure, acceleration and blockage of people, objects and signs rely on a bureaucratic-administrative component. It is usually taken for granted or considered as "invisible work" (Star/Strauss 1999). Take for example the early large-scale projects of distributed calculation and measurement, such as meteorological networks in the late 18th century or the computation of logarithmic tables led by Gaspard de Prony in the early 19th century (Schmidt 2011, chap. 11). Without the extensive and frequently failing coordination of data capture and standardisation of instruments, tables and forms, these distributed modes of calculation would not have been possible. The outcomes of this infrastructural work in turn mediated other micro-coordinative practices, serving scientific, civil engineering and military purposes.

Within the entire history of computing, software and programming, embedding computing machinery in organisations and work environments is still (Campbell-Kelly et al. 2018), and again, state of the art. While historian Geoffrey C. Bowker (1994) confronted an epistemology of computing that focused exclusively on cybernetics, reminding his readers that organisational work is key for computer-based information processing, most of today's historians of computing take into account the powers of organisation.

Consider the research on the rise of IBM, the coordination of British wartime computing and deciphering at Bletchley Park (Agar 2003, chap. 6), the "ontology of the enemy" in Second World War radar technologies (Galison 1997; Hugill 1999), the US missile defence system SAGE, the indivisibility of management and corporate computing (Haigh 2003; Ensmenger 2010) and, finally, the scientific and academic coordinative necessities used as arguments for the ARPANET, other research networks and the World Wide Web. In each case, computers were introduced and used as mechanisms for coordinated computation and the coordination of computing. This is also a key issue in the history of computing in the Soviet Union, as Slava Gerovitch (2008) and Ben Peters (2016) have shown. Since computers are structurally open and protean machines that are ontologically underdetermined, it is only through their communities of practice and institutions that they become media. If we take into account this notion proposed by Michael S. Mahoney (2011), the practically accomplished coordinative character of computational media becomes even clearer.

The software-based orientation of computing towards the coordination of work and industrial production was not inherent to digital computers. Yet, in practice, it became the defining element for the application and usage of computers in companies, administrations and nation states (National Research Council 1999). Scientific practices of computing are an important exception from this rule, although (or because) they have laid the technological and epistemological foundations for 'the' computer.[4]

While personal computers (PCs) became also de facto domestic computers and found their way into Western households in the 1980s, they were the dominant medium of both office coordination and household cooperation at the same time (cf. Gugerli 2018, chap. 6). Donna Haraway (1991 [1985], cf. Star 1996) brilliantly captured this double-sided culture of computing in the often forgotten sociological passages of her *Cyborg Manifesto*. According to Haraway, factories, households and markets were integrated by a new “homework economy”, in which feminised domains of work at home became a key component. In the 1980s, micro-coordinative practices transformed the coordination technologies tied to large centralised mainframes, thus becoming a long-term trend that is still driving today’s convergence of mobile media use with centralised, cloud-based infrastructures.

On Coordination Mechanisms and Boundary Objects

How can this history of coordinative practices and computing be focused for the purposes of media theory? The most comprehensive and thorough proposals so far, in our opinion, have been made by sociologist Susan Leigh Star and socio-informatics scholars Kjeld Schmidt and Carla Simone (1996). While Star’s notion of “boundary objects” primarily addresses cooperative practice between heterogeneous communities of practice (Star 1989; Star/Griesemer 1989), Schmidt and Simone’s “coordination mechanisms” focus on all artefacts involved in organising cooperative work. Both terms apply to protocols, forms, tables, files and folders, databases, maps, commonly used objects (from museum artefacts to measuring slides), maps, diagrams, worksheets, timelines, algorithms, software packages and mobile apps. These media of work and production[5] should therefore not be considered as “minor media” (Geoghegan 2016: 810), but as the infrastructural basis of everyday practices and the formation of media agencies.

The coordinative character of boundary objects and coordination mechanisms is based on practices of information processing that integrate multiple agents, thereby creating an elementary order of cooperative work. Even if coordination is the sole responsibility of one person or delegated to a small number of objects, all coordinative practices need to be made “accountable”. This means these practices rely on representation, since they must be legible, calculable, visible, audible and partly tangible. This applies to every situation of distributed work and often requires the “re-representation” of relevant information (Star 1995: 92).

It must be possible to address a medium of coordination indexically at every moment of its re-representation. Initially, coordination is therefore an elementary negotiation happening in every community of practice rather than a top-down process: it is a process of agreeing what to do next (in a given organisational context).

Kjeld Schmidt and Carla Simone have proposed the following definition of "coordination mechanisms" that accomplish the mediation of work:

> A *coordination mechanism* is a specific organizational construct, consisting of a *coordinative protocol* imprinted upon a *distinct artifact,* which, in the context of a certain cooperative work arrangement, *stipulates* and *mediates* the articulation of cooperative work so as to *reduce the complexity of articulation work* of that arrangement. (Schmidt/Simone 1996: 180)

Schmidt and Simone base their explanation for tailoring artefacts towards coordination on a terminological difference between "cooperative work" and "articulation work". Anselm Strauss's concept of "articulation work" encompasses all speech acts necessary to manage difficulties in work situations – interaction and conversation required to deal with crisis and problems (Star/Strauss 1999: 10). This work can partly be delegated to coordinative artefacts – take for example a checklist that each person involved recognises and consults as a protocol of their practices. For Schmidt and Simone, this articulation work is not part of cooperative work – yet, I argue that it is difficult to separate the usage of coordination devices and articulation work in action.

Schmidt and Simone emphasise the ordering aspect of coordination mechanisms, when they understand them as "artifactually embodied mediating structures that are used to *constrain the articulation of distributed activities* in cooperative work settings" (Schmidt/Simone 1996: 177). Susan Leigh Star's boundary objects encompass a different logic of coordination. Boundary objects are, right from the start, configured by the needs of the social worlds that create a boundary object for their heterogeneous purposes. Think of a table or form as an aggregate of practice: it is not primarily characterised by its embedded protocols, since the protocol of a boundary object is mutually accomplished in action.

Susan Leigh Star and James Griesemer (1989: 390) characterised this mode of negotiation as translations from "many-to-many". However, although some historiographies of boundary objects in computing exist (Ensmenger 2016), it is not possible to reconstruct an interactional negotiation of an object's mediating qualities for each historical case. This applies in particular to the level of micro-coordinative practice, since this is where the tools at hand are often used in a *bricolage* style. Star (1989) called the outcome of these situations a "structure of ill-structured solutions", in which the preferred choice is not the formally and organisationally "best" solution, but anything that gets the job done. In addition, boundary objects tend to be both vague and adaptable, with their information continually updated and re-worked along re-representation paths.

Object-based coordination happens in an environment full of tensions, affording certain practices while constraining others. This interplay between "affordances" and "constraints", between protocol and local appropriation characterises software use. It can be said that the way organisations use software provides the historical model cases for dealing with coordination problems. IBM's rise to a leader in the computing industry after the Second World War was due to the company's competence and skill at supplying customers with tailored hardware and software solutions for special purpose needs in information processing.[6] The professionalisation of programming as an occupation and business in the USA and the emergence of computer science as an academic discipline relied on the constant high demand of businesses, the military and government administrations. This is evident from a list of typical applications of the decades between 1950 and 1970: coordination of missile defence and radar (SAGE), internal payroll and accounting, flight reservation (SABRE), cheque and credit card clearance, networked stock exchange, etc. Computer networking projects also recognised the importance of coordination for digital infrastructures, whether implemented in the military, the national economy or in sharing scientific resources in the ARPANET (Gießmann 2016, chap. 9).

The historian of technology David Gugerli (2018) has aptly described the transformation of "How the world got computerized" between 1950 and 1990 and shown the high demand for coordination that arose in fields such as data processing. The period described by Gugerli is characterised by the computer being embedded in institutional ecologies. Organisations willing to adopt computers learned how to use them as coordination devices for work, membership, accounting and production. This development continued even after institutional usage receded into the background with the increasing adoption of personal computers, local area networks, intranets and the mobilisation and miniaturisation of computers since the 2000s. The coordinative organisational programming und software usage has shifted to a micro-coordinative level of logistics software, data warehousing, process management, etc. This business-to-business market is the foundation for the thriving computer services industry, which generates more revenue than computer hardware and software products combined ($955 billion in 2014, cf. Yost 2017: 273) and serves a multitude of micro-coordinative purposes.

Compared to centralised company-wide accounting systems, the local use of PC spreadsheets was a shift towards computing practice in small groups. In fact, a significant amount of software programs – think of spreadsheets, image editing, typesetting, computer-aided design [CAD/CAM], groupware – has pushed team and design work towards continuous micro-coordination (Schmidt 2015). The more functions we delegate to software, the more blackboxing occurs and the more intense articulation work and support become. Computers make us talk, even if or because users rarely understand all of their technological and organisational protocols. The coordinative use of computational media should not be confused with mere optimisation and process efficiency, even if it is a common goal in coordinative efforts. Automation movements usually create new modes of "heteromation", as Hamit Ekbia and Bonnie Nardi (2017) have argued convincingly.

So how can we understand the relation between computing, coordinative practice and work? Coordination can be characterised by the infrastructural practices of coordination mechanisms and boundary objects. Both are mutually accomplished, translated from many-to-many, customised and circulated; both control the conditions of cooperative work: coordination mechanisms by affording and constraining protocols of work, boundary objects by re-representing information along a given "path of work". If cooperation is the "mutual making of common goals, means, and processes" (Schüttpelz 2017: 24), then coordination can be conceived as ongoing mutual establishment and control of conditions for cooperation.

Yet, even if we take into account these conceptual considerations, computing becomes work in cooperative and coordinative practices. This is why all contributions to the "Computing is Work!" conference emphasised the social processes of work, thus showing an interdisciplinary potential to integrate a variety of historical, social and ethnographic research approaches into a revealing whole. We understand them as case studies that explain the workings of boundary objects, coordination mechanisms and socio-material practices in digital infrastructures. We invite you to join us and become an observer and listener.

Computing is Work! Contributions and Explorations

- Thomas Haigh / Sebastian Gießmann:
  Opening Remarks: *Computing is Work*

Scientific Workplaces

- Matthew Jones: *Data Mining is Work: Scaling Algorithms, Overcoming Friction, Redefining Knowledge*
- Jens Schröter: *Work will be 3D: Imaginary Workplaces and Volumetric Displays*
- Gerard Alberts: *Archiving is Work, Archaeology Even More*

Structuring Labor

- Roli Varma: *Women at Work: Decoding Femininity in Computing in India*
- Nathan Ensmenger: *Documentation is Work: Flowcharts as Temporal Boundary Objects*
- Discussion with Roli Varma and Nathan Ensmenger

Computer Supported Cooperative Work (CSCW) as Theory and Practice

- Round table with Erhard Schüttpelz, Volker Wulf and Dave Randall: *On CSCW*
- Kjeld Schmidt: *Coordination is Work: The Problem of Computerizing Coordinative Practices*

Workflows

- Kari Kuutti: *"Muddling through" is Work: A Plea for Workflow Oriented Computing*
- Maria Haigh / Tom Haigh: *Stopping Fake News is Work: The Work Processes of Peer-to-Peer Counter Propaganda*

Institutions and Markets

- Hallam Stevens: *Copycatting is Work: The Diverse Labours of the Shenzhen Electronics Markets*
- Ben Peters: *Networking is Work: How Computing Institutions Matter even When Networks Fail*
- Discussion with Hallam Stevens and Ben Peters

Fun and Games

- Ksenia Tatarchenko: *Leisure is Work: The Making of the Soviet Computing Collectives*
- Laine Nooney: *Games are Work: Notes from the "Little Silicone Valley"* *

Art and Literature

- Fred Turner: *Bohemia is Work: Reimagining Digital Labor inside Facebook*
- Matthew Kirschenbaum: *(Even) Literature is Work! Word Processing and Literary Labor*

- Sebastian Gießmann / Thomas Haigh: Closing Remarks

* Laine Nooney's talk has not been recorded, due to sensitive ethnographic data.

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Notes

1 https://u-si.de/vBDor.
2 For a conference report cf. Martin Schmitt (2017, in German).
3 Cf. Echterhölter, Anna (2016): *Infrastrukturen der Asymmetrie. Vom ökonomischen Handwerk des Messens*. Postdoctoral Thesis, Humboldt University Berlin, 2016, esp. chap. 4 on colonial metrology.
4 Cf. Ensmenger (2010, chap. 7) on conflicts between academic and technical professionalisation of computing in the US.
5 In German: *Arbeits- und Verfertigungsmedien*.
6 When IBM "unbundled" software and service from hardware sales in 1969, an actual market for software and services could develop in the US.

References

Agar, John (2003): *The Government Machine. A Revolutionary History of the Computer*. Cambridge, MA; London: MIT Press.

Beniger, James Ralph (1986): *The Control Revolution. Technological and Economic Origins of the Information Society*. Cambridge, MA; London: Harvard University Press.

Bowker, Geoffrey (1994): "Information Mythology. The World of/as Information", in: Bud-Frierman, Lisa (ed.): *Information Acumen. The Understanding and Use of Knowledge in Modern Business*. London; New York: Routledge, pp. 231–247.

Campbell-Kelly, Martin / Aspray, Bill / Ensmenger, Nathan / Yost, Jeffrey R. (2018 [2014]): *Computer. A History of the Information Machine*. 3rd ed. New York; Abingdon: Routledge.

Diogo, Maria Paula / van Laak, Dirk (2016): *Europeans Globalizing. Mapping, Exploiting, Exchanging*. London: Palgrave Macmillan.

Dommann, Monika (2019): *Authors and Apparatus. A Media History of Copyright*. Ithaca, NY: Cornell University Press.

Echterhölter, Anna (2016): *Infrastrukturen der Asymmetrie. Vom ökonomischen Handwerk des* Messens. Postdoctoral Thesis. Berlin: Humboldt-Universität zu Berlin.

Ekbia, Hamit R. / Nardi, Bonnie (2017): *Heteromation, and Other Stories of Computing and Capitalism. Acting with Technology*. Cambridge, MA; London: MIT Press.

Ensmenger, Nathan (2010): *The Computer Boys Take Over. Computers, Programmers, and the Politics of Technical Expertise*. Cambridge, MA; London: MIT Press.

Ensmenger, Nathan (2016): "The Multiple Meanings of a Flowchart", in: *Information and Culture* 51 (3), pp. 321–351.

Galison, Peter (1994): "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision", in: *Critical Inquiry* 21 (1), pp. 228–266.

Geoghegan, Bernard Dionysius (2016): "The Spirit of Media. An Introduction", in: *Critical Inquiry* 42, pp. 809–814.

Gießmann, Sebastian (2016): *Die Verbundenheit der Dinge. Eine Kulturgeschichte der Netze und Netzwerke*. 2nd ed. Berlin: Kadmos.

Gerovitch, Slava (2008): "InterNyet: Why the Soviet Union Did Not Build a Nationwide Computer Network", in: *History and Technology* 24 (4), pp. 335–350.

Gugerli, David (2018): *Wie die Welt in den Computer kam. Zur Entstehung digitaler Wirklichkeit*. Frankfurt a.M.: Fischer.

Haigh, Thomas (2003): *Technology, Information and Power. Managerial Technicians in Corporate America, 1917–2000*. PhD thesis. University of Pennsylvania, Philadelphia, History and Sociology of Science.

Haraway, Donna (1991 [1985]): "A Cyborg Manifesto. Science, Technology and Socialist-Feminism in the Late Twentieth Century", in: Haraway, Donna: *Simians, Cyborgs and Women. The Reinvention of Nature*. New York: Routledge, pp. 149–181.

Hoof, Florian (2019): *Angels of Efficiency. A Media History of Consulting*. New York: Oxford University Press.

Hugill, Peter J. (1999): *Global Communications since 1844. Geopolitics and Technology*. Baltimore; London: Johns Hopkins University Press.

Latour, Bruno (1999 [1987]): *Science in Action. How to Follow Scientists and Engineers through Society*. 11th ed. Cambridge, MA: Harvard University Press.

Mahoney, Michael Sean (2011): *Histories of Computing*. Edited by Thomas Haigh. Cambridge, MA et al.: Harvard University Press.

National Research Council (ed.) (1999): *Funding a Revolution. Government Support for Computing Research*. Washington: National Academy Press.

Peters, Ben (2016): *How Not to Network a Nation. The Uneasy History of the Soviet Internet*. Cambridge, MA; London: MIT Press.

Schmidt, Kjeld (2011): *Cooperative Work and Coordinative Practices. Contributions to the Conceptual Foundations of Computer-Supported Cooperative Work (CSCW)*. London u.a.: Springer.

Schmidt, Kjeld (2015): "Of Humble Origins. The Practice Roots of Interactive and Collaborative Computing", in: *Zeitschrift für Medienwissenschaft* 12 (1), http://www.zfmedienwissenschaft.de/online/humble-origins [06.05.2019].

Schmidt, Kjeld / Simone, Carla (1996): "Coordination Mechanisms: Towards a Conceptual Foundation of CSCW Systems Design", in: *Computer Supported Cooperative Work (CSCW)* 5 (2), pp. 155–200. https://doi.org/10.1007/BF00133655.

Schmitt, Martin (2017): "Tagungsbericht: Computing is Work!, 06.07.2017–08.07.2017 Siegen", in: *H-Soz-Kult*, 08.09.2017, www.hsozkult.de/conferencereport/id/tagungsberichte-7284 [06.05.2019].

Schnaithmann, Christine (2019): "Harmony, not discord. Kooperation im Büro der Larkin Company um 1900", in: Gießmann, Sebastian / Röhl, Tobias / Trischler, Ronja (eds.): *Materialität der Kooperation*. Wiesbaden: Springer VS, pp. 35–59 (in print).

Schüttpelz, Erhard (2013): "Elemente einer Akteur-Medien-Theorie", in: Thielmann, Tristan / Schüttpelz, Erhard (eds.): *Akteur-Medien-Theorie*. Bielefeld: transcript, pp. 9–67.

Schüttpelz, Erhard (2017): "Infrastructural Media and Public Media", in: *Media in Action* 1 (1), pp. 13–61.

Star, Susan Leigh (1989): "The Structure of Ill-Structured Solutions. Boundary Objects and Heterogeneous Distributed Problem Solving", in: Gasser, Les / Huhns, Michael N. (eds.): *Distributed Artificial Intelligence. Vol. II. Research Notes in Artificial Intelligence*. London: Pitman; San Mateo, CF: Morgan Kaufmann, pp. 37–54.

Star, Susan Leigh (1995): "The Politics of Formal Representations. Wizards, Gurus, and Organizational Complexity", in: Star, Susan Leigh (ed.): *Ecologies of Knowledge. Work and Politics in Science and Technology*. Albany: State University of New York Press, pp. 88–118.

Star, Susan Leigh (1996): "From Hestia to Home Page: Feminism and the Concept of Home in Cyberspace", in: Lykke, Nina / Braidotti, Rosa (eds.): *Between Monsters, Goddesses and Cyborgs: Feminist Confrontations with Science, Medicine and Cyberspace*. London: ZED Books, pp. 30–46.

Star, Susan Leigh / Griesemer, James R. (1989): "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39", in: *Social Studies of Science* 19 (3), pp. 387–420.

Star, Susan Leigh / Strauss, Anselm (1999): "Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work", in: *Computer Supported Cooperative Work* 8 (1), pp. 9–30.

Straeten, Jonas van der / Hasenöhrl, Ute (2016): "Connecting the Empire: New Research Perspectives on Infrastructures and the Environment in the (Post)Colonial World", in: *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 24 (4), pp. 355–391. https://doi.org/10.1007/s00048-017-0162-y.

Taha, Nadine (2019): *Medien der Industrieforschung*. Bielefeld: transcript (in prep.).

Vec, Miloš (2006): *Recht und Normierung in der Industriellen Revolution. Neue Strukturen der Normsetzung in Völkerrecht, staatlicher Gesetzgebung und gesellschaftlicher Selbstnormierung*. Frankfurt a.M.: Klostermann.

Yates, JoAnne (1989): *Control Through Communication. The Rise of System in American Management*. Baltimore: Johns Hopkins University Press.

Yates, JoAnne (1994): "Evolving Information Use in Firms, 1850–1920. Ideology and Information Techniques and Technologies", in: Bud-Frierman, Lisa (ed.): *Information Acumen. The Understanding and Use of Knowledge in Modern Business*. London; New York: Routledge, pp. 26–50.

Yost, Jeffrey R. (2017): *Making IT Work. A History of the Computer Services Industry*. Cambridge, MA; London: MIT Press.