

Infrastructural Media and Public Media

Erhard Schüttpelz

1. The Challenge for Media Theory

When Marshall McLuhan turned the medium into a scientific message, the cooperative nature of media was at the centre of his theoretical intervention:

The use of the term “mass media” has been unfortunate. All media, especially languages, are mass media so far at least as their range in space and time is concerned. If by “mass media” is meant a mechanized mode of a previous communication channel, then printing is the first of the mass media. Press, telegraph, wireless, telephone, gramophone, movie, radio, TV, are mutations of the mechanization of writing, speech, gesture. Insofar as mechanization introduces the “mass” dimension, it may refer to a collective effort in the use of the medium, to larger audiences or to instantaneity of reception. Again, all of these factors may create a difficulty of “feedback” or lack of rapport between “speaker” and audience. There has been very little discussion of any of these questions, thanks to the gratuitous assumption that communication is a matter of transmission of information, message or idea. This assumption blinds people to the aspect of communication as participation in a common situation. And it leads to ignore the form of communication as the basic art situation which is more significant than the information or idea “transmitted. (McLuhan 1954: 6)

Sixty years later, the impetus of this passage has lost none of its currency: the scientific challenge to overcome the blindness that prevents

a consideration of “communication as participation in a common situation,” and doing so in referring to “a collective effort in the use of the medium” through which a communicative form is first of all constituted as a “basic art situation.” The great achievement of classical media theory as presented by Edmund Carpenter (1960) and Marshall McLuhan (1964), and onward to Paul Virilio and Friedrich Kittler (both 1986) lay in the unmistakable proof that the technical conditions and elements of modern mass media and telecommunication media were adopted from infrastructural inventions. Those infrastructural inventions first emerged from the increase of requirements of cooperative work in industry and industrial research, the governmental and commercial bureaucracy, and the military.

A study of the history of media inventions confirms that all present technical media stem from special cooperative techniques and media practices, which only became universal techniques and public media through a contingent process of conversion. On that road, they were often enough delayed or impeded. All media are cooperatively developed conditions of cooperation and have evolved as such.¹ In comparing different media as well as the history of their invention and usage, this generalization suggests that media theory and social theory should not be viewed separated.

Looking back at the period of classical media theory and the media history that emerged from it, however, we see that neither has provided a stringent theorization of the cooperative infrastructures from which modern mass media and telecommunication systems emanated and in which they could be consolidated, despite and perhaps also because of classical media theory’s critique of a functionalistic reduction of the media. The initial premises of the shared foundational phase of communication departments and media studies, and especially some of their shared dichotomies, would reveal themselves as theoretically domineering well into the new millennium, in as much as their common generalization seemed to define the totality of technical media:

- 1) the separation of “production” and “reception” adopted from the theory of mass communication;
- 2) especially the categorical separation between telecommunication and interaction that, beginning in the early 1960s, theorized social face-to-face interaction from a space within proximity and without telecommunication and even “without media” (see Leeds-Hurwitz 2010). Media theory and telecommunication, however, were marked by an “ineluctable absence of interaction”, an idea that was generalized for the use of all technical media (see Luhmann 1986);
- 3) but also a separation between a mathematical notion of “information” and physical-technical “matter” that has retrospectively emerged as an intentional separation of universalized information theory from its official and confidential applications (Hagemeyer 1979; Roch 2009). Still, this notion found its way all the more effectively into the establishment of cybernetics and system theory, leading up to the reception of neo-cybernetics in recent decades (Pickering 2007);
- 4) furthermore, the conception of telecommunication, cognition, and mass-media as consisting of “black boxes”, whose automatism can be manipulated through input or following a given output, and whose modules are meant to be configured as prostheses (Harrasser 2013) or as something that can be cognitively improved by substitution (Crowther-Heyck 2005).

Since the triumph of digitally networked media in their application to ongoing media practices and organizational forms, the strength of these four basic theoretical motifs has been proven, both as a source of distortions and as a cause for continuous theoretical and empirical weaknesses. The most influential media theories and models of communication of the past and our introductory courses were not established in order to characterize the infrastructural techniques whose innovations led to modern media and which bring forth current media practices (Beniger 1989; Yates 1989). They were not designed to characterize the cooperative con-

stitution and processing of modern and non-modern media, nor to understand the processes of interactive and collaborative computerization, whose triumphal march began in the 1970s—a process that would have an enduring impact on the new permeabilities between production, distribution, and reception (Schmidt 2015a). The networked computer is no Turing machine, and neither is the Internet; and a media theory of interactive and collaborative computing has only been rudimentarily developed to date (Schmidt 2015b). Since the 1980s, a reconceptualization of those dimensions of media that, to this day, remain inadequately explored in the framework of both media and social theory has unfolded in three separate research branches. It is only recently that these research branches have begun to interconnect:

- in the research on science and technology within the international field of Science and Technology Studies (STS), with branches focusing either on contemporary or historical issues in their continuing discussion of modern infrastructures (Schabacher 2013a);
- in a wide range of ethnographic studies within the field of qualitative media research, dedicated to the cooperative constitution of media “on site” and incorporating ideas of STS (Larkin 2013); and
- in practical and theoretical work on interactive and collaborative computing, focusing on design questions in so-called Computer Supported Cooperative Work (CSCW) (Schmidt 2011) and other developments concerning human-computer interaction (Woods et al. 2005).

In any case, it is true for all three of these areas of research and their increasingly intense exchange that their focus has not been on generalizations emerging directly from media studies and theory, and that some of the most illuminating research on media has even been done without an explicit concept of media. Hence, some of the most empirically well-grounded research on analogue and digital screen-media in control rooms

as well as other coordination centres has been undertaken in the framework of “Workplace Studies” and “Studies of Work” (Bergmann 2006) and in studies of “Distributed Cognition” and “Cognitive Ergonomics” (Hindmarsh / Heath 2000; Hutchins / Klausen 1996; Woods / Patterson et al. 1998). These fields of research have indeed discussed cooperative objects and artefacts that, upon closer inspection, have turned out to be cooperative media (Heath / Hindmarsh 2000), and it is in those discussions that their requirements of cooperation and their procedural forms have been defined with unmatched precision, but with slightly differing terminologies. With a few exceptions, Science and Technology Studies, too, have dispensed with an explicit concept of media, for decades describing media with the vocabulary of cooperatively identified “inscriptions,” to be precise: the infrastructures of instruments of inscription (Sismondo 2004). One of the great exceptions is the description of modern media and laboratory artefacts from the standpoint of their standardisations, which Bruno Latour called “immutable mobiles” (Latour 2006)—a concept that has been broadly received both in international and German speaking research. The same applies to Latour’s notion of “centers of calculation” (Rottenburg 2002) as a complement of the “immutable mobiles”, for this terminology emerged in direct engagement with the media theory of its time. However, there was a certain delay in opening the theoretical discussion in STS and media studies via this prominent exception (Döring / Thielmann 2009).

The cooperative constitution of digital media has been most succinctly spelled out in the realm of “computer supported cooperative work”: quite simply, when the relevant task is described as CSCW, then computerized media used at the workplace are defined as work-supporting cooperative media. Meanwhile all media research in the social and cultural sciences with a focus on the contemporary has found itself forced to come to terms, in its own way, with the basic constitution of digitally networked forms of work as it was first defined by CSCW. This is because, at present, not only every form of work but also all forms of everyday media network-

ing contain their portion of work-supporting cooperative media or have been organized with their help. More than a decade ago, Jörg Bergmann succinctly summarized the challenge facing media research as follows:

With the progressive digitization and miniaturization of information technology, media have penetrated all of society's functional systems; modern everyday life can no longer be conceived without them. Without media communication and coordination, all modern transportation, transaction, and product-distribution systems would quickly collapse; today, imaging procedures are part of everyday activity in medicine, engineering, and the technical sciences; over the past years, the authorities responsible for social control have [...] undergone an unprecedented medialization; and organizations increasingly rely in their functional procedures (documentation, communication, development, etc.) on the most disparate forms of media-based transmission and storage. But however much medialization has penetrated broad fields of professional activity and the working world, the degree of attention this process has received in media research so far has been remarkably low. Not the least of the reasons for this is that, as a rule, media usage in the working world is completely different from the reception of entertainment media. Although stockbrokers, surgeons, journalists, and pilots do look at a "monitor," this monitor is not a "television screen". They do not receive pre-set programs but rather use information transmitted in media form for the successful execution of steps of their work. Here, media are a resource for professional work and their analysis only makes sense by taking this context into account. Except for ethnographical audience research, traditional methods of media research are not attuned to such decentring. (Bergmann 2006: 391f.)

The necessity of a form of research that can do justice to the ubiquitous medialization of our institutions, organizations, and areas of work as Jörg

Bergmann describes it, has meanwhile been recognized by all relevant strands of the social and cultural sciences, albeit with manifest methodological difficulties and terminological reservations. Moreover, the necessity for the invoked “decentring” has increased further—as now, it is not only everyday work and all the events organized by work, but everyday life in general, with its public and intimate spaces and procedures that is affected. The earlier often derided turbulence that the task of “defining your concept of media” tended to spark in discussions of media theory has now arrived in all the social and cultural sciences, disciplines that can no longer evade the challenges of their own media research and, thus, find themselves in the quandaries of media-theorizing their own procedures and findings. On the one hand, the greatest challenge appears to lie in the social- and media-theoretical conceptualization of the research field as outlined by Bergmann: its ubiquity. But also, on the other hand, in the difficulty to estimate the historical depth or newness of ongoing media developments. Are we here actually facing an *increasing* medialization through digital terminals, or do their functional practices only make explicit what was already medialized in other ways? Across all the above-mentioned disciplines, a socio-technical re-assessment of the digital present and its historical classification and reconstruction has become a steady desideratum. This is also apparent in various modalities of the basic concept including “medialization,” “mediatization” (Hepp / Krotz 2014), and “mediation.” The “decentring” of media research Bergmann diagnoses demands a “re-centring” that connects media and social theory, a process that should unfold through three interventions:

- through the introduction of a concept of *cooperation* that either renders more precise or replaces the concept of “communication”;
- through a historicization that makes possible an understanding of the interaction between “entertainment media” and “transportation, transaction, and product-distribution systems,” or more generally, between media *publics* and medialized *infrastructures*;

– and through an intertwining of media theory and social theory via the perspective of *practice theory*. In the following, the necessary relation between practice theory, the concept of cooperation, and media research will be outlined step by step.

2. Media Practices and Practice Theory

An enduring insight from early German media studies is that even the seemingly most stable modern media should be considered “historical interludes” (Zielinski 1989), i.e. that, at least indirectly, the practices that enable their transient or long-term technical and institutional consolidation need to be explored. This perspective has gained depth since the triumph of digital networked media: in order, for instance, to render plausible an app, but also all discoveries tied to interactive computing, it becomes absolutely necessary to prioritize cooperative media practices over the media techniques and stabilized media constituted through them, with all the practical misappropriations that can, in turn, emerge from such a practical priority. Which practice theories should media research revert to in order to reorganize the relation between “media” and “media practices”, and what can a particular media theory contribute to praxis theory? Even just a few years ago, the two seemed hardly reconcilable. The first “practice turn” in the social sciences (Schatzki / Knorr Cetina / Savigny 2001) had no direct impact on media studies although the recruitment involved partly came from STS, some of whose main themes had turned out to be genuine topics of media history: for example, telecommunication’s “large technological systems” (Hughes 2012) and the enduring topic of laboratory instruments and their inscriptions, both of which have remained favourite topics in German media studies. But not only in Germany, an enduring anti-sociological impulse tied to post-structuralist theorizing and the paradigm of discourse analysis impeded a systematic engagement with research that, in its own way, had moved from classical sociological references to unorthodox sociotechnical variables and controversial symmetrizations between social and

technical, human and non-human forms of agency. In addition, discussions in the wake of classical media theory (from McLuhan to Kittler) tended to consider the “status quo of the technical development of media” as an independent variable, whereas all the “messages” and “practices” of media should be treated as dependent variables, i.e. in their dependence on the status quo of the development of media technology. Studies of media appropriation and of the reception-behaviour of mass media consumers (Morley 1980) first appeared to be a mere instantiation, then a form of resistance within this relationship of variables. Only in the wake of the speedy triumph of digital media over the period of a few years would the results of this research be transformed into an all-penetrating symmetrization of “media” and “practices” (Couldry / Hobart 2010).

Therefore, the fulfilment of the promise of classical media theory seems to have happened in a more than paradoxical fashion: technology’s new status quo has effected not only a shifting of the force-field of media practice but media theory itself has turned out to be a limited or expandable practice. The German-language discussion regarding the categorization of the relationships between media and “cultural techniques” has fortified this insight (Krämer / Bredekamp 2013; Siegert 2013). Since then, the relations between independent and dependent variables of media theory have once again become a matter of debate: Based on which practices and media practices do we reconstruct the consolidation and stability of media? And which practice theories should be preferred in research on ongoing media developments?

In the ongoing praxeological boom in cultural studies, the social sciences, and some areas of engineering, too, it makes sense to distinguish between a genuine “practice theory” and research on practices. For several decades, research on practices and the theoretical programme of practice theory have supplemented each other without becoming conflated. The strength of practice theory should lie in its capacity to prioritise practice over all other theoretical variables (Schmidt 2015c). To this end, it can proceed as abstractly or speculatively as any other theoretic-

cal approach. While research on practices can help prepare the groundwork for any theoretical programme without such an orientation, it must prove its point, as it were by definition, in meticulous and adequate descriptions of concrete practices. Research on practices and the impetus of practice theory only become congruent when a sufficient number of documented practices are called upon to explain the constitution of non-practices, f.i. patterns, artefacts or structures. At the moment, this congruence of research on practices and the agenda of practice theory remains an exception. Cultural patterns, technical “scripts,” social structures, and behavioural dispositions (like “habitus”), dispositifs and media understood as dispositifs, all of these entities are drawn upon in the daily business of theory formation to *explain* practices. And when their own practical emergence is meant to be discussed, they are generally only extrapolated as the *consequences* and *effects* of such practices (f.i., Reckwitz 2003). In contrast, explicit methodological efforts to represent and derive social and cultural entities (e.g. entire institutions and institutionalized media) from their practices alone have remained rare and are often only undertaken in essayistic forms. Particularly helpful for a media history and ethnography oriented toward practice theory, is the theoretical discussion of practical knowledge or of “skills,” in recent years partly developed from STS and from both anthropology (Ingold 2000; Schüttpelz 2015) and socio-informatics (“communities of practice”) (Lave / Wenger 1991; Wenger 1998). The international theorizing of “skills” and their impact on media research is generally compatible with the German term “Kulturtechniken” (“cultural technologies”), with the qualification that the international research-literature on skill emphasizes “apprenticeship,” “enskilment,” and the cooperative exercise of technical and artistic capacities and has provided much more thorough research on these aspects (Goodwin 1994; Sterelny 2012a).

In both diachronic and synchronic research, the heuristic priority of media practices over the entities constituted by them requires a particular reflexivity: concerning the media practices that are manifested in

the relevant documents, and in both the historical documents assembled and scrutinized for research, and the ethnographic documents that are constituted by research itself. For research on ongoing media practices, a central question remains how to assess the impact of participatory observation becoming part of the field of research, be it by collaboration, by volunteering, by participation or by observation. How can non-predicative knowledge and habitualized behavioural forms be theoretically articulated? Which theoretical implications does the concept of participatory observation, an idea central to anthropology, produce through its emphasis on an intersection between researching (media-supported) and researched (media) practices? These methodological considerations provide the context for the epistemological question regarding the consequences of a position informed by practice theory for the objectives of research. Can an object defined as “an ongoing accomplishment”, i.e. practice, be pinned down with methods that deny their own processuality or “ongoingness”—or are there scientific procedures that for their part strive for such a reality and mediate between art and science (Mohn 2002)? And which form should a digital archive take that understands the research process as an “ongoing accomplishment” and makes it available as such?

Last but not least, the challenge of practice theory points media research to its own practical origins in various disciplinary forms of socialization and both objectively and personally risky changeovers. Since the nineteenth century, media have been planned and built on the basis of engineering and basic research in the natural sciences; at the same time, they have been shaped by socio-technical collectives, organized partly with the help of applied social sciences, and they are articulated, interpreted, and framed as a distinct “semiosphere” of circulating signs and linguistic manifestations in the humanities and cultural studies. In this way, media consistently participate in all three of the scientific formations of modernity, repeatedly drawing methodological and practical competencies from these formations, which encounter one another in a

turbulent and only temporarily consolidated middle - the medium. What we know about media depends on the practices that meet in that middle (or muddle), and on the practices of making them meet.

3. Media of Cooperation

It seems obvious that if, for many years, not only media studies but also academic research on media in general have lacked a concept informed by practice theory for denoting media's cooperative constitution, then the most effective term that could change this situation is "cooperation". All media are cooperatively created conditions of cooperation, a fact that lies at the heart of their *raison d'être*. In other words, they are media of cooperation.

What is cooperation? For decades, this question was both sharpened and distorted through abstract theory models, particularly from game-theory, whose dichotomies and reductions have been losing their persuasiveness for some time. In interdisciplinary and anthropological research on cooperation, empirical studies of cooperation that explore the full virtuosity of human and technical cooperation, including in the realm of media-supported research on linguistic and media practices, have meanwhile achieved prominence. These studies have avoided distorting the cooperative capacity by setting up premature oppositions (Bratman 1992; Goodwin 2013; Marshall 2010; Sterelny 2012; Strübing / Schulz-Schaeffer et al. 2004). And as mentioned before, a subsidiary realm of computer science, inspired through other ongoing approaches in practice theory (for instance "activity theory" and ethno-methodology) had a head-start in defining the formative difficulties and requirements of digital programming through the concept of cooperation, namely as CSCW (Schmidt 2011) at a very early stage. For our purposes, "cooperation" can be defined as the "*mutual making of common goals, means and processes.*" The etymological connection of "media" to "means" and "middle" points to these common means and processes as characteristics of media; in other words, in line with their etymology, above all as "means

and middle,” media contribute shared processes for cooperation of every sort and have stability even when common goals are lacking.

This foregrounding of cooperation in turn underscores a concept long-since anchored in science and technology studies and adjacent research fields but which has only been discussed in respect to media theory for a few years: the concept, coined by S. L. Star, of the “boundary object” (Star / Griesemer 1989). The concept emphasizes the conditions of “cooperation without consensus” and their shaping by media. Two characteristics in particular enable cooperation without consensus, equally characterizing modern work media of work and digital platforms, but also all historical media practices since the invention of writing: on the one hand modularity and modularization (the “overlapping boundaries” of wholes and the “repositories” and stacks of parts); and, on the other hand, incompleteness and supplementability (for instance through administrative “forms” with gaps for inserting new parts; or through an “ideal type” whose realization as a new whole demands substantive modification) (Star 2015). The boundary objects originally mentioned by S.L. Star are all media of work that continue to be in extensive usage; and already while the term was being coined, this concept facilitated the shaping of new digital “information infrastructures” (Star / Bowker 2002) in socio-informatics.

From a media theoretical point of view, the concept of the boundary object helps us to more precisely define what constitutes the cooperatively processed artefacts of digital and analogue media practices—namely a combination of context-dependent plasticity and context-independent robustness. In Star’s words, boundary objects are “plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites” (Star / Griesemer 1989: 393). When this common identity is endangered, the required robustness can also be affected. Meanwhile the socio-technical limitations of design have repeatedly been asserted for digital working tools and media, both making shared media objects flexible

(Bechky 2003) and making them overly flexible and, thus, robbing them of their function:

- Either because through their digital fluidity and constantly actualized versions they forfeit the robustness necessary for an unproblematic change of contexts (Bailey et al. 2012; Slayton 2013);
- or because they forfeit their practical verifiability through a patchwork consisting of diverse simulations (Gusterson 2005);
- or because the local alignment between two places (for example in multi-local work streams through monitor work) no longer succeeds without explicitly establishing consensus, in this way suspending the technical premises for friction-free cooperation without consensus (Hinds / Bailey 2003).

Cooperation without consensus in media practices thus has interlocking social and media-technical boundaries. If they are crossed, tests and controversies emerge, and the different paths for gaining consensus take centre stage. The more illuminating the concept of “boundary objects” for media theory becomes, the more it will be necessary to research cooperative media not only in their balanced “middleness” but in all pacified and non-pacified conditions “with and without consensus”, and to include the disturbances of all forms of media cooperation (Kümmel / Schüttpelz 2003). This undertaking must especially prove itself in an effort to bring together the two traditional research areas within communication theory and media theory: infrastructure and public.

4. Infrastructures and Publics

The media technological arrangement of infrastructures is based on shared means, procedures, and processes. In many respects, the immediate and more distant goals of the people involved are left open, or can only be defined to the extent that shared means and processes can be consolidated through boundary objects. In public media, we find an

invocation of consensus and dissent, together with the heterogeneous spheres which enable the successful recourse to the scaling of concerns (Boltanski / Thévenot 1991) and to normative but pluralized forms for the establishment of a public good. Publics battle out issues that very quickly refer to their own media staging (Marres et al. 2013) and only attain their full density and volume through this recursive constitution, becoming louder by self-reference. Whereas infrastructures often sink into a deceptive invisibility, from which they only step into the limelight through repair and maintenance or major disturbances (Potthast 2007). Nevertheless, these heuristic oppositions between infrastructures and publics are never final, for the process of establishing and forming media infrastructures and other infrastructures itself catalyses controversies and initiates the quest for public consensus (Nelkin 1979). And public media, too, are based on many forms of infrastructural cooperation that neither presume a substantive consensus or even have to explicitly omit it, for the sake of guaranteeing procedural agreements.

What is the nature of the interrelationship at work here? In general, modern infrastructures and media publics are intertwined through shared proportions and scales (Müller et al. 2010). This shared scaling of media publics and technical infrastructures has been well researched in some respects, particularly when it comes to the history of traffic system for persons, goods, and media (Morley 2011; Schabacher 2013b). However, this research never produced more than a theoretical outline of the shared social and technical scaling at play here (Joyce 2009; Ribes 2014). The intertwined scaling of local, regional, national, and international infrastructures and publics points to their common emergence in the framework of a historical interchange including a corresponding development of media, for only the comprehensive strengthening of modern transportation and media infrastructures made possible the development of a universal “public” into a first-rank collective singular. Corresponding to this conjunction, the concept of “publishing” and the vocation of the “publisher” were only generalized in the early nine-

teenth century, in a framework of regional, national, and international infrastructures of distribution, whose scaling corresponded to the reach of each addressed public (Johns 2009a). This shared scaling on the part of modern publics and infrastructures demonstrates that, upon closer inspection, what is at work here is not a series of independent developments but two aspects of a historical interchange that has yet to be researched.

In addition, it becomes clear that for the past two centuries, both media infrastructures and other infrastructures have emerged that have tended to form monopolies and repeatedly prompted a public discussion of their centralized regulation, governance, and breakup (Henrich-Franke 2009). Past and present media publics have rested on the organization and institutionalization of infrastructures whose operators either enable publics or who prevent them through censorship, hidden operations, or shutdown (Galison 2004). Hence the relationship between infrastructure and public is not only governed by the rather easily recognizable shared scaling of range and of network densities but also by the reconfiguration of economic, political, military, and ideological organizations of power, a process that will continue to play itself out within institutional negotiations and compromises about publics and infrastructures—including the enactment or impeding of egalitarian users' rights. Especially the history of globalization and intercontinental entanglements (Epple 2012) has, in harmony with this perspective, taken a standpoint that links the development of infrastructures and publics within the framework of a “logistic history” (Mann 1986; 1993). Thus, there are good reasons, not only for the history of modernity but also for media history in general, to explore publics and infrastructures at their “interfaces”. As suggested above, this exploration can invoke classical media theory, which likewise focused on the technical basis and infrastructural heritage of public media. So far, however, the theoretical discussion has in no way developed by systematically interconnecting or even systematically fine tuning the two concepts. While theories of “publics” continue to be informed by the research

literatures of social philosophy and of the social and political sciences, the theorizing of “infrastructure” is mainly grounded in research of the history of technology, in Science and Technology Studies, and in macro-history. Both strands, through their shared emphasis on practice theory, have, however, begun to reveal clear parallels and intersections. Within a single generation, the literature on infrastructure has moved from the macro-perspective of Large Technological Systems and their system builders to the grounding of a micro-perspective involving basic cooperative activities of “infrastructuring” (Pipek / Wulf 2009). And the long-lasting discussion of what Habermas termed the “structural transformation of the public sphere,” taking place with, following, and against Habermas (1962), has increasingly focussed on examining heterogeneous processes and spaces of public dissemination and of their particular publics, including the necessary references to an unrestricted, universalized, or particularized “public” (Bosse 2015). The approximations of research on the processes of “infrastructuring” and “publishing”, of negotiating infrastructures and of “making (something) public” suggest that defining their interfaces via practice theory will be possible (Potthast 2007; Simone 2004).

5. Public Media

When we relate the concept of a public sphere to media publics that are conceived and formed as the “cooperatively created conditions of cooperation” in establishing public dissemination, we need a definition of the concept of the public sphere which allows us to highlight pluralised and cooperative processes of the formation of a public. A relevant and current intervention is provided by the term “issue networks”, coined by Rogers and Marres (2005). Such issue networks are formed through a shared grappling with “issues” but are also capable of moving past any traditional catalysts and organizational forms (Kraft 2006).

John Dewey’s characterisation can be taken as the historical starting point for such a definition of media publics. Although he still uses the

term in the singular, his comments still hold strong currency today. “The public,” he writes,

consists of all those who are affected by the indirect consequences of transactions, to such an extent that it is deemed necessary to have those consequences systematically cared for....Since those who are indirectly affected are not direct participants in the transaction in question, it is necessary that certain persons be set apart to represent them, and see to it that their interests are conserved and protected. (Dewey 1927: 15f.)

In this pragmatic definition, Dewey is referring to political publics and their often highly traditionally conceived questions of representation. At the same time, his “matters of concern” can be easily generalized so that every public occasion for discussion and every controversy can be considered in terms of the formation of its sub-public, and every such public in terms of the formation and specialization of its controversial issues. Recognition of the overflowing nature of the objects of discussion and issues at play here and a concomitant pluralization of publics has meanwhile also been integrated into deliberative concepts of the public. In a retrospective foreword to his *Structural Transformation of the Public Sphere*, Jürgen Habermas thus writes as follows: “The corporatively organized opinion-making potentially leading to responsible decisions can only do justice to the goal of a cooperative search for truth to the extent that it remains *permeable* for the free-floating values, themes, contributions, and arguments of an *environment* of political communication.” (Habermas 1990: 43) And he explicitly describes it as “a mistake to speak of the public in the singular,” pleading for a perspective that “from the start onward takes account of competing publics and thus considers the dynamics of communicative processes excluded from the dominant public sphere.” (Habermas 1990: 15)

Both the notion of an ineluctable plurality of publics (which, meanwhile, has been widely accepted) as well as the idea of a pluralization of recourses to a “common good” (Boltanski / Thévenot 1991) remain central for a theorizing of the public sphere. The concept of plural “spheres of justice” (Walzer 1984) and the critical questioning of the modern interplay of exclusivity and universalism, too, are highly significant. In the framework of media theory, to speak with Marres (and with Dewey), what needs to be underscored is the temporalization of public “issues”. On the one hand, these issues may generate their own particular “issue networks” and paths of decision-making, which allow a transcending of every previous path. There will, however, always be media and well-operating media agencies that consistently cater to a number of issues and “issue networks”. For this reason, it would be mistaken to equate the concepts of issues and issue networks with an optimistic scenario of always possible egalitarian participation. The capacity for controversy of a sub-public itself remains a controversial matter; and every demand for and practice of egalitarian participation will encounter existing hierarchies, professional organizations, and agenda-setting institutions (Baringhorst 2014). Dewey’s redefinition of the “public” led him directly into a debate with Walter Lippmann about the capacities and incapacities of democratic media representations (Peters 2005). Moreover, this definition is connected to the modern invention of public relations, with its media agencies that force even actors and organizations from civil society into an infrastructural alignment or symbiosis:

Consequences have to be cared for, looked out for. This supervision and regulation cannot be affected by the primary groupings themselves....Consequently special agencies and measures must be formed if they are to be attended to; or else some existing group must take on new functions. (Dewey 1927: 15f.)

In this way, the development of media publics is marked by its “publicity” or media recursivity: the issues are already drafted, prepared, and reused as media issues; and the media documents, genres, and instances of media publication themselves become causes for processes of negotiation and for possible media controversies. Niklas Luhmann has generalized this feature of all publication processes as the “autologous nature” of media reality:

The function of the mass media would...be not the production but the representation of the public. And what is meant here is “representation” in a “contracting,” reductive sense. Precisely because the “public” always describes the other, inaccessible side of the boundaries of all systems, including the mass media, and cannot be specified in the direction of particular partner systems, it is necessary to represent them in the form of constructions of reality in which all subsystems, indeed, all people, can have a part, without any obligation arising to go about it in a particular way....As we have already noted repeatedly, this is an “autologous” concept. (Luhmann 2000: 105f.)

This version of the theme of media recursivity as recognized by Dewey, Lippman, and Bernays is well formulated but incomplete, even in the case of its digital radicalization through self-evaluations (Gerlitz / Lury 2014). On the one hand, there is no reason to limit it to the mass media of a single public; rather, it equally applies to scientific, political, artistic, and other sub-publics within the untameable heterogeneity of publication processes (Hoffmann 2013). On the other hand, it remains questionable if the constructed realities of a public generally have to turn out so autologous that they necessarily involve the absence of an obligation described by Luhmann. The media recursivity of public media does not only begin and end in the publications themselves but already takes place where they are prepared and processed (Zillinger 2013). And these locations are rarely characterised by autologous indifference but by substantive

discussions which unfold in processes of formalized and informal exchanges of opinions, and as technical discussions concerning the appropriate mode of cooperative production, both inside and outside the media realm (Rohde 2013). Yes, the self-references of “publicity” are strong, but the references of scientific, political, artistic and other forms of expertise are strong too.

For the practical processing of scientific publications, Bruno Latour has formulated a theorem that relates to the length and interlinkage of steps of publication and the simultaneity of their practical and media-related preparation: “the more instruments, the more mediations, the better the grasp of reality.” (Latour 2002: 21) In other words, there is a direct connection between the stability and practical reliability of the successive and the successively intertwined steps of mediation and publication for participants, and the number and degree of complexity of those steps. Antoine Hennion has transferred this theorem to processes of artistic and mass media production, drawing attention to analogous interlinkages of mediatory steps and the actors responsible for them (Hennion / Méadel 2013), and has shown that even the most meticulous evaluation of publications fails to shed light on the practical constitution of the publishing process. For this reason, what constitutes a public’s media recursivity should be considered less the outcome of an elegant theoretical reduction than a question for empirical and historical research. Before their publication and for the purpose of their publication, public media are prepared in non-public situations and from a number of interlinkages of non-public media. The emphasis of classical media theory on the self-referentiality of the mass media and its publics demands a revision that is not only oriented toward an assessment of publications but toward an ethnographic comparison of all media-related processes and mediatory steps enabling and preceding a publication. This is even more the case for low-threshold practices of digital publication (Klass 2013).

In the framework of perspectives of the History of the Book, A.I. Doyle has offered the following recent definition of the threshold for pub-

lication: “The communication of a work from one person to others with permission (perhaps tacit) to pass it on to others; which may be preceded or followed by the growth of knowledge of its existence and interest, rousing desire for further copies, consequent reproduction and gradual dissemination” (Doyle, cited in Tenger / Trolander 2010: 6). In line with this definition (giving permission for dissemination to unknown others), pre-publications of any kind are also publications in their own right. And before publication, there is a cooperative production process that, to the extent that it takes place within a division of labour or through friendly exchange, moves forward in a manner that is both productive and receptive at once, through commentary, correction, and versioning (Binczek / Stanitzek 2010), not only of texts, but of all publications-in-the-making, music, films, websites included. Where does the public status of this production, or, put more precisely, of this simultaneity of production and reception, this mutual making of a medium for publication begin?

6. Media in the Mode of their Making

The original focus of media theory lay in public media and publicly accessible telecommunication services. All explicitly non-public media and media in their making were initially ignored; they still remain outside the normal usage of the English (and journalistic) term “media”. Even now, they have to be specially marked, for the simple reason that they are not meant for the public. A film that is only half finished, is no “film”, because there is no publication in sight; once the footage is edited and released as a “fragment”, there is a “mass medium”. What about the film in between? And are the office files dealing with its production part of the film as “mass medium”? McLuhan’s original take on the medium as a cooperative art form came close to asking these questions, but failed to spell out the consequences.

For a long time, the most difficult case for a general theory of media was the telephone. Although it involved a standardized infrastructure and its public services, the practices of phone calls in private and

work-related spaces systematically entangle the dimensions of interaction and telecommunication, of production and reception, of information and corporeality, categories whose separation was meant to be constitutive for “media.” In both land-line and mobile telephoning, interaction is a resource of telecommunication and vice versa (Laurier 2001); production is a resource of reception and vice versa; and corporeal locatedness and situatedness is part of information and vice versa (Laurier 2004).

The social and technological history of the telephone (Fisher 1992; MacDougall 2003) could have been the touchstone for an alternative media theory (and via the diffusion of mobile terminals, this has meanwhile been realised through the backdoor, so to speak [Thielmann 2014]): for a shared consideration of technical applications, of the development of technical networks, and of the socialization in tele-communicative “communities of practice.” The same is the case for geo-referential media that have moved to the centre of media development through the refinement of sensor systems, spatial forms of visualization (Kolb et al. 2010), and tracking data, together with their mobile terminals. This has been even more the case for a plenitude of everyday work-related media, i.e. for all media (whether in business, the academic world, technology, entertainment, art, or politics) established for and within the organization of work processes (including the work of organizing work), and whose documents and inscriptions are not meant for publication or are used up or archived in the course of their usage (Ludwig-Mayerhofer / Sondermann 2010).

For their part, work-related media belong to an even larger group of non-public media practices that could be termed “media for making things” in as much as the term “work” does neither apply synchronically nor diachronically to all media formations in the household and family, in friendship, and aesthetic creation that can be declared and practiced as unpaid work, or even markedly as non-work or anything but work. With the present everyday world, including both its everyday activities and range of media products, being structured by numerous prac-

tices connected in a digital network, the diagnosis by Jörg Bergmann quoted above (Bergmann 2006) is made more poignant: to reiterate, that the everyday situation of media usage no longer corresponds to the basic situation framing classical mass media, not only for the world of work but also for the household, family, and for socialization (Reißmann et al. 2013), for entertainment, games, and for political debate.

Digitally networked media thus test the constitution of the everyday order of interaction (Hitzler 2010). Only a fraction of non-public, everyday media practices is destined for publication or serves as a step unto a broader public. This was the case in the past and is still a fact in the digitally interconnected present, despite the fluid borders between processing and publication that have emerged in the realm of social media and make it difficult—but so did earlier epistolary and rhetorical media practices (Marrou 1948)—to distinguish between private messages and the granting of a permission to disseminate messages to unknown third parties.

Which concepts can media research rely on to more precisely characterize, historically and intellectually, media not meant for publication, but also the relation between media operating in the context of non-public being-in-the-making and publications emerging from them?

The practical relation between “media in the making” and “public media”, together with the emergence of the latter from work-centred media and makeshift media, has been extensively researched and commented on mainly in two areas only:

- in Science and Technology Studies, regarding the relationship between “science in action,” i.e. science still being in the making (Latour 1987), and “ready-made science,” i.e. science that has been published; between, on the one hand, planned and improvised scientific research and experimental culture and, on the other hand, official representation and publication (Collins / Pinch 2000, 1999), with media on both sides of the divide;

- and in the *History of the Book*, for the period between 1450 and 1800. There have been some productive intersections between these two research areas, especially in the paradigmatic studies in media history by Adrian Johns (Johns 1998; 2007; 2009b; 2012).

In the first area, STS, the concept of media has usually been absent, despite all the paradigmatic analyses of publication procedures and illuminating general observations on the relationship between work-related and public media. The concept's absence notwithstanding, an important insight has been developed here into the infrastructural mediation of work-related scientific media and publications, an insight that with some modification can be applied to other domains of the work-related world and in part to the production, distribution, and reception of mass media (Hennion 1983). Since its emergence, the field of Science and Technology Studies has served as an inspiration for broad areas of the ethnography of organisations and of "shop-floor" technology (Rammert / Schubert 2006), in that context allowing research into many work-related media (Volmar 2012). However, there is at present still one gap in the core field of STS, i. e. methodologically rigorous research on work-related and production-centred media within the social sciences (Greiffenhagen et al. 2013) and in the humanities (Martus / Spoerhase 2009).

Over the past decades, research in *The History of the Book* has initiated a learning process tied to STS, that has only recently been recognised in the relevant German-language research literature. Especially concerning the Early Modern period and extending to the late eighteenth century, new scholarship has repeatedly unearthed different stages and outcomes in the processing of manuscripts for book-printing as well as of both manuscript-books not meant for printing, but for circulation as cooperative manuscripts (Ghanbari 2013). Historical research on print media has meanwhile offered paradigmatic accounts of interchanges between manuscript media and their publications, and is well underway to achieve a new synthesis, partly in the framework of a fundamental re-

vision of a number of concepts and areas of study: the “print revolution” (Johns 1998) and the “scientific revolution” (Smith 2009); literary history and the history of political, religious, scholarly/scientific, and literary publics until the early nineteenth century. It will be important to develop this perspective of media history for non-print media, and to extend it into the present so that it can be connected to STS, Workplace Studies, and media anthropology, and to find the right framework of media theory.

This development depends on sustained interdisciplinary cooperation, because of striking differences in the scholarly approaches involved. Nevertheless, we can already identify a number of general points that seem equally applicable to all “media in their making,” which is to say for historical and current, as well as digital and analogue practices. It is no accident that the best prospects for a theory of “media in their making” are embedded in a framework of precisely those four dichotomies of media theory that have been codified since the 1950s (from various precursors) for the mass media and for telecommunications. These are the disjunctive separations:

- i) between production and reception;
- ii) between interaction and telecommunication;
- iii) between the sending of signs and material transport;
- iv) between automatisms and human skills.

These four separations sharpened the theoretical awareness of the special achievements of the mass media and tele-communicative signal processing in already standardized infrastructures, but they were and remain invalid for the processing of the infrastructures themselves, hence for the forms of work and the inventions manifest in their “infrastructuring” (Pipek / Wulf 2009); they are also invalid for media in their making, for older and more recent work-centred media, as well as for everyday interactions embedded digitally networked media. For all of these media practices, we find that:

- i) The *production, distribution, and reception* of media in their making does not inherently unfold in separate stages. Many work processes thus often enough simultaneously contain media practices of reception (e. g. assessment and commenting), further distribution, and production or processing (of corrected, supplemented, or entirely new versions). Typical modern work media (files, forms, file cabinets) and their specific design are made for precisely these transitions (Chandler 1977; Yates 1989) and, therefore, constitute paradigmatic boundary objects (Star / Griesemer 1989).
- ii) *Interaction und telecommunication* do not proceed on separate tracks; telecommunication remains a part of interactive processes, and in fact one of its thematic and decision-guiding *resources*, and vice versa (Heath / Hindmarsh 2000). In addition,
- iii) Being in the making, the *material and physical mobility and the mobility of signs* do not function separately. This is equally the case for the private and everyday life of photos and documents (f.i. family media), in the everyday working world, and in logistics: in the world of modern transport, material transport and sign-delivery never proceed apart, neither on a small nor on a large scale, but rather through registration processes and “labels” that move with what is labelled. In other words, things are addressed, their data is systematically delivered and is verified, all the way to the “internet of things” (Busch 2011).
- iv) The *automatisms* of machines and of computers and their media are interactively processed and themselves remain part of *interactions*, with corresponding feedback effects on the connection of human and non-human processes (Schmidt 2015b).

For this reason, in every kind of non-public media in their making, from the most private media practices to large technical systems, the eight corners of the four classical dichotomies of media theory not only remain “unseparated” but are shaped in a highly-refined way; they are only

manageable and recognizable in the context of their shared shaping only. Hence, recognizing the four aspects of non-separation outlined above does not constitute a negative finding but what we positively know about all kinds of media that were initially addressed in very different interdisciplinary areas of media research. They are bound to challenge social theory as well as media theory alike:

Media in their making form communities of practice whose cooperative procedures enable a mutual *teaching and learning*. This apprenticeship and “enskilment” emerges from the needs and possibilities of a continuous reciprocal assistance, together with sequential repair and coordination of the interactive dynamic (Goodwin 2013; Rawls / Mann 2015).

The *physical anchoring* of media-related skills and the *material anchoring* of technical “extensions” take place via the same procedures and on the basis of mutual teaching and learning (Mohn / Wiesemann 2007). Techniques and technology, media techniques and media technology, all require consistently available bodily engagement, without which they would lose their functionality. In the case of modern media, this bodily engagement—for example in repair and maintenance, but also in programmers’ “communities of practice” (Knuth 1974; Naur 2001)—does not transpire as a result of separation but through interconnections and mutual delegations of interaction and telecommunication, through processing and usage (i.e. production and reception), automatization and skills, signal transport and material transport (Schubert 2011). Not to forget: in their mutual making, not in their “ready-made” state of affairs.

Only in and between such “communities of practice” are *technical innovations* possible. One of their typical forms, in both the field of programming and in those of earlier media inventions, consists of what von Hippel has termed the “functional source of innovation” (Von Hippel 1988; Shinn 2005). The emergence of cooperatively developed solutions to problems initially occurs in the context of obstacles emerging in the course of work or during technical meetings between different branches, first through preliminary and later through regulated technical facili-

ties, which are first generalised as specialized technical solutions in order to be later potentially universally marketed or transformed.

Kjeld Schmidt, a specialist in socio-informatics, has established a generalisation of media theory for the realm of interactive and collaborative computing, which may allow us to situate the most enduring and most successful digital media inventions within the framework of a theory of non-public media in their making:

What today, typically, is conceived of a “computing”, namely, “personal computing”, initially developed as a technology for facilitating large-scale cooperative work activities (initially air defense, later air traffic control and airline reservations) in order to deal with the problem that had become too complex to be performed by conventional means of the coordination of cooperative work, manual or mechanical. The technology of interactive computing subsequently branched out in all directions, ranging from interactive human-computer systems such as workstations, laptop computers, and smartphones, to “embedded” computing devices for the purpose of controlling machinery such as machining stations, car engines, and washing machines, in which the computing device “interacts” with mechanical or other environmental entities.

Important paradigms of interactive computing applications were developed in ways that have remarkable similarities: they were built by practitioners as practical techniques for their own use or for the use of their colleagues, and later generalized. (Schmidt 2015: 156)

7. Infrastructural Media

These revisions in media theory were initially developed mostly in research facilities dedicated to media-supported or technically equipped work. On the one hand, this was beneficial because the relevant results were presented with the unmistakable seriousness of empirically demonstrated “work requirements”. Furthermore, the work was and is

undertaken in a highly reflexive fashion as far as the methodology was concerned: as a media-supported analysis and design of media-based work, in other words as a practical analysis of media practices. Nevertheless, the concentration on media-supported work resulted in a number of shortcomings on several levels: On the one hand, as mentioned above, today all areas of everyday life have felt the impact of digital networking, whose organizational forms seemed to previously only pertain to computerized work. At the same time, however, the constitution of work processes in digital media has experienced a shift, as many media practices now exist apart from places of work and without suitable payment or financial motivation while competing or interacting with paid or unpaid work processes.

Consequently, the results are also significant for the realm of “computer-supported cooperative work”: will the basic concept of work now be decentred (Schmidt 2011), or indeed must it be decentred to newly adjust or to precisely define what stands at its centre, namely “work”? Even for current work-centred media (not to mention everyday digital media and platforms) it has now become necessary to take a step back and put forward a weaker concept with a wider scope, so as to allow to do without the term of work. This would justify the introduction of the term of “media in their making” or “media engaged in mutual making” as outlined above, to encapsulate the most mundane dimension of digital and historical media practices. However, the ongoing *dissolution of boundaries* between and the relativization of forms of media work also demands a more precise *historicization* of modern work practices. In order to characterize those current media practices that unfold far away from contexts of work and elsewhere undermine traditional forms of work (especially in the realm of digital social media), it seems particularly necessary to characterize the historical emergence of the special qualities of modern media of work. It is only then that a specific linkage between infrastructures and publics becomes evident, a connecting element which has been largely neglected by researchers and media theorists alike.

Since the systematic connection established between the rail and telegraph services (Beniger 1989), modern work media, like all media in their making, have been developed in localized interaction, while at the same time enabling a form of circulation that allows for hierarchically organised changes of scale (Gießmann 2014). The key to a mediation between localized interaction and specialized scaling lies in both standardization (Busch 2013) and bureaucratization (Yates 1989), and especially in techniques of identification and registration (Caplan 2005; About et al. 2013). Only continuously wielded techniques of identification and registration (i.e. media practices) allow administrations, on the one hand, an anonymization and a cooperative processing of circulating, reproduced, and assessed documents and data (to the point of enabling statistical evaluations). On the other hand, they make possible the verifiable referentiality or “traceability” of individual procedures (especially addresses and individual “dispatch” of goods, messages, and persons, or of individual services and contracts). Since the late 19th century, modern work-centred media have thus contained a mass-media aspect, namely the anonymization and aggregation of collectively gathered data and its assessment, but based on the simultaneous establishment of a “mass individualizing” reference-building and “traceability,” created via localized interactions and suitable media in their making.

There are thus good reasons to call this section of modern work-centred media “infrastructural media.” Firstly, the relevant work-centred media and their paths of circulation presume already existing modern infrastructures of transport and supply and hitch on to them (Braun 1991; Edwards et al. 2007). Moreover, modern work-centred media are created and used not only within organisations of work but also within the *administration* of working processes (Yates 1989). At least since the “second industrial revolution,” modern work-centred media—in business, technology, science, the universities, and in the realm of the mass media—have been characterised by a progressive proliferation and differentiation of administered work (Galambos 2005, 1983, 1970). Since the

nineteenth century, new media techniques have been able to count on the steady demand for more efficient ordering, transmitting, and duplicating techniques (Yates 1991) that, at the same time, guaranteed easier coordination, delegation, and registration. The proliferation of administered work since the 19th century was based on new technologies of reproduction and transmission as well as on the improvement of reference-building. It was only through the work-intensive and costly stabilization of techniques of identification and registering, that those quantitative assessments, aggregates, and variables, whose surveying and calculation—in the interplay of official and non-official programs, their avoidances, and appropriations—enabled the media history of computerization (especially in the use of censuses and life insurance [Yates 2008]), from individual data to statistical data and from computing these data to punch-cards and mainframe computers.

From a technical and socio-technical perspective, the thrust in innovation of both modern analogue mass media in the late nineteenth century as well as of the digital media emerging after World War II (Haigh 2003) developed in the wake of an already ongoing proliferation of infrastructural media. This fact, very much in line with classical media theory, might provide grounds for a possible “infrastructural inversion” of media history:

Take a claim that has been made by advocates of a particular science/technology, then look at the changes that preceded or accompanied the effects claimed and see if they are sufficient to explain those effects—then ask how the initial claim came a posteriori to be seen as reasonable. (Bowker 1994: 235)

For the case at hand, this would mean prioritizing the basis of non-public work-centred media vis-à-vis public media in both a historical and conceptual framework, in order to research the relationship between infrastructural and public media in a more systematic fashion. Apart from

American media research within the framework of business history (Chandler / Cortada 2000; John 2010; Starr 2005), however, the programme for such a media history has neither been completed nor become common currency in contemporary media research. The far more complicated history of European and non-European media has, until now, not been able to follow this paradigm. This presents researchers with the opportunity and challenge to also explore, in part comparatively, important facets of European and intercontinental media history in the realms of non-public work-centred media and their later computerization, in this way correcting the asymmetries of North American research. Where is a comparative history of European administrative media? And of their globalization?

8. The Longue Durée of the Digital Present

The theory and historiography of digital media is in a state of upheaval. During the 1980s and 1990s, the rise of digital and digitally networked media was marked by the promise of an epochal turn whose similarity to earlier media revolutions (especially book printing and analogue mass media) was underscored. In the work of several media theorists, this sea-change, at the same time, seemed to herald an eschatological “end of the media” (Kittler 1986), annulled within the universal medium of the computer. The elements of this diagnosis, which encountered considerable scepticism in other parts of Germany (Winkler 2004), have all been modified, although, or precisely because the penetration of all areas of life by digitally networked media continues apace. An end of media development is presently no more foreseeable than an end of history. The modifications of the above-mentioned diagnosis is most apparent in the theory of computerization and of the computer, with a dictum of Michael S. Mahoney now prevailing in the “history of computing”:

The computer thus has little or no history of its own. Rather, it has histories derived from the histories of the groups of practitioners who saw in it, or in some yet to be envisioned form of it, the potential to re-

alise their agendas and aspirations. What kinds of computers we have designed since 1945, and what kinds of programs we have written for them, reflect not so much the nature of the computer as the purposes and aspirations of the communities who guided those designs and wrote those programs. (Mahoney 2005: 119)

This shift from a history of the computing machine to a socio-technical history of computing, and from a history of invention of the Internet to a history of networking (Russell 2012) has had several consequences. Meanwhile, in order to understand the digital epochal threshold, we are helped less by an emphasis on ongoing discontinuities or a comparison with past media upheavals than by a registering of the long-lasting socio-technical continuities from which past and present “agendas and aspirations” of computerization and digital networking have drawn their effectiveness.

In a way, the perspective has been reversed. The prognosis of the 1980s and 1990s was that as a “universal medium”, the computer would take control of all existing media and thus bring about an “end of the media” or at least cause their “convergence”. To the extent that such a process really took place, previous media were transformed into digital formats on mobile platforms and entered into unpredicted combinations. Their media practices have taken possession of the computer and continue their own history under new and changing conditions—with the consequence for research in media history to be forced to orient itself toward other basic units and their continuities (e.g. toward a history of cooperative computing capacities and their practices and formats [Campbell-Kelly et al. 2003], instead of a chronology of computing machines). And because the individual or networked computer remains a “protean” machine only capable of definition through the features of its practical usage, the idea of the computer as a universal medium has largely lost its currency. Rather, the focus is on the emergence of steadily new computerized media practices that, because of their interactivity, networking, and mobility, can

only be examined to a limited degree in the computer itself. Current research has responded to this altered situation with a stronger and more experimental approach to the media ethnography of digital media practices, meant to explore such practices as they unfold between online and offline contexts; at the same time, with historical work on the continuities manifest in the present state of computerization.

The question of the interfaces between infrastructures and publics (see section 3.) is especially suited for addressing both the continuities and present turnarounds in computerization. This question leads to the insight that the emergence of nineteenth century infrastructural work-centred media constituted an epochal threshold signifying a transformation of modern public media which has yet to be sufficiently explored in research. Without understanding this transformation, the present period of digitally networked media, too, cannot be historically fully understood. Infrastructural work-centred media (see section 7) contain, on the one hand, localized interactive sequences with their situated “skills”, “communities of practice”, and “established procedures” and, on the other, standardizations and bureaucratic procedures involving an anonymization and duplication of circulating documents and data. Modern bureaucratic procedures are based on massively produced boundary objects (Star / Griesemer 1989), especially forms; the reports they produce can be in the mode of internally circulating media or media available to the outside world, extending from handwritten notes to printed and published editions. But because of the underlying media of identification and registration, the process of anonymization and duplication at play here remains reversible: all participating individuals, administrations, and work procedures are meant to remain legally accountable (Vismann: 2000). Much of the appropriation of new media technology is aimed at generating or restoring the manageability and legal accountability of interactive procedures, for example in the financial realm both around 1900 and at present (Preda 2007). Individual references to specific persons, things or deliveries are lost in statistical aggregations, but

they are maintained to make each transmission accountable and traceable, and statistical and data aggregations rely on their existence. It's a prestabilized harmony of identification and aggregation, registration and computing, forged not in heaven but in our modern institutions and organisations.

Even modern mass media themselves are not only administered but also produced via administered work. Both the establishment of modern administrative media and the form of production of mass media have thus been characterized by a double nature comprising a step-by-step transformation of localized work-centred media up to the point of publication, and by identification and registration techniques and administrative steps subject to legal control. For modern mass media, this documentation reveals clear parallels with other bureaucratized domains of working life, which have, however, only rarely been researched in the framework of "production studies" (Powdermaker 1950; Hennion / Méadel 2013), especially principal-agent-relationships and their contracts and accountabilities. For nearly a century, infrastructural work-centred media and public mass media and telecommunications media seemed to occupy two different worlds or faces of a planet, and only one side, the face turned toward the product, the audience and the public service, was treated as the "world of the media." A medium only became a medium by being a means of mass communication—in short, a mass medium—in publicly accessible form, while research of its non-public production and socio-technical being-in-the-making remained in darkness.

The genealogy of digitally networked media only becomes historically more plausible when infrastructural media and public media are seen in their historical correlation; this is particularly the case for the all-penetrating presence and digital ubiquity of techniques of identification and registration. The socio-technical foundations for digital media and computerization consisted of a production of documents and data that could be rendered anonymous and collective, but based on referential techniques of identification and registration (Deibert 2009; Engemann 2003;

Haigh 2003; Schröter 2004). In line with this double nature, over a few short years, digitally networked media became capable of integrating all past mass media, in order to develop new mass-media practices along this path. However, this development came at the price of a fully infrastructured organisational form, whose history and prehistory was largely unknown and seemed innocuous enough because of our ignorance. From the outset, the basis of digital networking consisted of techniques of identification and registration, without which, for instance, neither the digital administration of addresses, the legally monitored delivery of goods and digital mail, nor digital financial transactions and the mail-order business would have become possible. This foundation and its consolidation through sensor systems and databanks results in the four classical dichotomies of media theory only pertaining to digitally networked media on a case-by-case basis—which is to say no longer being able to signify an essential definition of developing media practices. They are pertinent:

- i) most prominently in the case of the separations between production, distribution, and reception that could be easily undercut (Ochsner et al. 2013) or cooperatively undersold in the framework of the Internet's end-to-end-architecture (Gillespie 2006);
- ii) just as strikingly in respect to the invalidity of the dichotomy between interaction and telecommunication, annulled through both sensor systems and media technologies and practices of a mobilised referentialities of place, time, and person; an “explosion of place” (Graham 1998) that would have signified no surprise for either media in their making or for infrastructural media, but that came as a big surprise for all expectations concerning an “overcoming of time and space” or “space-time compression”.
- iii) equally effectively with respect to the annulment of the dichotomy between delivered information and referential objects and persons, on the same basis (Busch 2011), extending to the possible personalization of every delivery and the cleverness of our “filter bubbles”;

iv) and regarding the postulated separation of physical skill and automatisms that, both for users and programmers, has shifted into the opposite of a mix composed of stabilizable skills and instable semi-automatisms (Gaver 1992; Vincente et al. 2001).

Despite these four revisions, now commonplace in the research literature under various fashionable designations, classical mass-media separations between production and reception also evidently exist on the Internet. In its first popular years, the Internet world appeared—partly on the basis of an orientation and maintenance dominated by academic values of egalitarian accessibility—as an optimized mass-media infrastructuring that promised a transparent formation of publics, together with increased market transparency. For the time being, the conditions for this mass-media infrastructuring have been maintained, albeit in a context marked by the steady erosion of the interim assumptions of transparency, equality, and anonymity. The mass-mediality of the Internet has unfolded on the basis of its bureaucratic setup: with the meanwhile generally known dangers of data mining that has become inter-operable and of the permeability of a security architecture that has been weak from the start in face of interested third parties who have turned out to be technically and institutionally superior.

In hindsight, and in the midst of this most deeply problematic media world—our present and its future—the mass media of the past and present appear in the light of their historical fragility and improbability: as public enclaves or, more precisely, as institutionally guaranteed or illegally realized exclaves only maintainable through technically and institutionally standardized practices of separation between interaction and telecommunication, production and reception. This practical “infrastructural inversion” (Bowker 1994: 235) of media history and historiography offers good reasons to newly study the intercontinental history and the present of the institutional and technical guarantees that facilitated anonymization and egalitarian participation, dis-identifica-

tion and un-registration in the epoch of earlier mass media—in order to restore them in an unknown media future, if possible and if it's not too late.

Notes

1 This article was written in the framework of preparation of the special research project “Media of Cooperation” in 2015. I would like to thank all project participants and its preparatory group for the cooperative work, especially Volker Wulf, Lene Faust, Sebastian

Gießmann, Christian Henrich-Franke, Christian Meyer, Wolfgang Reißmann, Gabriele Schabacher, Kjeld Schmidt, David Sittler, Nadine Taha, Tristan Thielmann, Ehler Voss, Martin Zillinger, and Cora Bender.

Bibliography

About, Ilsen / Brown, James R. / Longergan, Gayle (eds.) (2013): *Identification and Registration Practices in Transnational Perspective. People, Papers and Practices*. New York: Palgrave Macmillan.

Bailey, Diane E. / Leonardi, Paul M. / Barley, Stephen R. (2012 [2011]): “The Lure of the Virtual”, in: *Organization Science* 23 (5), pp. 1485–1504.

Baringhorst, Sigrid (2014): “Internet und Protest. Zum Wandel von Organisationsformen und Handlungsreper-toires”, in: Voss, Kathrin (ed.): *Internet & Partizipation. Bottom-up oder Top-down?* Wiesbaden: VS Verlag, pp. 91–114.

Bechky, Beth A. (2003): “Object Lessons: Workplace Artifacts as Representations of Occupational Jurisdiction”, in: *AJS* 109 (3), pp. 720–752.

Beniger, James R. (1989): *The Control Revolution. Technological and Economic Origins of the Information Society*. Cambridge: Harvard University Press.

Berg, Marc / Bowker, Geoffrey (1997): “The Multiple Bodies of the Medical Record”, in: *The Sociological Quarterly*, 38 (3), pp. 513–537.

Bergmann, Jörg (2006): “Studies of Work”, in: Ayaß, Ruth / Bergmann, Jörg (eds.): *Qualitative Methoden der Medienforschung*. Reinbek: Rowohlt, pp. 391–405.

Binczek, Natalie / Stanitzek, Georg (eds.) (2010): *Strong ties / Weak ties: Freundschaftssemantik und Netzwerktheorie*. Heidelberg: Winter.

- Boltanski, Lue / Thévenot, Laurent (1991):** *De la Justification. Les Economies de la Grandeur*. Paris: Gallimard.
- Bosse, Heinrich (2015):** "Öffentlichkeit im 18. Jahrhundert, Habermas revidiert", in: *Navigationen* 15 (1), pp. 81–98.
- 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: Cengage Learning EMEA, pp. 231–247.
- Bratman, Michael E. (1992):** "Shared Cooperative Activity", in: *The Philosophical Review* 101 (2), pp. 327–341.
- Braun, Ingo (1991):** *Geflügelte Saurier. Systeme zweiter Ordnung: ein Verflechtungsphänomen großer technischer Systeme*. Berlin: WZB.
- Busch, Lawrence (2011):** *Standards. Recipes for Reality*. Cambridge: MIT Press.
- Campbell-Kelly, Martin / Croarken, Mary / Flood, Raymond / Robson, Eleanor (eds.) (2003):** *The History of Mathematical Tables: From Sumer to Spreadsheets*. Oxford: Oxford University Press.
- Caplan, Jane (2005):** "Individual Identity Documentation: A Historical Overview", Conference on Ethical and Social Implications of Biometric Identification Technology, Brüssel.
- Carpenter, Edmund (1960):** "Introduction", in: Carpenter, Edmund / McLuhan, Marshall (eds.): *Explorations in Communication*. Boston: Beacon Press, pp. ix–xii.
- Chandler, Alfred D. / Cortada, James W. (2000):** *A Nation Transformed by Information, How Information Has Shaped the United States from Colonial Times to the Present*. Oxford: Oxford University Press.
- Chandler, Alfred D. (1977):** *The Visible Hand: The Managerial Revolution in American Business*. Cambridge: Belknap Press of Harvard University Press.
- Collins, Harry / Pinch, Trevor (2000):** *Der Golem der Technologie. Wie unsere Wissenschaft die Wirklichkeit konstruiert*. Berlin: Berlin Verlag.
- Collins, Harry / Pinch, Trevor (1999):** *Der Golem der Forschung. Wie unsere Wissenschaft die Natur erfindet*. Berlin: Berlin Verlag.
- Couldry, Nick / Hobart, Mark (2010):** "Media as Practice: A Brief Exchange", *Criticalica.org*, <http://www.criticalica.org/Sources/Media%20as%20practice%20-%20the%20CouldryHobart%20exchange.pdf> [15.06.2015].
- Crowther-Heyck, Hunter (2005):** *Herbert A. Simon: The Bounds of Reason in Modern America*. Baltimore: Johns Hopkins University Press.
- Deibert, Ronald J. (2009):** "The Geopolitics of Internet Control. Censorship, Sovereignty, and Cyberspace", in: Chadwick, Andrew / Howard, Philip N. (eds.): *Routledge Handbook of Internet Politics*. New York: Routledge, pp. 323–336.
- Dewey, John (2012 [1927]):** *The Public and its Problems. An Essay in Political Inquiry*. University Park: Penn State University Press.
- Döring, Jörg / Thielmann, Tristan (2009):** *Mediengeographie. Theorie – Analyse – Diskussion*. Bielefeld: transcript.

- Edwards, Paul N. / Jackson, Steven J. / Bowker, Geoffrey C. / Knobel, Cory P. (2007):** "Understanding Infrastructure: Dynamics, Tension, and Design, Report of a Workshop on 'History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures'", *pne.people*, <http://pne.people.si.umich.edu/PDF/ui.pdf> [17.05.2015].
- Engemann, Christoph (2003):** *Electronic Government – vom User zum Bürger. Zur kritischen Theorie des Internets*. Bielefeld: transcript.
- Epple, Angelika (2012):** "Globalisierung/en, Version: 1.0", in: *Docupedia-Zeitgeschichte*, 11.6.2012, <http://docupedia.de/zg/Globalisierung?oldid=106426> [17.05.2015].
- Finholt, Thomas A. (2002):** "Collaboratories", in: *Annual Review of Information Science and Technology* 36 (1), pp. 73–107.
- Fisher, Claude S. (1992):** *America Calling: A Social History of the Telephone to 1940*. Berkeley: University of California Press.
- Galambos, Louis (2005):** "Recasting the Organizational Synthesis: Structure and Process in the Twentieth and Twenty-First Centuries", in: *Business History Review* 79 (1), pp. 1–38.
- Galambos, Louis (1983):** "Technology, Political Economy, and Professionalization: Central Themes of the Organizational Synthesis", in: *Business History Review* 57 (4), pp. 471–493.
- Galambos, Louis (1970):** "The Emerging Organizational Synthesis in Modern American History", in: *Business History Review* 44 (3), pp. 279–290.
- Gaver, William W. (1992):** "The Affordances of Media Spaces for Collaboration", in: *Proceedings of CSCW'92*. New York: ACM, pp. 17–24.
- Galison, Peter (2004):** "Removing Knowledge", in: *Critical Inquiry* 31, pp. 229–243.
- Ghanbari, Nacim (2013):** "Patronage und deutsche Literatur im 18. Jahrhundert [Projektbericht]", in: *FrühneuzeitInfo* 24, pp. 95–97.
- Gerlitz, Carolin / Lury, Celia (2014):** "Social Media and Self-Evaluating Assemblages: On Numbers, Orderings and Values", in: *Distinktion: Scandinavian Journal of Social Theory* 15 (2), pp. 174–188.
- Gießmann, Sebastian (2014):** *Die Verbundenheit der Dinge. Eine Kulturgeschichte der Netze und Netzwerke*. Berlin: Kadmos.
- Gillespie, Tarleton L. (2006):** "Engineering a Principle: 'End-to-End' in the Design of the Internet", in: *Social Studies of Science* 36 (3), pp. 427–457.
- Goodwin, Charles (2013):** "The Co-operative, Transformative Organization of Human Action and Knowledge", in: *Journal of Pragmatics* 46 (1), pp. 8–23.
- Goodwin, Charles (1994):** "Professional Vision", in: *American Anthropologist* 96 (3), pp. 606–633.
- Graham, Stephen (1998):** "The End of Geography or the Explosion of Place? Conceptualizing Space, Place and Information Technology", in: *Progress in Human Geography* 22 (2), pp. 165–185.
- Greiffenhagen, Christian / Mair, Michael / Sharrock, Wes W. (2013):** "Social Studies of Social Science: A Working Biblio-

graphy", in: *National Centre for Research Methods Working Paper* 08/13.

Gusterson, Hugh (2005): "A Pedagogy of Diminishing Returns: Scientific Involvement across Three Generations of Nuclear Weapons Science", in: Kaiser, David (ed.): *Pedagogy and the practice of science: historical and contemporary perspectives*. Cambridge: MIT Press, pp. 75–107.

Habermas, Jürgen (1990): "Vorwort zur Neuauflage 1990", in: Habermas, Jürgen: *Strukturwandel der Öffentlichkeit*. Frankfurt a. M.: Suhrkamp, S. 11–50.

Habermas, Jürgen (1962): *Strukturwandel der Öffentlichkeit. Untersuchungen zu einer Kategorie der bürgerlichen Gesellschaft*. Neuwied: Luchterhand. Habilitationsschrift.

Hagemeyer, Friedrich W. (1979): *Die Entstehung von Informationskonzepten in der Nachrichtentechnik*, Berlin Freie Universität. Dissertation.

Haigh, Thomas (2003): *Technology, Information and Power: Managerial Technicians in the American Corporation: 1917–2000*, University of Pennsylvania. Dissertation.

Harrasser, Karin (2013): *Körper 2.0. Über die technische Erweiterbarkeit des Menschen*. Bielefeld: transcript.

Heath, Christian / Hindmarsh, Jon (2000): "Configuring Action in Objects: From Mutual Space to Media Space", in: *Mind, Culture, and Activity* 7 (1/2), pp. 81–104.

Hennion, Antoine (1983): "The Production of Success: An Anti-Musicology of the Pop Song", in: *Popular Music* 3, pp. 159–193.

Hennion, Antoine / Méadel, Cécile (2013): "In den Laboratorien des Begehrens: Die Arbeit der Werbeleute", in: Thielmann, Tristan / Schüttpelz, Erhard (eds.): *Akteur-MedienTheorie*, Bielefeld: transcript, pp. 341–376.

Henrich-Franke, Christian (2009): "Changing Patterns of Infrastructure Governance in the Transport and Communication Sectors in Europe", in: Auger, Jean - François / Künneke, Rolf (eds.): *Internationalization of Infrastructures*. Delft: University Press, pp. 7–30.

Hepp, Andreas / Krotz, Friedrich (eds.) (2014): *Mediatized Worlds. Culture and Society in a Media Age*. Basingstoke: Palgrave Macmillan.

Hindmarsh, Jon / Heath, Christian (2000): "Sharing the Tools of the Trade", in: *Journal of Contemporary Ethnography* 29 (5), pp. 523–562.

Hinds, Pamela J. / Bailey, Diane E. (2003): "Out of Sight, Out of Sync: Understanding Conflict in Distributed Teams", in: *Organization Science* 14 (6), pp. 615–632.

Hippel, Eric von (1988): *The Sources of Innovation*. New York: Oxford University Press.

Hitzler, Ronald (2010): "Der Goffmensch. Überlegungen zu einer dramaturgischen Anthropologie", in: Honer, Anne / Meuser, Michael / Pfadenhauer, Michaela (eds.): *Fragile Sozialität. Inszenierungen, Sinnwelten, Existenzbastler*. Wiesbaden: VS-Verlag, pp. 17–34.

Hoffmann, Dagmar (2013): "Die Kontinenz des Ästhetischen und die sozialen Arrangements von Künstlern, Designern und Amateuren im Netz", in: *Psy-*

chologie & Gesellschaftskritik 37 (2), pp. 91–112.

Hughes, Thomas P. (2012): “The Evolution of Large Technological Systems”, in: Bijker, Wibeke E. / Hughes, Thomas P. / Pinch, Trevor (eds.): *The Social Construction of Technological Systems, New Directions in the Sociology and History of Technology*. Cambridge: MIT Press, pp. 45–76.

Hutchins, Edwin / Klausen, Tove (1996): “Distributed Cognition in an Airline Cockpit”, in: Engeström, Yrjo / Middleton, David (eds.): *Cognition and Communication at Work*. New York: Cambridge University Press, pp. 15–34.

Ingold, Tim (2000): *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill*. London: Routledge.

John, Richard R. (2010): *Network Nation: Inventing American Telecommunications*. Cambridge: Belknap Press.

Johns, Adrian (2012): “Gutenberg and the Samurai: Or, The Information Revolution is History”, in: *Anthropological Quarterly* 85 (3), Summer, pp. 859–883.

Johns, Adrian (2009a): “Changes in the World of Publishing”, in: Chandler, James (ed.): *The Cambridge History of English Romantic Literature*. Cambridge: Cambridge University Press, pp. 377–402.

Johns, Adrian (2009b): *Piracy. The Intellectual Property Wars From Gutenberg to Gates*. Chicago: Chicago University Press.

Johns, Adrian (2007): “The Identity Engine: Printing and Publishing at the Beginning of the Knowledge Economy”, in: Roberts, Lissa L. / Schaffer, Simon / Dear, Peter: *The Mindful Hand: Inquiry*

and Invention from the Late Renaissance to Early Industrialisation, The Cambridge History of English Romantic Literature. Chicago: University of Chicago Press, pp. 403–428.

Johns, Adrian (1998): *The Nature of the Book. Print and Knowledge in the Making*. Chicago: Chicago University Press.

Joyce, Patrick (2009): “What Is the Social in Social History?”, in: *Past and Present* 205, pp. 175–210.

Kittler, Friedrich A. (1986): *Grammophon, Film, Typewriter*. Berlin: Brinkmann & Bose.

Klass, Nadine (2013): “Das Urheberrecht unter Druck”, in: Euman, Jan M. / Gerlach, Frauke / Rößner, Tabea / Stadelmaier, Martin (eds.): *Medien, Netz und Öffentlichkeit – Impulse für die digitale Gesellschaft*. Essen: Klartext Verlagsgesellschaft, pp. 195–202.

Knuth, Donald E. (1974): “Computer Programming as an Art”, in: *Communications of the ACM* 17 (12), pp. 667–673.

Körber, Esther-Beate (2008): “Vormoderne Öffentlichkeiten. Versuch einer Begriffs- und Strukturgeschichte”, in: Böning, Holger / Kutsch, Arnulf / Stöber, Rudolf (eds.): *Jahrbuch für Kommunikationsgeschichte*, Band 10. Stuttgart: Franz Steiner Verlag, pp. 3–25.

Kolb, Andreas / Barth, Erhardt / Koch, Reinhard / Larsen, Rasmus (2010): “Timeof-Flight Cameras in Computer Graphics”, in: *Computer Graphics Forum* 29 (1), pp. 141–159.

Krämer, Sybille / Bredekamp, Horst (2013 [2003]): “Culture, Technology, Cultural Techniques – Moving Beyond Text” (engl. Version von Krämer, Sybille / Bre-

dekamp, Horst: Kultur, Technik, Kulturtechnik: Wider die Diskursivierung der Kultur, 2003), in: *Theory, Culture & Society* 30 (6), pp. 20–29.

Kraft, Claudia (2006): "Paradoxien der Emanzipation. Regime, Opposition und Geschlechterordnungen im Staatssozialismus seit den späten 1960er-Jahren", in: *Zeithistorische Forschungen / Studies in Contemporary History*, Online-Ausgabe 3 (3), Zeithistorische Forschungen, <http://www.zeithistorische-forschungen.de/16126041Kraft-3-2006> [15.06.2015].

Kümmel, Albert / Schüttpelz, Erhard (eds.) (2003): *Signale der Störung*. München: Wilhelm Fink.

Larkin, Brian (2013): "The Politics and Poetics of Infrastructure", in: *Annual Review of Anthropology* 42, pp. 327–343.

Latour, Bruno (2006): "Drawing Things Together: Die Macht der unveränderlich mobilen Elemente", in: Belliger, Andréa / Krieger, David J. (eds.): *ANTHology. Ein einführendes Handbuch zur Akteur-Netzwerk-Theorie*. Bielefeld: transcript. pp. 259–308.

Latour, Bruno (2002): "Iconoclasm. Gibt es eine Welt jenseits des Bilderkriegs?", in: Latour, Bruno / Weibel, Peter (eds.): *Iconoclasm*. Cambridge: MIT Press, S. 14–37.

Latour, Bruno (1987): *Science in Action. How to Follow Scientists and Engineers through Society*. Cambridge: Harvard University Press.

Laurier, Eric (2004): "The Spectacular Showing: Houdini and the Wonder of Ethnomethodology", in: *Human Studies* 27 (4), pp. 377–399.

Laurier, Eric (2001): "Why People Say Where They are During Mobile Phone Calls", in: *Environment and Planning D: Society and Space* 19, pp. 485–504.

Lave, Jean / Wenger, Etienne (1991): *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Leeds-Hurwitz, Wendy (ed.) (2010): *The Social History of Language and Social Interaction Research*. Cresskill: Hampton Press.

Ludwig-Mayerhofer, Wolfgang / Sondermann, Ariadne (2010): "BAC, BuB, VerBIS & Co.: Neue Wissensformen in der öffentlichen Arbeitsverwaltung und die Entwertung naturwüchsigen Wissens", in: Soeffner, Hans-Georg (ed.): *Unsichere Zeiten. Herausforderungen gesellschaftlicher Transformationen. Verhandlungen des 34. Kongresses der Deutschen Gesellschaft für Soziologie in Jena 2008*. Wiesbaden: Verlag für Sozialwissenschaften.

Luhmann, Niklas (2000 [1996]): *The Reality of Mass Media*. Transl. Kathleen Cross. Stanford: Stanford Univ. Press.

MacDougall, Robert (2003): "The People's Telephone: The Political Culture of Independent Telephony, 1894–1913", in: *Business and Economic History Online* 1, *Business and Economic History*, http://www.thebhc.org/sites/default/files/MacDougall_0.pdf [15.06.2015].

Mahoney, Michael S. (2005): "The Histories of Computing(s)", in: *Interdisciplinary Science Reviews* 30 (2), pp. 119–135.

Mann, Michael (1986): *The Sources of Social Power. Vol. 1: A History of Power*

from the Beginning to AD 1760. Cambridge: Cambridge University Press.

Mann, Michael (1993): *The Sources of Social Power. Vol. 2: The Rise of Classes and Nation States, 1760–1914.* Cambridge: Cambridge University Press.

Marres, Noortje / Rogers, Richard (2005): "Recipe for Tracing the Fate of Issues and their Publics on the Web", in: Latour, Bruno / Weibel, Peter (eds.): *Making Things Public: Atmospheres of Democracy.* Cambridge: MIT Press, pp. 922–935.

Marres, Noortje / Veltevrede, Esther (2013): "Scraping the Social? Issues in Live Social Research", in: *Journal of Cultural Economy* 7 (3), pp. 313–335.

Marrou, Henri-Irénée (1948): *Histoire de l'éducation dans l'Antiquité.* Paris: Éditions du Seuil.

Marshall, Robert C. (ed.) (2010): *Cooperation in Social and Economic Life.* Lanham / New York / Toronto: AltaMira Press.

Martus, Steffen / Spoerhase, Carlos (2009): "Praxeologie der Literaturwissenschaft", in: König, Christoph / Lopper, Marcel (eds.): *Geschichte der Germanistik* 35/36, pp. 89–96.

McLuhan, Marshall (1954): "Media as Art Forms", in: *Explorations* 2, pp. 6–13.

McLuhan, Marshall (2011 [1964]): *Understanding Media. The Extensions of Man.* Berkeley: Gingko Press.

Mohn, Bina E. (2002): *Filming Culture. Spielarten des Dokumentierens nach der Repräsentationskrise*, Bd. 3 der Buchreihe 'Qualitative Soziologie'. Stuttgart: Lucius&Lucius Verlag.

Mohn, Bina E. / Wiesemann, Jutta (eds.) (2007a): *Handwerk des Lernens. Kamera-ethnographische Studien zur verborgenen Kreativität im Klassenzimmer.* Göttingen: IWF Wissen und Medien.

Mol, Annemarie (2002): *The Body Multiple: Ontology in Medical Practice.* Durham / London: Duke University Press.

Morley, David (2011): "Communications and Transport: The Mobility of Information, People and Commodities", in: *Media, Culture & Society* 33 (5), pp. 743–759.

Morley, David (1980): *The Nationwide Audience: Structure and Decoding.* London: British Film Institute.

Müller, Claudia / Pipek, Volkmar / Reuter, Christian (2010): "Globale Infrastruktur – lokales Arbeiten: Praxis IT-gestützter Wartung bei einem Energieversorger", in: Ziegler, Jürgen / Schmidt, Albrecht (eds.): *Mensch & Computer 2010.* München: Oldenbourg Verlag, pp. 37–46.

Naur, Peter (2001): "Programming as Theory Building", in: Cockburn, Alistair (ed.): *Agile Software Development.* Bonn: Addison-Wesley, pp. 227–239.

Nelkin, Dorothy (1979): *Controversy: Politics of Technical Decision.* Beverly Hills: Sage.

Ochsner, Beate / Otto, Isabell / Spöhrer, Markus (eds.) (2013): "Objekte medialer Teilhabe", in: *AugenBlick* 58, Sonderheft 'Objekte medialer Teilhabe', pp. 5–11.

Peters, John D. (2005): *Courting the Abyss: Free Speech and the Liberal Tradition.* Chicago: University of Chicago Press.

Pickering, Andrew (2007): *Kybernetik und Neue Ontologien*. Berlin: Merve-Verlag.

Pipek, Volkmar / Wulf, Volker (2009): "Infrastructuring: Towards an Integrated Perspective on the Design and Use of Information Technology", in: *Journal of the Association of Information Systems (JAIS)* 10 (5), pp. 306–332.

Potthast, Jörg (2007): *Die Bodenhaftung der Netzwerkgesellschaft. Eine Ethnografie von Pannen an Großflughäfen*. Bielefeld: transcript.

Powdermaker, Hortense (1950): *Hollywood: The Dream Factory. An Anthropologist Looks at the Movie Makers*. London: Little, Brown and Company.

Preda, Alex (2007): "Technology and Boundary-Marking in Financial Markets", in: *Economic Sociology. The European Electronic Newsletter* 8 (3), *Economic Sociology_The European Website*, http://econsoc.mpifg.de/archive/econ_soc_08-3.pdf [17.05.2015].

Rammert, Werner / Schubert, Cornelius (2006): *Technografie. Zur Mikrosoziologie der Technik*. Frankfurt a. M.: Campus.

Rawls, Anne W. / Mann, David (2015): "Getting Information Systems to Interact: The Social Fact Character of 'Object' Clarity as a Factor in Designing Information Systems", in: *The Information Society* 31 (2), pp. 175–192.

Reckwitz, Andreas (2003): "Grundelemente einer Theorie sozialer Praktiken. Eine sozialtheoretische Perspektive", in: *Zeitschrift für Soziologie* 32 (4), pp. 282–301.

Reißmann, Wolfgang / Nedic, Antonela / Hoffmann, Dagmar (2013): "Wenn ich

in den Spiegel gucke, soll es noch ein kleines bisschen ästhetisch aussehen". Eine Fallstudie zum Verhältnis von Körpererleben, Schönheitshandeln und Medienaneignung im Lebensverlauf", in: Schwender, Clemens / Hoffmann, Dagmar / Reißmann, Wolfgang (eds.): *Screening Age. Medienbilder – Stereotype – Altersdiskriminierung*. München: kopead, pp. 217–236.

Ribes, David (2014): "Ethnography of Scaling. Or, How to Fit a National Research Infrastructure in the Room", in: *CSCW'14 Proceedings of the 17th ACM conference on Computer Supported Cooperative Work & Social Computing*. New York: ACM, pp. 158–170.

Ribes, David / Finholt, Thomas A. (2009): "The Long Now of Technology Infrastructure: Articulating Tensions in Development", in: *Journal of the Association for Information Systems* 10 (5), pp. 375–398.

Roch, Axel (2009): *Claude E. Shannon. Spielzeug, Leben und die geheime Geschichte seiner Theorie der Information*. Berlin: gegenstalt Verlag Berlin.

Rohde, Markus (2013): "Trust in Electronically-Supported Networks of Political Activists", Workshop-paper, in: *Proceedings of ACM Conference on Computer Supported Cooperative Work (CSCW)*. New York: ACM-Press.

Rottenburg, Richard (2002): *Weit hergeholte Fakten. Eine Parabel der Entwicklungshilfe*. Stuttgart: Lucius & Lucius.

Russell, Andrew L. (2012): "Histories of Networking vs. the History of the Internet", paper presented at the 2012 SIGCIS Workshop, College of Arts & Let-

ters, Stevens Institute of Technology, 7. Oktober, <http://arussell.org/papers/russell-SIGCIS-2012.pdf> [17.05.2015].

Schabacher, Gabriele (2013a): "Medium Infrastruktur. Trajektorien soziotechnischer Netzwerke in der ANT", in: *ZMK 4* (2), pp. 129–148.

Schabacher, Gabriele (2013b): "Medien und Verkehr. Zur Genealogie des Übertragungswissens zwischen Personen, Gütern und Nachrichten", in: *Tumult. Schriften zur Verkehrswissenschaft* 39, pp. 39–55.

Schatzki, Theodore R. / Knorr, Cetina, K. / Savigny, Eike von (2001): *The Practice Turn in Contemporary Theory*. London / New York: Routledge.

Schmidt, Kjeld (2015a): "Von niederer Herkunft", in: *Zeitschrift für Medienwissenschaft* 12, pp. 140–156.

Schmidt, Kjeld (2015b): "Of Humble Origins: The Practice Roots of Interactive and Collaborative Computing", in: *ZfM Web Extra*, <http://www.zfmedienwissenschaft.de/online/humble-origins> [17.05.2015].

Schmidt, Kjeld (2015c): "'Practice Must Speak for Itself'. Remarks on the Concept of Practice", in: *Navigationen* 15 (1), pp. 99–115.

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

Schröter, Jens (2004): *Das Netz und die virtuelle Realität. Zur Selbstprogrammierung der Gesellschaft durch die universelle Maschine*. Bielefeld: transcript.

Schüttpelz, Erhard (2015): "Skill, Deixis, Medien", in: Voss, Christiane / Engell, Lorenz (eds.): *Mediale Anthropologie*. Paderborn: Wilhelm Fink, pp. 153–182.

Schüttpelz, Erhard (2002): "'Get the Message Through'. Von der Kanaltheorie der Kommunikation zur Botschaft des Mediums: Ein Telegramm aus der nordatlantischen Nachkriegszeit", in: Schneider, Irmela / Spangenberg, Peter M. (eds.): *Medienkultur der Fünfziger Jahre*. Opladen: Westdeutscher Verlag, pp. 51–76.

Schubert, Cornelius (2011): "Die Technik operiert mit. Zur Mikroanalyse medizinischer Arbeit", in: *Zeitschrift für Soziologie* 40 (4), pp. 174–190.

Shinn, Terry (2005): "New Sources of Radical Innovation. Research technologies, Transversality, and Distributed Learning in a Post-industrial Order", in: *Social Science Information* 44 (4), pp. 731–764.

Siebert, Bernhard (2013): *Cultural Techniques: Or the End of the Intellectual Postwar Era in German Media Theory*. London: Sage.

Simone, AbdouMaliq (2004): "People as Infrastructure: Intersecting Fragments in Johannesburg", in: *Public Culture* 16 (3), pp. 407–429.

Sismondo, Sergio (2010 [2004]): *An Introduction to Science and Technology Studies*. Chichester: Wiley-Blackwell Publishing.

Slayton, Rebecca (2013): "Efficient, Secure Green: Digital Utopianism and the Challenge of a 'Smart' Grid", in: *Information and Culture* 48 (4), pp. 448–478.

- Smith, Pamela H. (2009):** "Science on the Move: Recent Trends in the History of Early Modern Science", in: *Renaissance Quarterly* 62 (2), pp. 345–375.
- Star, Susan L. / Bowker, Geoffrey C. (2002):** "How to Infrastructure", in: Lievrouw, Leah A. (ed.): *Handbook of New Media*. London: Sage, pp. 151–162.
- Star, Susan L. (2015):** "Die Struktur schlecht strukturierter Lösungen. Grenzobjekte und heterogenes verteiltes Problemlösen", in: *Navigationen* 15 (1), pp. 57–78.
- Star, Susan L. / 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.
- Starr, Paul (2005):** *The Creation of the Media: Political Origins of Modern Communications*. New York: Basic Books.
- Sterelny, Kim (2012a):** *The Evolved Apprentice. How Evolution Made Humans Unique*. Cambridge: MIT Press.
- Sterelny, Kim (2012b):** "Cooperation, Culture and Conflict", Vortragsmanuskript zur Veranstaltung 'Cultural evolution – patterns of cultural change and diversification' in Stockholm, 12.–15. September 2012, <http://www.philbio.org/wp-content/uploads/2012/09/Sterelny-Kim-2012-CooperationCulture-and-Conflict.pdf> [15.06.2015].
- Strübing, Jörg / Schulz-Schaeffer, Ingo / Meister, Martin / Gläser, Jochen (eds.) (2004):** *Kooperation im Niemandsland, Neue Perspektiven auf Zusammenarbeit in Wissenschaft und Technik*. Wiesbaden: Springer.
- Tenger, Zeynep / Trolander, Paul (2010):** "From Print versus Manuscript to Social Authorship and Mixed Media: A Review of Trends in the Scholarship of Early Modern Publication", in: *Literature Compass* 7 (11), pp. 1035–1048.
- Thielmann, Tristan (2014):** "Mobile Medien", in: Schröter, Jens (ed.): *Handbuch Medienwissenschaft*. Stuttgart: Metzler, pp. 350–359.
- Vincente, Kim J. / Roth, Emilie M. / Maw, Randall J. (2001):** "How Do Operators Monitor a Complex, Dynamic Work Domain? The Impact of Control Room Technology", in: *Int. J. Human-Computer Studies* 54, pp. 831–856.
- Virilio, Paul (1986):** *Krieg und Kino. Logistik der Wahrnehmung*. München: Hanser.
- Vismann, Cornelia (2000):** *Medientechnik und Recht*. Frankfurt a. M.: S. Fischer.
- Volmar, Axel (2012):** *Klang als Medium wissenschaftlicher Erkenntnis. Eine Geschichte der auditiven Kulturen der Naturwissenschaften seit 1800*. Universität Siegen, Dissertation.
- Wenger, Etienne (1998):** *Communities of Practice: Learning, Meaning, and Identity*. Cambridge: Cambridge University Press.
- Winkler, Hartmut (2004):** "Medium Computer. Zehn populäre Thesen zum Thema und warum sie möglicherweise falsch sind", in: Engell, Lorenz / Neitzel, Britta (eds.): *Das Gesicht der Welt. Medien in der digitalen Kultur*. München: Fink 2004, pp. 203–213.

**Woods, David D. / Klein, Gary / Felto-
vich, Paul J. / Bradshaw, Jeffrey M.
(2005):** "Common Ground and Coordi-
nation in Joint Activity", in: Rouse, Wil-
liam B. / Boff, Kenneth R. (eds.): *Organ-
izational Simulation*. New Jersey: John
Wiley & Sons, pp. 139–184.

**Woods, David D. / Patterson, Emily S. /
Sarter, Nadine B. / Watts-Perotti, Jen-
nifer (1998):** "Patterns in Cooperation
Cognition", *CiteSeerX*, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.36.6837&rep=rep1&type=pdf>
[15.06.2015].

**Yang, Mundo / Baringhorst, Sigrid
(2014):** "Re-Intermediation durch So-
cial-Web? Eine Analyse von Social-
WebProjekten im Bereich des politi-
schen Konsums", in: Oehmer, Franziska
(ed.): *Politische Interessenvermittlung
und Medien*. Wiesbaden: VS Verlag,
pp. 399–423.

Yates, JoAnne (2008): Structuring the
Information Age: Life Insurance and

Technology in the Twentieth Century.
Baltimore: John Hopkins University
Press.

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

Yates, JoAnne (1991): "Investing in In-
formation: Supply and Demand Forces
in the Use of Information in American
Firms, 1850–1920", in: Temin, Peter (ed.):
*Inside the Business Enterprise: Historical
Perspectives on the Use of Informa-
tion*. Chicago: University of Chicago
Press, pp. 117–160.

Zielinski, Siegfried (1989): *Audiovi-
sionen: Kino und Fernsehen als Zwi-
schenspiele in der Geschichte*. Reinbek:
Rowohlt.

Zillinger, Martin (2013): *Die Trance, das
Blut, die Kamera. Trancemedien und
Neue Medien im marokkanischen Sufis-
mus*. Bielefeld: transcript.