

Methods and research outcome in the age of cyberscience*

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1. Introduction

This paper builds on an ongoing research project at the Institute of Technology Assessment of the Austrian Academy of Sciences in Vienna.¹ We explore the impact of information and communication technologies (ICT) on academia. We coined the term “cyberscience” (Nentwich 1999) to depict the gradual move from traditional science (in a wide sense, including the social sciences and the humanities) where computers and telecommunication played only a marginal role towards a new type where, in particular, the Internet seems to have changed the way academics produce knowledge. This research project proceeds in four steps. *First*, we looked at the technological development which may have an impact on academia. In particular, we monitored how the Internet evolved, how new software allows academics around the globe to communicate with each other on a bilateral as well as a collective basis, to retrieve and store information, to publish in innovative electronic formats and so on. Furthermore, we surveyed the status quo of ICT use in the various disciplines and documented the considerable differences between them. In a *second* step, we scanned the literature of a number of fields such as library, information, computer and communication sciences as well as the sociology of sciences and of technology to get a broader picture of how researchers and actors in the field (e.g. librarians and publishers) assess the development. In particular, we looked at how these new technologies impact on the roles played by the various actors in academia (e.g. what new roles librarians play now as “cybrarians”); at the way academic knowledge is produced collaboratively and at distance (e.g. in virtual institutes or via electronic conferencing); at how it is represented in new formats (e.g. hypertext or hypermedia, see Nentwich 2000b); at the publication system (e.g. whether the printed academic book will survive, see Nentwich 2000a); at how quality is assessed and controlled (e.g. via new forms of open refereeing); and finally at economic aspects (Nentwich 2001b) and the legal framework (e.g. old copyright provisions may not be adequate any longer in the digital world). In the *third* phase, we put forward a number of initial hypotheses about the qualitative impact of the advent of the new technology on how academics work and what they produce (Nentwich 2001a) and then tested them in a series of interviews.² In the *fourth* and

¹ The project homepage can be found at <<http://www.oeaw.ac.at/ita/cyberscience.htm>>.

² 50 in-depth interviews on the basis of a semi-structured, open questionnaire with researchers in 13 disciplines (comprising 36 sub-disciplines) during winter 2001/02.

concluding phase of the “Cyberscience” project we are now modelling the impact of ICT on academic knowledge production.

This paper takes for granted the findings of the first and second phases of the project and presents both the hypotheses and the empirical evidence gathered from the interviews on *how ICT may affect the outcome of research*. We proceed as follows: in the next section (2), we define what we mean by “outcome of research” and describe on what routes the changes in scholarly communication may affect the former. In the main part (3), we shall discuss the impact on substance via one of these routes in the light of our empirical evidence, followed by a summary (4).

2. Definitions

To begin with, we need to define our dependent variable. “Outcome of research” is obviously a qualitative category. We are not talking here about the quantity of the research output as such. Only if a considerable quantitative change – e.g. concerning average length of articles, number of articles published by individuals, speed of publication etc. – acquires a qualitative dimension (“quantum leaps”), it would become relevant in our context.

Further, we have to distinguish between formal aspects of substance and those more directly related to content. Both aspects are interrelated, however, and influence each other. At first glance, changes in knowledge representation (e.g. hypertext) are formal changes. We argue, however, that this formal change might have anticipated effects directly linked to the process of knowledge production. At least theoretically, there seem to be also directly content-related changes. ICT might, for instance, lead to more variety or to more unification of academic opinions in a field, to a reinforcement of the mainstream or of dissenting sub-communities.

We may ask questions about changes in research substance either in a normative way (“Will the research output be better or worse?”) or without reference to any normative yardstick (establishing such a yardstick is in any case difficult). We will only occasionally make reference to normative assessments given by our interviewees, but follow a non-normative route of assessment. We compare the outcome of research with or without the involvement of any kind of ICT and look at differences in kind or type or, more generally speaking, in quality (not understood in a normative sense). Since for practical reasons, it is not possible to actually directly compare research with and without the involvement of ICT, we are bound to establish these differences in an indirect manner (via the assessments of expert-observers).

To sum up, our dependent variable “substance” as well as “output” of research is to be understood in a broad, qualitative and non-normative sense. We use

*“**substance** of research” to depict the essence proper of the research results, devoid of the form or representation,*

and define

*“scholarly **output**” as the results of research in the sense of new knowledge in whatever form, be it an entry in a database, a scholarly article, a research note describing an experiment or a lengthy report reviewing and analysing the results of previous literature; the form of representation is part of the output (output = substance + form),*

and apply

*“**outcome** of research” as a generic term including both substance of research and research output.*

How new knowledge is created and represented in a scientifically accepted way often involves communication whereby all layers of communication are affected (Gibbons et al. 1994, 36ff.) Conceptually, changing scholarly communication does not directly influence the substance of research. Rather, there are three possible routes how these changes may impact, namely via

- changes of the *methodology*, defined here as the sets of rules of “how to” and standardised ways how researchers carry out research (e.g. surveys, experiments, literature research, mono-, multi-, inter- or transdisciplinary, etc.);
- changes in the *representation* of scientific knowledge (e.g. digital instead of paper, hypertext instead of linear, database instead of book and article etc.);
- changes in *work modes*, that is the practical, day-to-day, carrying out of research (e.g. whether the research is done collaboratively or not, how fast or efficient it is done, how it relates to the work of others etc.).

Figure 1 below depicts these three routes of impact:

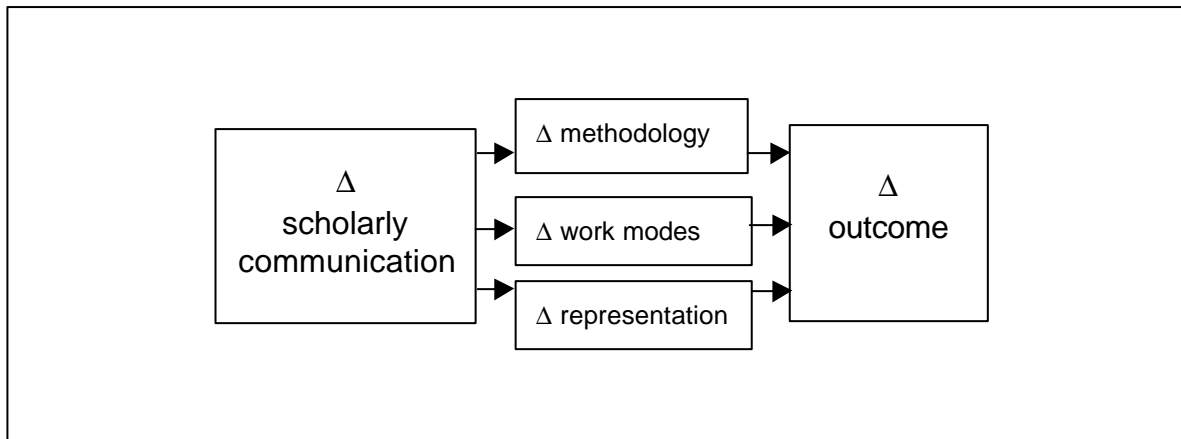


Figure 1: Routes of impact of scholarly communication on research outcome

3. ICT-related impact on scholarly outcome via changes in methodology

In this paper, we shall discuss only the first of the impact routes distinguished above, namely the one on methodology (the two other routes will be the topic of further papers). Note that we are in an early phase of the development of cyberscience. Therefore, there is not much experience yet with the new modes of doing research. The expert opinions have to be interpreted in this light.

3.1. Outcomes, otherwise impossible

ICT is opening up new ways of producing results which could not have been produced before. I am not arguing here that different results being produced, but that they *are* produced at all. In other words, these outcomes would otherwise be impossible, that is not feasible without ICT. Note that “impossible” has to be understood here in a broad sense including alongside impossibility in principle also practical impossibility due to restrictions of time and money. Obviously, this will be different in the various research fields. Indeed, many of our interviewees said that, in their field, ICT is not capable of producing new results. However, the following groupings exist for such innovation:

- *Access to data:* In many circumstances, projects would not have been carried out if getting the necessary data would not have been so easy due to remote, dispersed archives and databases for country or regional comparisons in the social sciences (e.g. panel studies, combining time series and cross-sectoral studies in economics). Comparative research and transnational questions are favoured. Another example is the online availability of legal

acts which allows for statistical analysis of growth of legislative activity by political scientists. Furthermore, legal scholars seem to be more inclined to access a text in the original language if access is easy. Also in molecular biology, the combined computing of data of several sequence databases opens up new research questions. The same is true in papyrology where cross-database full text search has led to new activity areas of papyrologists. One interviewee summarised that if a certain piece of information is not available in due time, it cannot be used, while if it is easily available, it will be used and we have to expect that the substance is altered.

- *Distributed computing* enables researchers to fulfil tasks which would take much too long for single computers (or even local clusters of computers). Prime examples come from chemistry and mathematics, other fields may follow suit with a view to compute world-models (e.g. climatology, astronomy, economics).
- Software for administering large *Internet surveys* allows for new ways of reaching research subjects around the globe and is transforming and revolutionising (Bainbridge 1999, 124) the methodologies of the human-related disciplines. Although today such surveys have the disadvantage that they cannot potentially reach everyone (as access to the Internet is not universal), this is likely to change in the future. In addition, “appropriate techniques can be developed to compensate for non-randomness of the samples” (ibid., 128). Furthermore, web-based surveys allow for dynamic “on the flight” analysis of the data as the input flows in in digital format.
- *Shifting the work through time zones* may in some cases be a *conditio sine qua non* for a project to be carried out. An example may be the co-ordination of astronomical projects where scanning of a particular stellar region needs to be handed over from one observatory to the next.

To sum up, there are scientific results being delivered in the age of cyberscience which would not have been possible without the help of ICT.

3.2. Initial input side changes

One of the most striking features of the emerging mode of doing research in the age of cyberscience is the improvement of direct access to relevant information. It is to be expected that sooner or later almost all written information necessary for research (in most fields) will be available online. Other material such as pictures, numerical data, audio or video files will follow suit.

The networked environment with its multiplied opportunities to access and filter information may lead to a different starting point or initial input side of the research. Our interviewees almost univocally agreed with the thesis that cyberscience changes these starting conditions. This might be positive and negative at the same time: on the one hand, it may lead to a broader basement of the research. Research will start with more up-front information available and will be more broadly founded in the existing literature as well as empirical data. For instance, literature surveys are likely to be more comprehensive (bibliographies get larger).³ Another effect mentioned by our interviewees was that this triggers more variation, more selection opportunities, more information turn-around. For instance, it seems that cyberscientists are more inclined to use grey literature, that is not formally published papers and pieces of information found in the WWW. Furthermore, structured full text databases with appropriate search-tools in place may help the researcher “to make a navigation chart, and avoid hazards, waste lands and culs-de-sac” (Davenport/Cronin 1990, 182).

On the other hand, selection opportunities may also be interpreted in a negative way: the input may simply be too much to process adequately (problem of *information overload*⁴). One interviewee pointed at the danger that the scientific products may become less concise and even spoke of the danger of stasis. The online availability of full text may lead to less original work when copying and pasting quotes into a new piece without much value added. Mittelstraß, a philosopher, argues that information technologies will not help much in the humanities (and elsewhere) since too much information, although easily accessible at one key stroke, is rather inhibitory for research than promotional because this is not the way our brain works (1996, 28f.). Therefore he asks for the preservation of the unforeseen which is crucial for research. We think, however, that Mittelstraß is underestimating the potential of hyper-browsing through the new electronic information bases. In a similar context, Dicks and Mason argue

“that since the human mind is clearly capable of making multiple linkages and connections, and since the social world itself requires flexible and multi-faceted

³ Note, however, that in many research areas the initial input plays a minor role as the main thrust of information used in the research is only produced during the research itself, e.g. in the case of field research, interviews or experiments. Here the influence of initial input on content is naturally restricted. Also in philosophy, valuable books can be written with reference to only one other book in the bibliography.

⁴ This problem may, however, be diminished in the future with the help of technical solutions like filtering based on meta information.

analysis, then the creative integration of different media may offer the reader and analyst a more adequate approximation of the richness of (...) knowledge.” (1998, 6.5)

Furthermore, in the present time of transition, the selection criterion may be *biased towards availability through the electronic networks*. The early cyberscientist may remain negligent of literature and information which is not online. This has two aspects: First, keyword search in databases. will let the cyberscientist find only what has been keyworded and indexed. How we will be “browsing” for information is about to change: we will not find any more the “book shelved next to the one we were searching for” because there are no physical shelves any more. In exchange, we might find other resources that were given the same keyword. Second, as regards access to full texts, one may argue that there might be a trend that only the most recent online publications will be quoted since older publications, in particular from the printed world, “lose” their value in the sense that they may be considered as probably not containing the most recent data, information, arguments in an ongoing discussion. Odlyzko (2000, 4) observes that

“we are very shortly going to cross a sort of critical mass boundary where those publications that are not instantly available in full-text will become kind of second-rate in a sense, not because their quality is low, but just because people will prefer the accessibility of things they can get right away.”

Mueller agrees and risks the prediction “based on assumptions about human inertia” that “once the electronic literature of a discipline is sufficiently large and diverse to give scholars the sense they may have enough stuff for their project, they will be tempted not to look elsewhere” (2000, 8). In the longer run, this will be no problem anymore as soon as most of the sources are indeed online. In some disciplines, however, there is a long way to go still and this may lead to blind spots.

However, once all the material is available online, information seeking behaviour may change again, as Odlyzko predicts: “With lower costs of access, a greater fraction of reading is of the superficial browsing variety. (However, that does not mean that there is less deep study, since there is general growth in information processing.) Older material is accessed much more frequently than before.” (ibid.)

In any case, what the scholar starts with before specifying the proper research question and elaborating the theme is changing. In some respect, it is (a bit) less (what has not been keyworded or put online), in another it is (much) more (full-text search). Bourguignon agrees: “Thus it is highly likely that these databases will end up by themselves exercising a subtle and important influence on the long-term evolution of research in the field.” (1999, 113)

3.3. Impact on choice of topic

While in the previous section we did not discuss the choice of the research topic, but only how it will be treated, we may further ask whether different subjects will be chosen due to the different opportunities to organise scientific work. Do networked researchers do different things (ask different questions, treat different subjects) than those not working in the net? Obviously, in a variety of disciplines, there is the new field of Internet research, i.e. research on the Internet with the set of tools and concepts applied in the particular field (e.g. from the point of view of sociology, ethnography or law). Here, we are instead interested in knowing whether researchers adapt their research topics and questions because of the new opportunities available.

One such mechanism may be the participatory nature of the new medium. In the report “Realizing the Information Future“, the authors observe that “(q)ualitative benefits have arisen with changes in the nature of the work being done: broader interaction can change the questions being asked” (NRENAISSANCE Committee et al. 1994, 113). This may trigger interdisciplinarity (see below) as well as more collaborative work.⁵

Another reason for changing or “adapting” topics is the structure of the digital information available. Brandtner gives us an example from the humanities:

“If literature science is in a position to revert to manuscripts and autographs, then the focus of research and theory as well as methodology building will shift and reconstitute. (...) Under today’s conditions, [to provide optimal access to autographs] is only possible with the help of current information technologies. (...) The structure of the searchable categories defines also the topics of literature science.” (1998, 2055f., transl. MN)

The majority of experts included in our survey acknowledged the potential of the Internet to influence the choice of subject (and perhaps also the choice and perception of new/different methods). While only philosophers hold that their choice of topic is not at all influenced by the new media, in all other fields the opinion was either univocally in favour of this effect or at least partly in favour. The reasons mentioned were the following: that new horizons are opened up, in particular, with regard to hot issues in related fields; that one is more up-to-date about what is going on in one’s own field and what others are currently doing (orientation effect; this may avoid duplication and enhance connectivity of the research); that an

⁵ With the effect of a different outcome due to the participation of more people with different specialisations and research interests (this will be discussed in a further paper under the heading “changed work modes”).

international (and often comparative) perspective is added (“inbreeding” of ideas is less likely); that the ease with which projects with remote collaborators can be managed may often stand at the root of a decision to actually engage in it (even if it would be possible otherwise); that the Internet enables the establishment of a critical mass of researchers to lay the foundation of a new field⁶.

Against this effect, some experts hypothesised that it would rather be the younger (and peripheral) scholars which are influenced by the available information on the Internet while those with more experience and a better personal network are not. Obviously, individual habits and preferences play a role here, too. Furthermore, there is the argument that the choice of the research topic is mainly dependent on previous research done by the same person and comes, as it were, from “within” the research, not from outside impetus. In addition, the policies of research funds, the aims of the respective research institution and money play an important role.

To sum up, the net impact of the Internet could only be marginal in some cases, but there is evidence that ICT has an impact on the choice of subjects in other fields.

3.4. *Creative potential of the new media*

While some fear that the Internet brings chaos and less clarity (too much “background noise” in the words of Glanz 2001), others point exactly at the creative potential for the research process of this very chaos produced by the wealth of information in the network, the various forms of interactivity and participation.

Written E-mail discussions are one such half-chaotic medium. Gresham speaks of idea generation through such discussions (1994, 48). Harnad predicts that what he calls “scholarly skywriting” will revolutionise how science is done. He suggests that there is “plenty of room on the net for exploring freer possibilities, and the collective, interactive ones, are especially exciting” (1993, 9). He praises the potential of “unrefereed discussion, perhaps among a closed group of specialists with read/write privileges (while others have read-only privileges)”. He argues that the shift from P- to E-publishing is not only a change of medium, but a revolution in the way science is done, namely much more interactively, and concludes

⁶ The example given was that military historians were completely separated from feminist historians, but then the initiative of the web group “Minerva” helped to transgress the sub-critical mass of researchers in the new field which became now the established area of feminist military history.

that “(s)cholarly inquiry in this new medium will proceed much more quickly, interactively, and globally; and it is likely to become a lot more participatory” (1990, 2). Based on his case study of the cold fusion newsgroup, Lewenstein (1995, 141), too, argues that this form of communication, despite all shortcomings, contributed to awareness building and information gathering and influenced “the process by which social consensus – knowledge – was produced”.

In a similar line of argument, Harasim/Winkelmans argue that computer mediated communication (CMC) offer the “opportunity for serendipitous contact” (Harasim/Winkelmans 1990, 397) and make “a near-immediate audience” available which those actively contributing a presentation to the extended discussion (conference) found “stimulating and motivating, enhancing their creativity and productivity” (ibid., 399). Therefore, the new media simultaneously support two thinking modes: “brainstorming, as ideas encountered online spark immediate responses; and reflection, as transcripts are studied and responses composed prior to uploading” (Harasim/Winkelmans 1990, 401).

The creative potential has to be tamed, though. Winiwarter observed that one of the main problems of an interdisciplinary discourse is how to get hold of volatile creativity of the group, i.e. the good ideas coming up and being forgotten as the process goes on. She proposes E-mail discussion forums with a searchable archive as a solution to this problem (2000, 6) and other forms of “collective memory” such as Krajewski’s hypertextual slip box (Krajewski 1997).⁷ Harasim/Winkelmans think in a similar direction: “Interactive information dissemination and exchange contribute to a synergistic relationship among the members of the group.” (1990, 397) However,

“(a)n important part of scholarly collaboration is the need to move beyond ‘synergy’ into organizing and managing the information generated by a synergistic encounter. (...) The convergence of these sociotechnological systems (computer conferencing and hypertext) will have significant implications for scholarly work in the future.” (ibid., 405)

The answers of our interviewees in this context varied. While the political scientists, biologists, economists and mathematicians were divided amongst themselves and rather sceptical, all others saw at least some creative potential in the information chaos produced by

⁷ Another possible technical solution is heralded by a recent version of a sophisticated software which allows collaboratively and remotely to structure a brainstorming activity graphically in the form of shared “mind maps”.

the Internet. While anthropologists, historians and lawyers univocally acknowledged the big potential, most sceptics pointed at the danger of information overload which may easily lead to the contrary of creativity. Some doubted that the effect, although certainly present, is really important.

Brainstorming (and reflection) may thus be raised to a new level, awareness of concurring approaches may rise and ideas may more easily influence each other. Borrowing Dennett's (1997) metaphor of the gene-like "memes" – ideas that proliferate from brain to brain just as genes use living organisms to survive –, one could formulate: the ecosystem for memes is improving because its viscosity is enhanced. However, making use of this ecosystem requires new and special skills which not every researcher already masters. Our conclusion is that there is a potential, but it still needs to be realised.

3.5. Favouring inter- and transdisciplinarity

Another possible methodological consequence of ICT use is that it may lead to de-sealing disciplines in two variants: first, *interdisciplinary* work may become more likely since it is both easier to get in contact with people interested in the same subject area but looking at the issues from another disciplinary angle and to access the academic knowledge of other fields. One argument in favour of this hypothesis is that we can observe large numbers of issue or thematic websites which attract the attention of people regardless of their disciplinary background. Wildman argues:

“Yet all the evidence today points to ‘net’ or ‘relatio’ knowledge, i.e. knowledge being generated between the disciplines. The World Wide Web with its ‘hotlinks’ is an excellent example of this. Clearly WWW has enormous implications for [the future university]. As it is a virtual ‘relatio’ host (...) Here meaning is less facts and figures locked within their respective discipline boxes and more nodes in networks of realtime web interaction. Consequently meaning is not objective, universal and fixed rather it is intrajective, provisional and partial.” (1998, 628)

Technological solutions may help to attain the goal of more interdisciplinarity. “Hypertext encourages such flow [of thoughts and information] by removing Chinese walls within disciplines, and Berlin walls between them.” (Davenport/Cronin 1990, 182). An interface to the E-print archive “that allows rapid identification of papers that provide pedagogic review material or are otherwise likely to be of specific interest to outsiders” (Ginsparg 1996, 6) has been proposed in order to facilitate interdisciplinary research. Access to knowledge bases has to be organised in a way particularly suited for interdisciplinarity (Winiwarter 2000, 15). Atkinson (2000, 67) envisages a one-stop shopping system of scholarly publishing in a

discipline which would be interoperable on the basis of the open archive initiative (OAI) and argues that this would not impede but promote interdisciplinarity by favouring borrowing from one discipline by another. Once the so-called Semantic Web became a reality, interdisciplinarity might be facilitated, not through a (not very likely) harmonisation of terminology, but of the meta code (Hartmann 2001).

However, we should not forget that personal contact at least in an initial phase of a co-operative and even more so of an interdisciplinary project is paramount since you need to find a common language first. Winiwarter (2000, 10) argues that for interdisciplinary endeavours the main focus of the use of CMC should be with the communicative rather than the informative functions. She hypothesises that interdisciplinary research needs a good deal of trust which cannot be produced through CMC, but only face-to-face (ibid., 14). In their survey-generated data, Walsh/Maloney (2001) found no evidence that E-mail was associated with greater multidisciplinary collaborations. Hence, the technological opportunities will not be sufficient.

That there is no direct relationship between new technological opportunities and interdisciplinarity seems to be also mirrored in what our interviewees answered. Again, the answers were split: the experts of about half of the fields felt that yes, interdisciplinarity will be favoured, those of four disciplines doubted it uniformly and the rest was split. Most of those answering in the positive direction, however, were not convinced that these favouring factors will indeed be strong enough as “practicalities” speak against more interdisciplinarity. Among these adverse factors, the following were most often quoted: how to find a common language and understanding (difficulties of presentation of highly specialised knowledge to non-specialists) and the forceful overall trend towards specialisation (both triggered by content-related considerations and career tactics). Furthermore, individual preferences seem to play an important role whether or not a researcher is inclined to enter into an interdisciplinary co-operation or discourse. Others pointed at the fact that, not at the individual level, but at the level of projects commissioned by the large funds (national and international), both international co-operation and interdisciplinarity is a key asset of any application.

Second, at the level of communication with the public and the commissioning bodies, we may hypothesise a relationship between the increasing communicative and information space and the type of knowledge production, in particular *transdisciplinarity*. As Gibbons et al. in their book on Mode 2 knowledge production argue, the

“development of (...) information and communication technologies have created a capability which allows [the new sites of knowledge production] to interact. Mode 2 is critically dependent upon the emerging computer and telecommunication technologies and will favour those who can afford them.” (1994, 10)

Or even stronger: “To function the new mode needs to be supported by the latest that telecommunications and computer technologies have to offer.” (ibid., 14) Also Hitchcock et al. (1996, 9) predict that, in the longer term, E-publishing may be an “agent to change the boundaries between academic disciplines.” One of the most important features of the transdisciplinary mode of science is the interaction with (groups of) people outside academia.

As to whether the “academic Ivory tower” would get new doors and windows due to ICT, the answers of the interviewees were rather sceptical except those of the social sciences which were rather optimistic. All others were divided or rather negative. Most experts noted that, at least so far, the Internet is more about shopping windows than two-way-doors; nobody seems to expect active involvement of lay persons, but a few observed increased exchange with professional experts outside academia (for instance, asking for opinions or facts, which can be and is done more systematically today via E-mail than previously in face-to-face conversations). With regard to the latter, it has been noted that there are signs that traditional hierarchies are being circumvented through direct contacts with the experts in a business or administrative organisation. However, some effects in the sense of public understanding of science and awareness building seem not unlikely, including journalists. But even this is critically dependent upon better presentation and non-technical language which is not at all standard yet.

4. Summary

As regards methodology-related effects, we found, first, that ICT is opening up new ways of producing results which could not have been produced otherwise. This relates to new ways of accessing data, distributed computing, Internet surveys and time-zone shifting of research tasks. None of these ways is universal, but their applicability depends on discipline and research task. Second, the initial input to every research project is definitely changing due to the widespread instantaneous availability of information resources. At least for the phase of transition, we found that selection is an issue here: the wealth of information may lead to overload and the concrete selection may be biased towards availability through the electronic networks (later on sophisticated filters will be available and there will be an ever diminishing share of material not yet online). Third, at least in some research fields, it seems likely that the

choice of topic may be co-determined by the availability of up-to-date information in the Internet. Fourth, there is a potential that the chaos produced by the wealth of information in the network, the various forms of interactivity and participation leads to new creativity – but the potential still needs to be realised. Fifth, there seems to be no mono-causal relationship between new technological opportunities and interdisciplinarity, but again some potential to ease interdisciplinary collaboration exists. The technological opportunities are certainly not sufficient. Similarly, genuine transdisciplinarity is not likely to emerge simply because the academic ivory tower has got new shopping windows (the WWW) and easy-to-use communication channels. Without particular efforts, better dissemination and awareness of scientific results, not to speak of an interactive exchange, is not likely.

It seems impossible at this point in the development of cyberscience to do more than list these first assessments. Final conclusions cannot yet be drawn as there is not enough experience yet. A noteworthy potential is, however, there and it awaits to be realised. The same holds for two other areas, not dealt with here, namely the impact of changed work modes and new kinds of knowledge representation, on research outcomes.

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