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cyberscience

Research in the Age of the Internet

Chapter 11

CYBERSCIENCE AND POLITICS

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> "As information and communication technologies have become essential tools for science, governments need to understand their role in the science system in order to develop appropriate science policies."
> (OECD 1998, 189)

11 CYBERSCIENCE AND POLITICS

This chapter of the concluding part discusses the implications of cyberscience on science and research policy as well as on the steering mechanisms of the scholarly organisations. I shall first present the framework in which the politics of cyberscience are being shaped, that is I distinguish between the various arenas, actors and issue areas (11.1). Second, I shall explore in more detail some selected issues that either are very high on the (international) agenda or should be (11.2). Finally, I shall be able – on the basis of my findings – to give the main actors at the state level and in the research communities advice on how to cope with the incremental changes which have been discussed here under the label of cyberscience (11.3).

11.1 The politics of cyberscience: arenas, actors and issues

The politics of cyberscience are a good example of multilevel governance (Marks et al. 1996) as they play at different geographical and functional levels which all influence each other. First, we find relevant policy *arenas* at the *international, supranational and national levels*. In the *world-wide* arena, for instance in the WIPO or at the WTO level, international treaties and agreements are negotiated that influence the general rules of the game when it comes to the publication of academic knowledge (cf. 9.2.1). At the *supranational* level, we find mainly the European Union activities. The EU is engaged in the building of the research infrastructure at the highest level (high-speed networks, below 11.2.1), in the harmonisation of the legal framework and in targeted R&D programmes, for instance with regard to digital libraries[924]. Also the *national* governments have many stakes in the cyberscience business. There are again infrastructure and R&D programmes (including the guidelines and policies of research funds) as well as important legal activities, both at the content level (e.g. implementing IP law) and the organisational level (e.g. shaping the structure of the university system).

Second, and beyond this public policy level, there is what one may call *private* cyberscience politics, i.e. non-state actors are shaping politics within the public policies framework, too. We can again distinguish two levels. At the *associational* level, scholarly societies as well as library and university networks play a role when it comes to spreading new media and setting the standards for their use (e.g. quality control, pricing policies, copyright practices). Some of these informal networks, in particular in the library scene on both sides of the Atlantic and the "Open Movement" (cf. 9.1.3.3), are quite stable – de-

[924] E.g. project Scholnet <Cyberlink=895>.

spite their single-issue and often "grassroots"-like character[925] – and share a particular belief system. They have a common set of basic values (e.g. scholarly communication must not be restricted), causal assumptions (shareholder value thinking is the main cause for the crisis of the scholarly publication system) and problem solution perceptions (academia must act now). These networks fit well the definition of advocacy coalitions (Sabatier 1993) and represent a strong factor when it comes to organising and shaping behaviour in practice. At the level of research *institutes* (both extra- and intra-university), many important decisions are taken which shape the face of cyberscience (e.g. on internal formal and informal communication behaviour). Often, important initiatives are taken within single research institutes and then spread into cyberworld (e.g. E-archives and other E-publication initiatives).

The *individual actors* in cyberscience politics are as diverse as the arenas (above) and the issues (below). They include both national and international decision-makers in R&D policy; academics in various functions, both as individuals (cyber-entrepreneurs, editors of journals) and as decision-makers within organisations, associations, networks; networked librarians; and the big players of the publishing industry. Potentially, also academic users (library users, students etc.) may be involved in the shaping of the future E-infrastructure via participation processes (Oechtering 1996, 411).

The politics of cyberscience come close to what Heclo (1978) describes as an "issue network". This is a specific type of state-interest group relations within the political system that is less stable and coherent than a "policy community". The cyberscience arena comprises a large number of participants with variable degrees of mutual commitment or of dependence on others in their environment. Participants move in and out of such networks constantly so that it is in fact almost impossible to say where a network leaves off and its environment begins (ibid., 102). Despite this soft definition, we cannot speak of one single issue network, but rather of many intermingling ones because the politics of cyberscience are so multi-faceted.

The *main issues* for any specific set of networked actors in this field are at present (without any particular order): intellectual property law (shielding academia against world-wide trends); the technical infrastructure (networks, access); R&D policies (development of cyberscience tools, foster co-operation, "media policy"[926]); publication policies (P- or E-publishing, quality control, credentialing); archiving and digitisation; formation (cybrarians, researchers); information management (within institutions); and last, but not least, de-commodification (breaking away from commercial interests). Often these issue networks overlap with each other and with wider issue networks that extend beyond academia. For instance, intellectual property policy worldwide mainly focuses on the music and video industry whereas the needs and challenges for academia are only a sideshow, recognised by a small sub-set of the larger policy network.

A number of these issues will be discussed below in brief. My goal is to point out and present the most salient issues, not to study the functioning of cyberscience politics in-depth. Some of the themes are selected because that is where the highly visible action is

[925] Taking the example of the academic library scene in Germany, we find that not all activities are of a grassroots character (like, for instance, the IuK Initiative: <Cyberlink=259>). Others are triggered by state policy (e.g. the projects by the German ministry of research: MeDoc, InterDoc, GlobalInfo; see Sietmann 1999, 226).

[926] For instance, Glotz (1998, 20) pleads for a "media policy" as science policy that supports a transdisciplinary approach to cope with the new questions raised by the use of ICT in society, and science and research in particular.

(in particular infrastructure, IP law and de-commodification). Although only limited political activity can be noticed for other issues, they are nevertheless discussed here because this study has shown that these topics are of utmost importance if we look at the evolution of cyberscience as a whole (archiving, information management, formation, quality control and credentialing).

11.2 Salient policy issues

The most important cyberscience policy issues fall naturally into three clusters: the provision of an adequate cyberscience infrastructure and of reliable and universal access to it (11.2.1), the design of a trustworthy E-publishing environment (11.2.2) and the establishment of and training for academic information management (11.2.3).

11.2.1 Cyberscience infrastructure and access

Without the ICT infrastructure, cyberscience could not take place. By ICT infrastructure I mean both the data network, the central computing capacities (e.g. in universities) and the ICT equipment at academic work places in the research units. Furthermore, in addition to the hardware, the software is equally necessary and part of my notion of technical infrastructure. However, the cyberscience infrastructure would not be helpful without content. Access to databases, full text publications etc. belongs to the basics for any academic. Last, but not least, it is important to also include the running of this infrastructure, as the servers, cables and pieces of software plus the content alone would still not be sufficient. Therefore, the cyberscience infrastructure also encompasses the staff who install, control, debug and update all the equipment in the computer departments and who are responsible for helping the non-technical users with their daily problems.

Providing this infrastructure raises a number of policy issues. First, there is the issue of scale: What is actually needed? What is the baseline, what is not necessary? I shall look at this both in technical terms (11.2.1.1) and from an organisational point of view (11.2.1.2). Second, we should look at the issue from a global perspective and ask who should have access to which parts of the infrastructure (11.2.1.3).

11.2.1.1 Technical needs

To a large degree, the basic technical cyberscience infrastructure is, at least in the so-called developed world, already in place. Most academics have access to the networks, that is at least an E-mail connection and Internet access; most have a PC, many not only at work, but also at home. Consequently, the basic requirement for ICT-based communication and exchange are fulfilled: fast mailing is universal, access to the wealth of information available in the WWW is possible, further basic services such as access to library OPACs and other databases are already common place. However, many of the second-generation cyberscience services are far from universal. This is not only due to the fact that these services are not yet well developed and established in the communities, but also because of a lack of adequate infrastructure. This includes in particular everything that has to do with real-time video and audio transmission (videoconferencing), remote computing, scientific modelling and real-time exchange of massive data volumes.[927]

One hot area of R&D policy therefore are the worldwide activities to make the networks fit for cyberscience. As we have already discussed in section 2.1.2.1, there are two alternative (or perhaps complementary) ways to deliver the quality of service needed for widespread application of "higher-order"[928] cyberscience services: the first alternative is to improve the routing by distinguishing between the services which are not all equally time-critical. This leads us to the new Internet protocol IPv6 and to virtual private networks. The second alternative could be called "brute force". That is the resolute enhancing of bandwidth, not only of the backbone (that are the highest order inter-connections), but also of the finer grains of the network (that is the connections between the academic LANs, including end-users and the regional and supra-regional networks).

Apart from the networks, the technical cyberscience infrastructure is still not complete. To take just two examples: If we are expecting widespread use of desktop videoconferencing, the hardware (in particular web-cams) has to be bought or updated. Another deficit is the storage capacity for the digital archives, which needs to be put in place, too. Enormous investments will be necessary to establish the infrastructure for digitisation, scanning, storing and updating of the digital archives.

The need to invest in the improvement is recognised widely (OECD 1998, 225; European Commission 2002) and it is likely that the academic telecommunication networks will remain a persistent task for the public authorities (Leib/Werle 1997, 183). The states and regions do not only co-operate in the establishment of the international network, but also act independently as the quality of the infrastructure is seen as a competitive advantage for R&D in a country or region. The sub-title of the latest EU report on research networking reads accordingly: "Striving for global leadership". Competition takes place among universities, too. The level of ICT infrastructure may become an important criterion in selecting universities by researchers and students alike (OECD 1998, 225).

A particular task for public policy is set by the relationship between the academic, so far mostly publicly run networks, and the commercial sector. In its 1998 recommendation, the OECD points out that "(s)ince the development of ICT infrastructures will be increasingly driven by commercial needs, governments will need to play a role in ensuring that the requirements of the science system are sufficiently met" (OECD 1998, 225; cf. also Fuller 1998). This has two aspects:

First, while being a defined and distinguishable network[929], the academic part of the Internet is all but independent in financial terms from the rest of the Internet. The connection lines are hired from the commercial sector; contracts for use have to be established; the hardware to run the network has to be bought on the market; etc. If we want the academic network to remain (or to become again) free of commercial considerations and institutionally supported with a view to guaranteeing equal access, politics has to set the terms.

Second, we need to be aware that the academic infrastructure (hard- and software) is only a small fraction of the entire global market for ICT technology. Market trends in the latter tend to flood academia, too. Take the example of the dominance of certain computer

[927] Axmann/Payr (1999, 41); see also Aubert/Bayard (1999), for an overview, and Bainbridge (1999, for the social sciences).
[928] That is, everything beyond E-mailing and simple web browsing.
[929] Cf. fn. 156.

operating systems which already led to a very high dependency on proprietary data formats (see 2.4.4.1), at least in some disciplines and contexts. These dependencies are not only a threat to any academic archiving endeavours (below 11.2.2.3), but may also lead to dis-functionalities of the academic communication system. For instance, the exchange of data may be hampered due to incompatibilities between different proprietary formats; debugging of software may be dependent on commercial strategies rather than necessities; important amendments and developments may never see the light of day because the academic market is not big enough; etc. In this situation, many plead for an open infrastructure design to guarantee interoperability, flexibility and reliability. Such an open infrastructure would also more easily allow for what the respondents of Kircz/Roosendaal's (1996, 6) study[930] ask for (and with them many others), namely "a communication system allowing for the integration of needs, as defined from the reader's viewpoint" whereby "(i)ntegration is not restricted to text, but includes also data, pictures, film, sound, etc." Open source and open standards would be an option to reach this goal.

11.2.1.2 Organisational needs

I noted above that the cyberscience infrastructure also encompasses organisation and personnel, that is all the staff who manage the equipment. Academic users of soft- and hardware often need help. This is true for all levels of users. Beginners obviously need the most basic hand, but even those who are already well-experienced and computer savvy to a large extent often reach their limits when it comes to going beyond standard applications. This is a very important, but often-overlooked area for systematic policy action in institutions. Most institutions do not invest much in the provision of a well-equipped and well-staffed computer department that is able to solve the small and larger problems typical for computer and ICT use and that can provide adequate training for the academic staff (cf. 2.6).

As I have shown in section 5.5, the future role of academic computer departments will go beyond helping the non-technical users with their daily problems. The infrastructure needs to be filled with services, i.e. with software carefully adapted for specific academic uses, and appropriate content.

Another organisational aspect is the need for co-operation among the various actors. Cyberscience will be based on a highly integrated information and communication system. The integration of the various levels, actors, technical systems and organisational approaches is an important task. Interoperability is not only a technical matter, but even more so a challenge for the participating institutions in academia. See, for instance, projects like CARMEN[931], which aims at creating both the technical and organisational basics for a meta-language to describe the knowledge of many disciplines. The information infrastructure of the future will need many such efforts at various levels (see also below 11.2.1.1).

930 The focus of their interview-based study was on opinions, wishes and expectations as regards the scientific communication process, in particular information needs and the infrastructure. They come up with a series of needs the academic users would like to see fulfilled by the communication system. They distinguish between acquisition needs (further sub-divided into information needs and the process of acquisition) and dissemination needs.

931 <Cyberlink=51>.

11.2.1.3 Universal access

While basic access to the cyberscience infrastructure (E-mail, Internet) is almost universal, at least in Europe and North America, this is not the case for what I called above "higher order" services that need high-speed connections. But what is even more important is access to the digital information (similar Tauss 2001, 209ff.). If academia is increasingly based on E-documents and online databases, on remote resources as opposed to local repositories, it is crucial for research to have access to this digital content. While it may seem that the Internet and its contents are for free, it is important to note that this is only true for parts of it. First, practically all E-journals by commercial publishers are available only to those researchers who are lucky enough to work for a wealthy institution that can afford the high subscription rates. Note that even large universities are only partly in a financial position to offer their researchers access to the majority of, not to speak of all journals.[932]

This is not the place to argue that de-commodification should be worth a sincere thought (below 11.2.2.4, above 9.1.3.4), but merely to point out that the potentially huge advantage of universal access to academic publications on the Internet is by far not automatic. Given shrinking budgets, present strategies of research libraries hardly can solve the problem. In most cases, they only subscribe the core journals, but this means that access to the rest is not available. The problem will even be reinforced in the future in case the DRM systems of the publishers are able to control for (and restrict) interlibrary exchange (see 9.2.1.2) which excludes specialisation strategies. In any case, fees for access to digital information resources have become increasingly important. It may be cheaper not to fund one's own physical library but to profit from a distributed library in the net. It remains to be seen, however, whether this strategy does not limit the range of accessible resources to a large extent.

The situation is similar when it comes to databases. For instance, the best bibliographic databases and indices to the research literature are not available to every researcher. Furthermore, while there are free data repositories and databases in many fields, some of the most important are commercialised. In some fields, this is a salient issue. In molecular biology (cf. 3.2.3.2), for instance, where analysis has been recently separated from raw data production, access to the so-called "ome" databases (gen*ome*, prote*ome* etc.) has become increasingly essential and politically relevant: publicly funded raw data (such as HUGO) should be publicly accessible. But the same should be the case with the raw data produced in a commercial setting, too. There is already the model of the genome of rice that has been partially decoded commercially, but is now available publicly.[933]

A further aspect of this issue of access is universality in a geographical sense. By this I mean, on the one hand, mobile access so that tele-working researchers have reliable access to the data from home and en-route. This is not only a technical matter of mobile

[932] A simple empirical comparison can be carried out on the basis of the excellent service of the E-journal catalogue of the university library of Regensburg (<Cyberlink=162>) which lists a very high proportion of all E-journals published worldwide. Many academic institutions in the German speaking world (universities, Max Planck Society etc.) use this service as it can be individualised for each institution so that the user can see what journal is actually accessible for him/her at this institution (yellow "traffic light") as opposed to free E-journals (green light) and those not licensed to this institution (red). Red lights are abundant, even as regards core journals in most institutions.

[933] Cf. the homepage of the Japanese Rice Genome Research Programme <Cyberlink=906>.

computing networks, but also of licensing policies: IP-controlled access to databases and journals (see 2.3.4.2) often hinders access from outside the institution's network. On the other hand, there is the important issue of digital divide or digital unity on a global level. The enormous costs of hooking up remote and peripheral areas (both in terms of technical infrastructure and of access to information behind password-protected walls) constitute a danger for the often-assumed advantages for peripheral research, namely that it could be better integrated (see 4.3.4.3).

At the end of the day, cyberscience is going to either need extra money, or imaginative approaches. In any case, this is an important matter for politics and should be addressed immediately.

11.2.2 E-publishing environment

If academic publishing is to "go digital", the E-publishing environment needs careful shaping. In this section, I shall review those areas in which policies of various kinds and at different levels may play a role. The underlying assumption is that the E-publishing environment needs to be stable and trustworthy (cf. 7.3.2.1). To reach this goal, four areas need attention: legal security (11.2.2.1), quality (11.2.2.2), longevity (11.2.2.3) and affordability (11.2.2.4).

11.2.2.1 Intellectual property

As we have seen in section 9.2.1, the legal situation with regard to E-publishing is neither universally perceived (there are many doubts about the correct application of existing laws) nor clear (because of the intermingling of different international and national regimes plus contractual relationships) nor stable (as it is a highly dynamic legislative and jurisdictional area). Compare this to the situation with regard to print publishing where a long tradition and widespread experience have produced an almost universal perception of legal certainty. Given this state of affairs, it is quite understandable that E-publishing in whatever form is far from being universally accepted, despite some of its convincing advantages. If E-publishing were to be promoted, IP law is certainly one of the prime areas for political action.

The "regulatory framework that ensures and governs access, protects property rights, and allows the development of collaboratory structures", recommended among others by the OECD (1998, 225), is in the making. However, some of the solutions found are not well adapted for the scholarly communication system (see already 9.3). Hence many voices around the world ask for the adoption of more appropriate rules for academia. The overall direction of this opposition to the current IP law trends (both on statutory and contractual level), may be exemplified by the following quote:

> "Publishers will do best by recognizing and encouraging the complementary contributions of others. Society will do best by recognizing that subsequent authors/inventors may make important additions to original contributions. Intellectual property protections should be limited to achieve a balance that prevents direct copying but that encourages value-adding imitation." (Bessen/Maskin 1997)

Many initiatives by individuals, scholarly associations, libraries and universities have been launched to push the development towards a legal framework in which the authors and hence academia as a whole retains as many rights as necessary to secure free flow (and archiving) of academic information.[934]

Among the most important issues to be tackled are: the grey area in which public self-archiving of E-prints and pre-publication takes place (cf. 9.2.1.2); the threat of digital rights management (DRM) to archiving and academic use (cf. 9.2.1.3); and a fair definition of what is to be subsumed under the privilege of free academic quoting with a view to making the publishing of non-commercially oriented research economically feasible, in particular when it comes to multimedia (cf. 9.2.1.1). In addition, the drafting and judicial control of (global) general terms and conditions in the E-publishing sector should be envisaged. Finally, transparency of the legal regimes should be enhanced, for instance via establishing a worldwide, multi-lingual, continually updated FAQ website on the legal aspects of cyberscience.

11.2.2.2 Integrity, quality control, credentialing and incentives

E-publishing is still ill famed for potential loss, inadmissible alteration (lacking trusted integrity) and low quality. Credentials for E-publications are rare. Consequently, there are no strong incentives to use this new publishing route. As we have seen in section 8.3.1, there is, however, no intrinsic reason why the two publishing worlds should differ as far as quality is concerned. If this perception is to change, there is need for action in many directions.

Integrity and reliability: Policies have to be devised and implemented by the academic institutions that lead to a secure publishing environment. The aim should be to avoid data-loss as well as digital fraud. The system has to cope with the new opportunities of removing, versioning and changing of research publications. It should allow both for corrections and amendments with a view to keeping the academic record free from errors and incomplete arguments, and guarantee that references made to all parts of any publication remain valid and useful (cf. 6.4.1.3). The system also needs to deal adequately with priority claims: As it is, in principle, possible to fake the date in the digital environment, a network controlled by trusted institutions (e.g. scholarly associations) will be needed to guarantee reliability.

Quality control: Academic institutions need to forcefully put forward policies aiming at the establishment of a trusted system of quality control. Based on my conclusions in section 8.3.2, I expect that peer-review will be (re-)introduced, transformed and adapted for cyber-publishing. Along the path a number of implementation issues will arise (8.3.3). Among them need to be carefully discussed questions like these: how to establish and market quality labelling systems; how to improve the working and reliability of open peer commentary and rating systems; how to handle revisions of manuscripts; and how to reward reviewers. Technical solutions to detect plagiarism should be envisaged. This would be particularly helpful for academic teachers marking students' essays, but could – in combination with an institutionalised complaints procedure (ideally under the auspices of the academic associations) – also be a way to avoid undue quoting without making a reference.

[934] See also 9.1.3.3. These initiatives are commented and described among others by Okerson (1997b, 4; 1997c; see also Morton 1997, 5; Bachrach et al. 1998; Denning 1996; Pew Higher Education Roundtable 1998, 6; Ullman 1996; Fisher 1993). In addition, consider the various alternative contractual solutions, based on less restrictive open licenses, such as OPL (cf. 9.2.1.2).

Credentialing: In most fields, it is already accepted to quote E-publications in one's own publications and to hand in E-journal articles for promotion and tenure procedures. However, even if they are formally accepted, their relative weight vis-à-vis traditional publications is (often much) lower. Furthermore, E-journals still have a problematic relationship to the big indexing services (that is they are often not included for lack of a respective policy). For sure, accepting E-publications on a truly equal footing with their paper counterparts is bound to the fulfilment of integrity and quality criteria (see above). It seems to be clear, however, that both associational, university and state policies have to accept that E-publishing is a forceful trend, which needs to be addressed properly. Including E-publications in the general system of credentialing is not yet a pre-emptive (positive) decision, but still a neutral acknowledgement of facts. From this study it follows, however, that even the promotion of E-publishing would be a valuable goal. Arguably, there will probably be also other factors leading to increasingly more E-publications with a higher standing (e.g. the marketplace approach to status, as analysed in 8.4.1). However, this might not be enough. Consequently, a "diversity policy, to replace the period of positive discrimination of text only" (Kircz 2001, 7, with a view to multimedia publications in particular) or even reverse discrimination (privileging innovative over traditional forms of publishing) could be implemented. This brings me to the next point, namely the setting of incentives.

Incentives: It is argued at various places in this study that the new forms of cyberscholarliness have important potentials. We cannot yet know for sure to what extent these new forms will be good complements to existing practices or perhaps even radical improvements. While my analysis shows that there are good arguments that the latter could be the case, experience is still limited. Given the possible prize to win, it seems a permissible policy to set incentives with a view to putting cyberscience to a test. This relates both to E-publishing in general (see above), computer conferencing (cf. 4.2.2.2), writing hypertexts (cf. 6.4.3.2) and skywriting (cf. 8.4.2). Incentives could be set in the form of credentials (see above), but also at other levels. For instance, scholarly associations could offer annual prizes for the best E-papers (e.g. Lesk 1997, 13); or they could invest in hypertext bibliometrics based on meaningful links (Davenport/Cronin 1990, 188) with a view to proving the worthiness of the new way of academic authoring. Furthermore, successful strategies for launching cyberscience innovations could be collected as "best practice" examples in order to make them available for imitation (see for instance Harnad's (n.y.) description of his two-step strategy to launch an E-print self-archive[935]).

While this is not the place to recommend specific ways of improving the E-publishing environment in terms of integrity, quality, credentialing and incentives, the message should be clear: Active, perhaps even pro-active (that is taking the initiative) policy-making at all levels should replace the passive or, at best, reactive stance of parts of academia today. If my conclusion is right, namely that the potentials of E-publishing outweigh any possible disadvantages and that the latter can be avoided by deliberate action, then it would be a policy failure to risk that things develop fully unguided. In the later case, a possible effect could be that academia would never be in a position to fully exploit the advantages.

935 "(T)he reason I am launching it this way – first approaching the most important researchers in the cognitive sciences directly, and archiving their papers 'by hand' for them – is to make sure that the Archive is launched in the right direction. If I opened it to everyone immediately, it would quickly become the kind of Global Graffiti Board that most of the Net (especially Usenet) still is. Once the quality of the initial archive has been assured by a critical mass of invited contributions that can serve as a model for its continuation, I will open it up for public Archiving."

11.2.2.3 Archiving and digitisation

As longevity of the scholarly record is a precondition for further research and hence for the functioning of the whole system, the still unresolved issue of digital *archiving* should be a prime concern for research politics. In section 2.5, I presented the various technical solutions; in section 7.4, I discussed the various options as regards the questions what is to be archived and who should be responsible for it; finally in section 9.2.3, I pondered the legal issues involved in archiving. From all of these various viewpoints, my conclusion was that there are various options available (both technically, organisationally and legally) but the respective decisions have not yet been taken in academia (nor outside of the academic realm).

Given the importance and magnitude of this task, considerable effort at all levels is needed. As I concluded that there will be no centralised (not to speak of a world-wide) solution, action should start not only in the central libraries but also in the libraries and archives of the institutions producing academic publications, that is the universities and research units. Responsibility has to be accepted immediately as time is the enemy of all ill-kept archives. At the same time, national and international co-ordination of these activities is paramount to avoid duplication as well as oversight and to strive for a concerted and structured, multi-centred academic archive.

Politics has to be aware that important budgets with a long, potentially permanent commitment need to be assigned. This is all but trivial. Budgetary planning is often not longer than a few years. This task seems comparable to other "eternal" projects like ultimate disposal places for nuclear waste. Mark, however, the following difference: while it seems that disposal places have huge up-front, but relatively low current costs, digital archiving may prove to have steadily growing costs over time (cf. 7.4.2).

Furthermore, there is a related issue of a slightly different order, namely *digitisation*. On the one hand, digitisation of older material is one means of archiving with the aim both to harmonise archiving strategies and to cut a share of the costs of maintaining huge traditional libraries (Odlyzko 2000, 5). On the other hand, it aims at making material available that would otherwise become increasingly neglected (cf. 10.2.2). In this sense, research policy would be well advised to promote digitisation of older material so as to make it freely available. Even if it seems impossible to retro-digitise the whole corpus of the research literature, a valuable aim could be to digitise at least everything quoted and referred to in subsequent literature, published after a certain cut-off date. The date would certainly be different for each discipline, given the differences in half-time of the research literature (cf. 3.4.2.4).

11.2.2.4 De-commodification

Apart from a few wealthy research institutions and a few highly application-oriented and hence well-funded research fields, academia as a whole is simply not rich enough to afford a commodified system in the long run. Most research, in particular in the social sciences and humanities, not to speak of peripheral regions, is carried out on a rather low budget base and would not have access to the information networks of the rich (cf. 4.3.4.3). An important policy issue, therefore, is how "to avoid a new kind of information feudalism that may come out of a total commercialization of the knowledge networks" (Tehranian 1996, 442).

A de-commodification strategy seems to be promising to avoid that the majority of researchers have no access to the essentials of their fields. As we have seen in section

9.1.3.4, there have been a number of reasons for this development to come about. Clearly however, many political and practical actions could be taken to favour this development if this aim were accepted as legitimate. Both legislative activities in the area of IP law (cf. 9.3) and policies of change by scholarly associations, universities, libraries and university presses (cf. 9.1.3.3) are conceivable.

11.2.3 Information management

The management (ordering, archiving, retrieving, collecting and tagging) of resources of all kinds was always an important task of science and research (cf. Figure 1-1). Now that a good deal of the information processed in academia comes in digital form, information management "got to go" digital as well. While in principle the tasks have stayed the same, the methods, work modes and range of options are changing (cf. also 10.2.2). This is both a collective and an individual challenge. In the following, I distinguish between the systems of information management adequate for academia (11.2.3.1) and the formation or training side of the issue (11.2.3.2).

11.2.3.1 Systems

By information management systems I understand both the technical and the organisational infrastructure necessary to cope with the growing digital information. So far, such systems are known from the business world or an individual level. Academia, by contrast, has not yet fully grasped the challenge and potential of the digital information revolution. Only in parts, systematic approaches are being implemented. For instance, the academic libraries have gone online, at least with their OPACs. In many areas we also find more or less comprehensive link collections and databases of all sorts. However, seen from a professional point of view, most of these activities cannot but be considered very first steps and worthy of improvement, systematisation and generalisation. In other words, if academia wants to profit the most from the potentials of cyberscience, a more professional and less individualistic approach is needed.

A number of institutional and cultural reforms regarding the handling of information are to be tackled. In particular, the development and introduction of methods of "systematic information acquisition, filtering, reduction and concentration", rewards for users if they help improve the databases (error reports), the creation of "scientific information managers" and "new ethics of scientific information and communication" (against the "publish or perish" principle) are on the agenda (Fröhlich 1996b, 10f.; 1993, 8f.).

This endeavour could take place at various levels. Libraries need to become cybraries that understand themselves as information brokering and managing institutions (cf. 5.3.1). Scholarly associations should upgrade review, state-of-the-art and clearinghouse activities to make the wealth of intra- and extra-academic knowledge available to the community (Fröhlich 1993, 9). Two options in this regard are what I have discussed under the labels of field-wide thematic hyperbases or of consolidated knowledge bases (cf. 6.3). Furthermore, at the institutional level, content management systems (cf. 2.4.6) may prove to be a means of coping professionally with distributed knowledge. These systems need, however, careful adaptation for academic purposes as their present target group lies outside academia.

Even if there are reasons to be rather pessimistic that this may actually take place on a larger scale[936], the decision-makers at all levels should be mindful of the warning by Glotz (1998, 18, transl. MN):

> "(T)he avant-garde of the world is trying to overcome the current information shortages through multimedia information structures on the basis of visual, graphical codes. (...) We should not seal ourselves off this avant-garde, otherwise not only the (...) university, but the whole of the (...) society will go on to the defensive."

11.2.3.2 Training

This emerging information and communication infrastructure that will shape how science and research is done in the future asks for new competencies of those doing science and research. So far, similar to the overall information management systems, academia has pursued a rather individualistic approach. It is mainly the initiative of the single researcher or student to build up the skills needed to deal with the new media. To a certain extent, this is a promising and successful route. However, there are limits to such an approach. Take the basic example of researching facts in the WWW. With the advent of the, undoubtedly and astoundingly well performing, GOOGLE search and indexing algorithm, most people and perhaps already the majority of researchers tend to rely on an ever increasing degree to use only this service when searching the Web. Other search strategies are either not even known or not used, and the serious limits of GOOGLE and other such search-engines, including the possible manipulation of data (censorship), are often not recognised (Grötker 2002). The same is true for "expert modes" in database retrieval (cf. 5.1), inter alia.

A more systematic and general approach is needed for two reasons. First, it seems obvious that widespread skill deficits should be avoided, as they are most likely to have a negative impact on how academia performs. Second, only knowledgeable users are in a position to co-determine and thoughtfully shape the path to and in cyberscience (cf. Grötschel/Lügger 1996, 16). The latter task is particularly important as the type of knowledge generation differs very much from field to field. Input from users outside the technical disciplines with a view to making the emerging cyberscience infrastructure as adequate and adapted as possible, seems indispensable. However, this is probably exactly where the greatest knowledge and skill deficits are to be expected.

Consequently, many academics advocate obligatory courses in all curricula teaching practical skills (e.g. Fröhlich 1992, 10) or even "radical adjustments in training, indoctrination, and research" (Atkinson 1996, 260). This will be a task for universities. On a political level, not only the OECD recommended to its member governments that they should foster "the technical support for and ICT training of scientists", e.g. in the field of the establishment of electronic databases (OECD 1998, 225). Also many other organisations saw which way "the wind was blowing" (e.g. Hochschulrektorenkonferenz (BRD) 1996).

[936] Fröhlich (1988, 443) puts forward a number of grounds derived from the sociology of science and cognitive or social psychology.

11.3 Policy recommendations

In a situation like the present with a highly dynamic and constantly evolving system, it is quite difficult to jump from analysis to policy recommendations. However risky it may seem, this is no doubt an important task of any technology assessor.

Some plead for taking no action. Based on a comparison with the printing press and the long-term negative consequences of regulating its use, Dewar, for instance, comes to the conclusion that "the Internet should remain unregulated". Instead he favours a "policy of experimentation, paying particular attention to unintended consequences" (1998, 29). This point of view is certainly worth considering. In the recent past, those working in and for the Internet proved highly innovative with the effect that a promising array of tools and options are now available. Therefore, quite a number of the policy issues discussed above aim at funding and supporting cyber-activities with a view to go beyond prototyping. Regulating the way those tools and services should or should not be used, by contrast, may indeed hamper further development. However, as we have seen in our analysis of the factors influencing the evolution of cyberscience, the very factors which favour experimentation and the production of new tools and new ways of doing lead at the same time to uncertainty and distrust. In such a situation, *our aim is to find the right balance between steering the creation of a stable and trustworthy cyber-environment, on the one hand, and providing the necessary open space to let new ideas blossom, on the other hand*.

Having discussed the various policy issues as such, it is the place here to assign tasks to the various players at the different levels (for details regarding content, see the respective sections above 11.2). I distinguish between (1) public research policy actors, (2) the scholarly associations, (3) the universities and research institutes, and (4) the libraries. Note that some tasks are relevant for more than one group of actors (e.g. digitisation, training, de-commodification).

(1) *Public research policy actors* at national, international, and EU level (including funds) will be responsible for (i) financing the ICT and network infrastructure with a view to building up a technically stable and reliable high-performance network and the respective infrastructure at the academic user's side; (ii) supporting world-wide network building as regards the interoperability of the various technical and organisational levels and systems which form in their totality the cyberscience infrastructure; this should include the promotion of open source and open standards; (iii) ensuring universal access, both physically and as regards content, that is, anti-digital-divide policies eventually on the basis of specific database grants; and (iv) amending intellectual property law with a view to shielding off academia from the market-driven developments outside.

(2) *Scholarly associations* at national and international levels should aim at (i) implementing discipline-specific quality policies for E-publishing with a view to putting it on an equal footing with P-publishing; (ii) supporting steps towards a de-commodified E-publishing environment in order to ensure long-term sustainability and unrestricted functioning, e.g. via editing free E-journals; and (iii) promoting digitisation of older, heavily used (quoted) material with a view to easing the crossover to cyberscience.

(3) *Universities' and research institutes'* tasks will consist of (i) introducing and adapting information management tools in academia; (ii) organising the training of scholars with a view to making them fit for cyberscience; (iii) elaborating credentialing policies for new forms of cyber-scholarliness with a view to promoting targeted experimentation;

(iv) supporting the digitisation of their own paper-based materials; and (v) organising and investing in adequate support centres for computer-related and ICT problems in order to unburden academics as well as staffing these centres with experts in the development and customisation of general software for academic purposes.

(4) *Research libraries* worldwide are charged with (i) devising the organisation (including international networking and co-ordination) and technical implementation of all activities relating to archiving academic E-publications; (ii) implementing digitisation policies for older paper-based material important for current research, which has been published by the respective superior institution; (iii) playing a key role in the establishment of a technically stable, controlled and mostly de-commodified E-publishing environment; and (iv) training librarians with a view to qualifying them for cybrarians and academic information brokers.

These recommendations are summarised in the following Overview 11-1.

POLICY RECOMMENDATIONS

Public research policy
- Network infrastructure
- Interoperability networks
- Universal access
- Intellectual property law

Research libraries
- Archiving
- Digitisation
- E-publishing environment
- Training cybrarians

Universities and research institutes
- Information management
- Training scholars
- Credentialing
- Digitisation
- Support centres

Scholarly associations
- E-quality policies
- De-commodification
- Digitisation

Overview 11-1: Recommendations for cyberscience politics