New Perspectives of a Distributed Electronic Information System for Mathematics – Part II –

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7. Special Tasks and Pilot Projects

This chapter contains a summary of special tasks and pilot projects. It does not claim completeness. Which activities and which projects will be realized in the Forum will mostly depend on the partners' initiative and, of course, on the financial and technical means the Forum will be able to acquire.

7.1 Special Task: Information Clients and Servers

Partners: Mathematical Departments of Universities; Mathematical Research Institutes; Mathematical Laboratories in Industry; Publishing Houses; Libraries; Museums with Scientific/Technical Departments; DMV; Special Interest Groups of the DMV, and other mathematical societies and institutions; FIZ Karlsruhe, Zentralblatt.

Task: Installation and operation of information stations (one per partner) and clients (on all Internet workstations) at the partners' institutions. Implementation of the corresponding Gopher, WAIS, WWW, Hyper-G responder and client software.

Besides scientific-technical information of the kind described in the following special tasks and pilot projects, the partners also offer information with an organizational character, such as descriptions of institutes and departments, research programs and projects, service facilities and departmental libraries, lectures, seminars and courses, current publications, contact addresses and functions.

Technical Contents:	Connection to the Internet and its distributed information services.
Options:	WWW-interface to STN-databases; Electronic information services (discussion lists as in Opt-Net; [Lügger 93]) for special interest groups (of the DMV and other societies).

Effect: Technical infrastructure for information services of the partners; Efficient transfer of information for special interest groups; Informative presentation of the partner institutions; Transparent description of services offered.

7.2 Special Task: Distributed Preprints

Partners: Mathematical Departments of Universities; Mathematical Research Institutes; FIZ Karlsruhe, Zentralblatt;
Publishing Houses; Libraries.

Task: Availability of preprints, prepublications of books, lecture notes etc. in the Distributed Information System (information for students to improve studying conditions).

The Zentralblatt integrates the abstracts into the MATH database – with reference to where the full text can be obtained electronically.

The Zentralblatt prepares reviews on selected preprints.

Technical Contents:	Data exchange formats; Standardization; Organization of accessibility.

Effect: Speeding-up of the reviewing process; Cost Reduction; Improvement of studying conditions; Increased transparency for students.

7.3 Special Task: Distributed Software and Data Collections

Partners: Mathematical Departments of Universities; Mathematical Research Institutes; Mathematical Laboratories in Industry; International Software Suppliers.

Task: The offer of mathematical software and data collections available at research institutes (e.g., concrete data of important applications) will be opened up to the community. The offer will be made available in the Distributed Information System – together with test data and relevant documentation.

Software libraries at the partner institutions and software that is, e.g., available in the electronic library eLib of the Konrad-Zuse-Zentrum (e.g., CodeLib) [eLib], in the NetLib of AT&T [AT&T] and the REDUCE Network Library [RedLib] will be indexed.

These software collections also include algorithm databases (including comparative test results) as well as example and model databases (including open problems). The data collections also contain fact databases (including logical relations between these facts), collections of mathematical formulas and tables, such as computer-readable collections of results from number theory (whose compilation may well have taken months of intensive, interactive work with a symbol manipulation system).

Options:	Cooperation with further international partners offering relevant information in the Internet.
Technical Contents:	Central entry of distributed software; WAIS-database.
Access:	Internet Gopher, WAIS, WWW, Hyper-G.

Effect: Offer of mathematical software and data collections for mathematics and for other fields of science (natural sciences, engineering etc.); Avoidance of double development work.

7.4 Special Task: Global Information Systems in Mathematics

Partners: Forum for Mathematical Information; Special Centers of Competence, e.g., Euromath Center in Copenhagen or Computer Algebra Netherlands (CAN).

Task: Compilation of mathematical information systems – worldwide – in a web of hypertext documents.

Technical Contents	On-line selectibility (by mouse-click) of major "external" mathematical information systems.
Options:	Searchable index for external information systems.

Effect: Opening of the German Distributed Information System towards Europe, North America and other active regions.

7.5 Pilot Project: Electronic Reviewing

Partners: FIZ Karlsruhe, Zentralblatt; Reviewers; Akademie der Wissenschaften in Heidelberg; Publishing Houses; Special Interest Groups of the DMV.

Project: Installation of an electronic conference system and an electronic reviewing organization for reviewers of the Zentralblatt. Reviewers with e-mail access write their reviews in a TEX-form that can be directly integrated into databases of the Zentralblatt.

Option:	The Zentralblatt editors send articles to its reviewers in electronic form wherever possible.
Precondition:	Cooperation with publishing houses, which may supplement the editors of the Zentralblatt by electronic announcements of their products.
Technical Contents:	Standards for reviews (TEX, format of the MATH database); SGML exchange format.
Cross Reference:	Special Task: Distributed Preprints.

Effect: Speeding-up of the reviewing process; Cost reduction.

7.6 Pilot Project: Electronic Mathematical Journals

Partners: Publishing Houses; Mathematical Research Institutions; Forum for Mathematical Information; DMV; EMS.

Project: A technical and organizational model for the electronic offer of mathematical journals is to be developed. The model for such a journal shall not only be usable at the developing institution itself, but also externally (exportability).

Distribution:	via Internet.
Questions:	Data exchange formats; Copyright; Costs; Access control, if necessary.

Effect: Testing of new electronic distribution concepts; Cost reduction.

7.7 Pilot Project: Historical Books and Documents

Partners: University and Technical Information Libraries; Museums; Publishing Houses; FIZ Karlsruhe, Zentralblatt; Forum for Mathematical Information.

Project: Valuable mathematical books and historical documents will be scanned and, in this way, republished electronically (in the Internet).

The Zentralblatt prepares special reviews on these reprints.

Options:	CD-ROM "Printing on Demand".
Technical Contents:	Data exchange formats; Access control, if necessary.
Questions:	Copyright; Costs.

Effect: Inexpensive access (by electronic reprints) to valuable documents from the libraries' treasuries; Testing of new distribution channels.

7.8 Pilot Project: Living Museum of Mathematics

Partners: University Libraries with Mathematical Archives such as Staats- und Universitätsbibliothek Göttingen with its Manuscript Department (Mathematical Archive); Technical Museums with Scientific/Technical Departments; University Departments and Research Institutes; Mathematical Laboratories in Industry; Forum for Mathematical Information; Individual Mathematicians Interested in History.

Project: Creation of a core organization for an Electronic ("Virtual") Museum of Mathematics and expansion of the concept towards other countries.

The Living Museum of Mathematics compiles in its departments

* Ancient Mathematics
* Modern Mathematics
* Didactics of Mathematics

mathematical ideas in the form of historical documents (scanned), algorithms, visualizations of mathematical models and contemporary computer art as well as mathematical experiments ("living books") and makes them available in the context of their place in scientific history. In this context, there will also be biographies of great mathematicians, photographies of old mathematical instruments and modern computers, descriptions of modern mathematical fields of research etc.

Options:	Mathematical experimental laboratory; Electronic exhibitions on up-to-date topics (e.g. chaos theory); Fast-Algorithm Competitions in selected areas, such as the DIMACS Algorithm Implementation Challenges at Rutgers University.
Technical Contents:	Data exchange formats for graphics, photographies, video and audio; Multi-media hypertext protocols and applications.
Influence:	The Living Museum of Mathematics will include interested institutions and research laboratories in Europe, if not the whole world, into its activities right from the start (as a broadly-based infrastructural project).

Effect: Inexpensive creation of the first Museum of Mathematics.

The foundations are already available (networks, workstations and visual storage media) or will soon (in approx. 5 years) be available (high bandwidths).

With this Living Museum of Mathematics, for the first time in history, mathematics will receive a worldwide exhibition space for old and modern ideas from the mathematical cosmos.

"Visitors" in this museum will not only be mathematicians, but also appliers of mathematics (natural scientists, engineers, pupils, students, teachers etc.) as well as persons interested in the history of mathematics and mathematical education.

7.9 Pilot Project: Electronic Library Catalogs

Partners: Specialized Libraries of University Departments and Research Institutes; University and Central Information Libraries; Deutsche Bibliothek in Frankfurt.

Project: Access to catalogs of selected specialized and central libraries via Internet. Installation of appropriate clients at all partners for access to these catalogs.

Options:	Offer of (scanned) titlepages of articles from journals and of books, (the latter with table of contents) for retrieval at the partners.
Technical Contents:	Universal dialog communication software; Client-server oriented retrieval; Z 39.50 protocol.
Questions:	Retrieval at distributed databases (offered by selected partners); Simple formats for bibliographic information; Universal access via WWW gateway.

Effect: Electronic reference to articles and books (locations) also for traditional specialized information; Improvement of the information offer by enlarging the retrievable contents; Increased transparency of traditional publications for students and teachers.

7.10 Pilot Project: Electronic Document Delivery

Partners: TIB Hannover; University Library Bielefeld; University Departments and Research Institutes; Technical and University Libraries; Publishing Houses.

Project: Electronic delivery of (also of scanned) articles, which (until now) have only been offered in the context of traditional publishing. Selected partners offering or handling a particular (traditional) journal or series supply single articles of these journals electronically (upon electronic request/order).

Technical Contents:	Electronic entry, order and supply system; Data exchange formats (e-mail oriented).
Questions:	Contractual realization of corresponding organizational regulations; Copyright; Costs.
Cross References:	Pilot Project: Electronic Mathematical Journals; Pilot Project: Historical Books and Documents; Pilot Project: Electronic Library Catalogs.

Effect: Increased efficiency of the supply of documents for traditional journals; Access to traditional mathematical literature; Rationalization; Cost Reduction.

7.11 Special Task: Electronic Project Organization

Partners: All partners in a community.

Task: Electronic association of all partners (in some project) using the most up-to-date means for electronic communication and cooperation.

Transmission of:	Project news; Project discussions and joint reports; Questions and solutions etc.
Technical Tools:	Electronic Conferencing (Mailing list or News system); Groupworking.
Options:	Realization of electronic WhitePages with contact addresses; Whois servers; Project descriptions; Research funding information.

Effect: Efficient project organization for a distributed project; Informal (efficient) electronic exchange of information.

8. CD-ROM

The Internet is the main distribution medium for the electronic offer of mathematical information. CD-ROM is an alternative and also (relatively) inexpensive medium for the dissemination of specialized electronic information. There are many possibilities to produce CD-ROMs for special mathematics-related purposes. One can think of collections of preprints or collections of important papers on certain topics or of historically interesting documents. CD-ROMs seem to be particularly suited for countries that do not yet have adequate and reliable access to the international electronic networks or are unable to buy books and journals due to very limited budgets, but where a few PCs are available. In particular, CD-ROMs could provide the convenient and inexpensive means to distribute up-to-date mathematical information to developing countries. For customers in such countries, Zentralblatt could offer special prices for its CD-ROM version CompactMath so that at least information about existing mathematical information is available.

9. The Environment and The Chances

Since the economic situation and, in particular, the funding of research and education has declined in many countries (such as Germany) in recent years, innovative ideas are particularly needed today.

One important goal should be that government information and the results of publicly-funded project be disseminated electronically and without charge. It seem a paradox that the access to the catalog FORKAT of projects that may be supported by the German Minister of Research and Technology (BMFT) is as expensive as the access to any other database at FIZ Karlsruhe (presently DM 185.– per hour plus DM 1.10 for each on-line display). We should follow the United States, where all public institution and facilities (e.g., libraries) have come to see it as their natural duty to make the mission, aims, and major results of their institutes available in electronic networks free of charge [Lange 93].

The present situation in our scientific and public libraries (cuts in library budgets) calls for new organizational approaches that are likely to induce cost reductions. It is one of the major aims of the Forum for Mathematical Information to achieve a joint course of action supported by all parties involved, at least for the field of mathematics. Library budgets must be relieved without library services being reduced. In this context, CD-ROM could play an important role as an inexpensive carrier and storage medium in the mathematical publication process. We consider the Internet as the main medium for the distribution of specialized information that is (nearly) free of charge.

The prices for reviewing journals such as Mathematical Reviews (MR) and Zentralblatt (Zbl) have soared in the recent years and reached a level where only libraries in well-to-do countries are able to subscribe. Mathematical production continues to grow and, thus, there is an increasing number of books and articles to be reviewed. It is agreed among all experts that mathematics needs comprehensive and inexpensive reviewing journals and associated searchable electronic databases.

This situation calls for a merger of MR and Zbl to cut costs, improve service, and reduce prices. Unfortunately, a serious attempt of Zbl within the last 15 months to reach an agreement on a joint operation with MR failed due to the unwillingness of MR to share the editorial work and the database. Even support of the merger plans from IMU, EMS, DMV and other European mathematical societies did not help. New organizational concepts and measures are now in the planning phase at Zbl that include various ways of electronic communication and service. Moreover, positive signals from European countries indicate that it may be possible to extend the base of Zentralblatt so that it will become a European reviewing journal. This move should lead to an improvement of Zentralblatt's scope, service and efficiency. It will make heavy use of the "electronic world".

Many examples could be quoted to illustrate a current backwardness in Germany in the field of electronic tools and, in particular, electronic communication. Only very few public authorities in Germany can be reached via e-mail. This state may be improved in the Berlin region in the course of 1994/95 due to a planned "Metropolitan Area Network" (MAN) [ZIB 94]. In Munich and several other important regions corresponding Metropolitan Area Networks are under construction, which will also provide the framework for some libraries to offer information (catalogs and scanned titlepages of papers and books) in a digitalized form [Bayer 94]. The Deutsche Telekom is planning a "data highway" between Berlin and Bonn to connect the two centers of government (BRAVO Project with distributed office organization [Tagesspiegel 93]).

Nevertheless, the day when all important national authorities such as the federal ministries can be addressed by e-mail is not in sight. What is even worse, however, is that the

majority of industrial partners in Germany is not available electronically. If contract proposals and assignments as well as product planning and coordination can only be carried out the slow way (via regular mail), this is likely to develop into a real location disadvantage for the German economy.

We also consider the Distributed Information System for Mathematics as a project to show how to make use of the new technological opportunities on the basis of a model:

Electronic Information and Communication
for Science **AND** Industry.

The point is to create an example of an electronic information infrastructure – also for other fields of science – for database retrieval, electronic mail, electronic conferencing, specialized information networks. In this context, libraries and museums, publishing houses and information centers, industry and commercial enterprises, and public authorities must be included in this process.

The current backwardness compared with the United States must be overcome – not only in mathematics. In the United States, people already talk of the "data superhighway" as a national task. We consider such a "Infobahn" to be of special importance for Germany, too. However, to keep to the image, we also see the necessity to have the corresponding "traffic signs" and "road signals" (organizational regulations) for our field of science.

10. A Vision of "Electronic Prepublishing"

In the past few years, Steven Harnad (Princeton) has developed a special view of electronic publishing [Harnad 90], [Harnad 94], which has been proposed by Andrew Odlyzko (AMS, AT&T) in a similar form for mathematical publishing [Odlyzko 94] and which is of particular importance to us as well. Both authors regard the traditional publication process as extremely slow and expensive and predict that it will be revolutionized in the near future (say, in the next 5 to 10 years).

They point out that today the technical means for a considerably less expensive information dissemination, especially in the field of science, are already available and that with the development of cheap storage media and the distribution of the Internet this process of fundamental change has long since begun. The increasing offer of preprints in the Internet is only a first sign of what might have to be expected: the almost complete substitution of printed material (scientific journals) – in the field of scientific publishing – by the much more efficient and far less expensive electronic offer. The only thing still lacking today is the electronic version of editorial and reviewing structures that have the important function of "filtering", i.e., extracting high-level publications.

Harnad and Odlyzko propose to publish solely electronically (on principle) and to regard a scientific publication as a "living document". The life cycle of such a document starts with the preprint, which is made available to everybody in the "public domain". Every scientist in the same area of research shall now be given the chance to make his/her comments, which will be added to the preprint together with the author's replies. Revisions shall also be attached to the original preprint as well as "peer reviews", which are embedded in a particular organizational structure (see below). Whatever is written as a comment on this document and made available electronically shall be preserved. Nothing that has ever been made available electronically shall be withdrawn.

In this way, a global archive of research works will be set up, which will all be classified and indexed in a customary way and can therefore easily be searched for. You may picture this archive as a huge database, however, you are not bound to this notion: the "living document" may just as well be distributed over a network, however, they shall be

available "forever" as to ensure continuity (and storage media are really cheap today). Harnad calls the accessibility of a scientific work in such a public, electronic archive "scholarly skywriting".

According to Harnad and Odlyzko this horizontal dimension of the archive is to be supplemented by a vertical dimension of "peer expertise", an electronic hierarchy of editorial and refereeing structure. At the bottom level of this hierarchy there are articles that have not yet been refereed. Every higher level of this hierarchy is linked to special reviews and "peer reviews", which are to ensure higher quality standards. One could imagine that a publication climbs higher from level to level in this hierarchy and that the best articles in a way reach "top level quality". Every peer review prepared against this background is attached to the "living document" in the archive. After all, it should be possible to search for documents with a certain level of quality.

One can view it that way that the editors and reviewers on a certain level of quality and in a certain field of science act like editors of an electronic journal that you can subscribe to as reader. If an article is accepted, the subscribers are informed electronically of its acceptance.

Odlyzko substantiates his considerations by an evaluation of the storage requirements for mathematical publications: all mathematical publications of one year (text and pictures), for instance, require approximately 10 GigaByte storage capacity. This means that they could be stored on a single optical disk of the new generation. Disks of this kind only cost a few hundred dollars today and their price is likely to fall even more in the near future. Thus, not the storage of mathematical information is the problem but the compilation of articles (technically: transfer of information) is the real barrier.

In his essay, Odlyzko also asks the question which role printed mathematical journals will play in the future. Surely his reflections are dominated by a technological point of view. Nevertheless, we as well as the traditional actors in the publication process (publishing houses, Fachinformationszentren, libraries) have to face the fact that fundamental social changes in the past have again and again been triggered off by technological breakthroughs.

Acknowledgement

The idea to create a Distributed Information System for Mathematics came up when the Federal Minister for Research and Technology (BMFT) invited the project management of the current DMV Project "Fachinformation" to develop a concept for scientific-technical information with a longterm perspective (beyond the year 2000). An initial concept proposal was presented during a special workshop on "The Future of Electronic Specialized Information in Mathematics" [ZIB 93], [Grötschel 93c] and discussed among the participants.

These early ideas have, in particular, been further developed by the fruitful discussions with the Specialized Information Coordinators of the DMV Project "Fachinformation", with participants in a similar project in the field of physics [Bischoff 93], and with experts from the field of computer science [GI], e.g., Prof. R. Bayer, regarding his notion of scanning books and documents (see, e.g., [Bayer 93]). New developments from computer sciences in Austria in the field of global hypermedia systems (see, e.g., [Kappe 93] by Dr. F. Kappe, Prof. H. Maurer and their working group let the realization of the first stage of the Distributed Information System seem realistic in the very near future. Furthermore, there is Dr. G. Lange of the Computing Center of the Technische Universität Clausthal-Zellerfeld, who is in charge of the working group "Information Systems" at the DFN,

to be mentioned [Lange 93] as well as A. de Kemp [deKemp 93] of the Springer-Verlag in Heidelberg and Dr. A. Odlyzko of AT&T and AMS, who have illustrated the highly topical subject of electronic publishing in science. We would like to take this opportunity to thank them for their valuable ideas.

The initial concept was then – in a preliminary version – widely distributed electronically (e-mail) among mathematicians, physicists and computer scientists as well as libraries and publishing houses. This has led to a great number of supplements and additions; however, it will not be possible to refer to all contributions now. They also came from other countries, where the discussions about the plans of the Deutsche Mathematiker-Vereinigung had become noticed during a very early phase (e.g., [Lügger 94a], [Lügger 94b]).

With the Gesellschaft für Informatik (GI) and the Deutsche Physikalische Gesellschaft (DPG), close cooperation was agreed, which led to an intensive, mutual exchange of information in the subsequent preparatory phase. In February, 1994 the Council (Präsidium) of the DMV agreed upon the project plannings, which were then (in May, 1994) presented to the Konferenz der Mathematischen Fachbereiche (in Germany) and welcomed unanimously.

Last but not least, we wish to thank Ms. C. Schöning-Walter of the Projektträger Fachinformation (at the GMD in Darmstadt), who is not only handling the current DMV "Fachinformation" Project with great personal commitment, but has also encouraged us again and again to make a contribution to the next BMFT support programme by furnishing new ideas.

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Call for Cooperation

The set-up of an electronic information and communication system in Germay and the above list of possible projects is currently discussed in detail within the DMV, the mathematical institutions and other interested partners in Germany. It is planned that – after Germany's policy for furthering the electronic infrastructure has been announced around the end of this year – the DMV seeks (modest) financial government support for some of the plans described before. Surely, only few of the projects and plans have a "national character". The electronic network clearly is the most important base for international cooperation. But it is not only a base. It is vital to add structure to it so that it will become a versatile and easy to use medium for communication and information retrieval that considerably improves our working conditions. The DMV invites the EMS and other European mathematical societies to discuss the plans sketched above and to cooperate with DMV wherever coordinated efforts seem sensible.

For a detailed list of literature and electronic references please refer to the end of Part I.