EMANI, ERAM AND OTHER EUROPEAN ACTIVITIES CONTRIBUTING TO A GLOBAL DIGITAL LIBRARY IN MATHEMATICS

Prof. Dr. Bernd Wegner

Fakultaet II, Institut fuer Mathematik, TU Berlin, Sekr. MA 8-1, Strasse des 17. Juni 135, D-10623 Berlin, Germany,
wegner@math.tu-berlin.de

With the rapidly growing activities in electronic publishing ideas came up to install global repositories which deal with three mainstreams in this enterprise: storing the electronic material currently available, pursuing projects to solve the archiving problem for this material with the ambition to preserve the content in readable form for future generations, and to capture the printed literature in digital versions providing good access and search facilities for the readers. Long-term availability of published research articles in mathematics and easy access to them is a strong need for researchers working with mathematics. Hence in this domain some pioneering projects have been established addressing the above mentioned problems.

The talk will describe some of these activities and the plan to develop a global Digital Library in Mathematics (DLM). For example, in the archiving area as a special project for mathematics the Electronic Mathematics Archives Network Initiative (EMANI) had been designed. Having in mind that a distributed architecture would be more suitable and reduce the load on the partners for such a project, a network is proposed, which also might be a more open approach for extending the project from a initially restricted solution to a more comprehensive enterprise. For the core of the network, a co-operational system of reference libraries and content providers like publishers and editors has been be set up. On the side of the libraries the following partners have agreed to set up a prototype for the archive: the Tsinghua University Library in Beijing, the Cornell University Library in Ithaca (N.Y.), the Mathematical Library at Orsay in Paris and the Lower Saxony State and University Library in Goettingen. The first group of content providers consists of the Springer publishing house, associated publishers and journals posted in the Electronic Library of EMIS.

The Electronic Research Archive in Mathematics (ERAM) is a German project dealing with capturing the content of a classical bibliographic service in mathematics in a database, and combining this with the retro-digitisation of selected mathematical publications. This is extended now by further projects which shall try to retro-digitise the national mathematical heritage in several countries world-wide. In particular ideas to cover the Russian publications in a digital repository called RusDLM are investigated at present, and they may contribute to a bigger programme for the Russian Federation, called "Electronic

Russia", As further digitisation projects the French activity NUMDAM, pursued by Cellule MathDoc in Grenoble, and the European Cooperation in DIEPER have to be mentioned.

1. Electronic offers and their providers

The impact of electronic devices on the daily life of researchers, teachers or other professionals results from a variety of tools and offers installed in local machines or made accessible through the internet. The part libraries are mostly involved in consists of electronic publications, or better electronic versions of printed publications. Some libraries already developed digital repositories containing retro-digitised publications, which had been obtained by scanning printed articles and books. But also offers which could be published only in electronic form become more and more important. I addition to this researchers and teachers increasingly take advantage of computer algebra systems and other computing software, and visualisation techniques using graphics software and image processing tools have become background for most of their presentations and publications. Finally, we should not forget that the internet has been used to establish a communication infrastructure which strongly facilitates their daily work and extend the possibilities for co-operation at distributed sites.

There is a wide range of providers of these offers, going from commercial publishers and learned societies to volunteers and single authors. Also the list of distributors and information brokers is a long one: libraries, databases and indexing services, internet-portals of different types, web browsers et al. In contrast to the "old world" of printed publications these providers have different aims and it is not always clear for the user what he really could expect from these services, when he is searching for some information or article of his own interest. Clearly, libraries try to transfer their system, they have developed for their printed holdings, to these new publications, and hence they still seem to be the most reliable information provider also with respect to electronic offers. But this role has to be acknowledged more widely and the offer has to be improved.

There are good reasons why libraries will be able to maintain their central role for distribution and storage of scientific information and succeed to extend this to the electronic media. They have developed precise and reliable access structures. Their service is free for their specific group of users, and this group is a large one in most cases. Even for external users they developed a good network of exchange facilities, which enables scientists to make their work really accessible for a wide community of users and to read the work of their colleagues without being confronted with bigger commercial barriers. Commonly libraries cover a broad area of subjects and within that they try to be relatively comprehensive. Independent from the frequency of their usage these holdings had been preserved and kept accessible with great care. The objectives of science libraries are user-oriented on one side. and on the other side libraries feel obliged to protect the treasure of knowledge they have accumulated in their col-

lection. This makes them also the best choice for solving the problem of the long-term preservation of electronic publications.

Mathematics is a science where the availability of electronic publications and retro-digitised documents lead to a considerable improvements of the conditions for research. Hence, though some of the subsequent arguments may apply to all sciences, they turn out to be of particular importance for mathematics: Mathematicians and professionals applying mathematics need quick, reliable and integrated access to mathematical publications. Long-term availability of publications is a particular need in mathematics. Digitising of print-only publications and the adjustment of these offers to the current facilities provided for electronic publications leads to a additional series of problems to be solved. Electronic publishing offers a variety of additional information in mathematics which may be integrated into the access and display structures enhancing the traditional types of publications.

2. Some evidence by numbers

For non-mathematicians it is not clear at all that mathematics is so much different from other sciences as far as easy availability of older publications will be concerned. For some it is even hard to understand the subjects of mathematical research and the special way how this research is published. For example, extensions and improvements of older results only care about the publication of the additional achievements, and there detailed proofs are essential. Older results may and should be cited, but it is not honest to repeat their proofs in research publications, even if the understanding of these proofs is essential for seeing what the new results are about. Many proofs can be found at one place only. Hence an article is just an addition to a sequence of other articles, more or less tightly interrelated in a structure which combinatorically is more complex a tree. It provides another shell to a core of theorems, propositions, examples, models and proofs representing the current knowledge of a subject domain in mathematics. Mathematical research articles commonly are rather thin, and the publication frequency of a mathematician is rather low compared to other sciences.

Admittedly, parts of such a domain may be exhibited comprehensively in monographs, but as can be seen by the variety of material in the research surveys in mathematics which have been published by VINITI, for example, such monographs with detailed exhibitions of arguments only can cover a part of the domain of reference, giving a motivating introduction with proofs, while the surveys have no space to provide proofs at all, if they really want to be comprehensive. This underlines that references in mathematical papers are not just a matter of honesty, but that at least a part of them plays an important role for a complete understanding of the content of an article. Hence the following figures give a good evidence for the need to have also older mathematical publications available.

The evidence will be demonstrated in the case of three journals where the numbers are taken from an investigation by Joachim Heinze [6]. The most surprising figures (also to mathematicians) are the numbers of citations before 1992. In the case of the most traditional mathematical journal from North-America, the Annals of Mathematics, 60 % of the citations in the 35 articles published in that journal in 2001 had a publication date before 1992. Viceversa, the number of cites from the volumes of 500 journals published in 2001 to the Annals was about 4.500 and 82 % of them were before 1992. Looking at one of the first journals which published mathematics only (in contrast to journals which deal with several sciences), the Journal fuer die Reine und Angewandte Mathematik, founded as Crelles Journal in 1826, the first figure was 61 % and the second 65 %. Finally, these numbers still were high for a more "modern" journal which had been founded in the second half of the 20th century, the Inventiones Mathematicae: the first figure was 55 % and the second one 68 %. Such high numbers of older citations are not common for most of the other sciences. It would be quite interesting to have a more comprehensive comparison of this type.

3. Current and future problems

In the "paper world" the long-term preservation of publications was simple on the first view, though at a closer look a lot of problems had to be handled. They mainly came from the deterioration of the paper or the binding of a book or journal, and they appeared after a comparatively long period in which the physical situation of the document could be considered as stable. Also a wide distribution of documents to several locations world-wide was a factor of stability, protecting them against being all destroyed simultaneously by the impact of wars etc.

For digital publications this period of stability turned out to be extremely small. What everybody experiences with his old releases of word-files, became true meanwhile for the readers of PDF-files, for example. Without conversions, if they exist at all, or simultaneous installation of several versions of the Acrobat-reader a whole range of PDF-files over the period, where the Acrobat reader was offered, is not readable anymore. But this is only one problem. Another one is the stability of the physical carrier, where the data are stored, and there is a variety of plug-ins which depend on additional software to be offered with the electronic document. Current releases of this software may have a short lifetime. What should we do with the document afterwards?

To solve this problem will be even more complicated when documents in mathematics are considered, because they are most likely to have software depending enhancements. Interactive documents will play an important role in the future. Furthermore, projects like MoWGLI ([2]) will develop different types of structures enabling semantic mark-up of documents. Hence preservation will go far beyond caring about the displayed text only. Structures, links and other

informational background provided with electronic articles will have to be taken care of, and all these tools are in permanent evolution.

Hence the problem only can be attacked by a long-term approach as it is described with in EMANI in the next section.

4. The EMANI project

There is a period of approximately 10 years during which electronic publications in mathematics developed from some offers in pioneering freely accessible journals to a first class publication facility with enhanced services in comparison to traditional printed publications. As mentioned above, older publications are still of big value for research in mathematics. Hence retrospective digitisation projects increased the current digital content in mathematics considerably. One major of these projects is ERAM (see [3] or [8]) which will be described later on.

In the first half of 2001, the Electronic Mathematics Archives Network Initiative (EMANI) had been founded as a special project to develop models for the archiving of electronic contents in mathematics. Having in mind that a distributed architecture would be more suitable and reduce the load on the partners for such a project, a network is proposed, which also might be a more open approach for extending the project from a initial restricted solution to a more comprehensive enterprise. The initiative has been formalised in July 2002 at their workshop at Cornell University with the partners mentioned below as the first set of members and the author of this article as the co-ordinator of the project.

Thus, for the core of the network, a co-operational system of reference libraries and content providers like publishers and editors has been set up. In the ideal final version they are supposed to serve for a long list purposes: The basic action will be to store the digital content in mathematics from the content providers at the reference libraries. This will be complemented by retro-digitising all printed publications in mathematics from the content providers at the reference libraries, covering a big part of the publications in mathematics by electronic versions finally. On this basis first measures can be undertaken to care about the long-term preservation of this content in readable form. First projects for the technical support of this co-operation have been just initiated.

For example, to have the content stored somewhere will not be sufficient. Retrospective digitisation may lead to scanned images only, which hopefully can be accessed in some repository. As an important enhancement it will be necessary to improve the usability of the retro-digitised publications by introducing advanced linking and searching facilities and to provide convenient and affordable access to the stored content for mathematicians and professionals using mathematics world-wide.

The reference libraries even may serve as a reference system for other libraries which want to store and provide part of the content or refresh their exist-

ing offers by updated material. Having in mind the long time scale of the publications provided through the network, going from articles from the 19th century to current publications, a system of distribution agents will be needed. This may be a good reason to develop new business models for a distribution of mathematical publications in a combined enterprise between reference libraries and content providers. But there is not only a theoretical discussion about potential activities in the furture.

5. The starting point of EMANI

It will be reasonable to start with such a complicated enterprise only on a smaller well-controllable scale at first. Once the architecture and the action plan will have been made sufficiently precise, an extension may be considered. The current partners which collaborate for the first steps in order to implement the initiative on the side of the librariesare:

- The Cornell University Library, Ithaca, N.Y.: They have a good tradition in retrospective digitisation projects and are involved in the archiving discussion for other sciences also. In particular they are building up an offer of a bundle of electronic journals in mathematics through project Euclid. They serve as a mirror site for EMIS (see [9]).
- The State and University Library Goettingen: Also there some important retrospective digitisation projects like ERAM (see [3] or [8]) and DIEPER are pursued. In addition to this the SUB Goettingen is obliged to collect all publications in mathematics. In this role they have a high reputation as a centre for access to mathematical publications. Moreover they also serve as a mirror site for EMIS.
- The Tsinghua University Library, Beijing: This library has experience with the digitisation of Chinese publications. They are a Chinese centre of excellence for installing and offering electronic publications.
- The Orsay Mathematical Library, Paris, in co-operation with the Cellule MathDoc in Grenoble: The group in Orsay is co-ordinating a quite comprehensive consortium of French mathematical libraries. The strength of the partner in Grenoble consists in their excellent retro-digitisation project NUMDAM ([4]).

The content providers for the start are Springer-Verlag, Birkhaeuser Verlag, Teubner Verlag, Vieweg Verlag and the electronic library ELibM offered through EMIS, the European Mathematical Information Service (http://www.emis.de). The four publishers are looking back to a long tradition in publishing mathematics. They are in charge of several of the best journals in mathematics. In contrast to this the ElibM is a co-operation of several journals and editors on a voluntary basis bundling electronic offers in a world-wide system of WWW-servers (see [9]).

First agreements on the architecture of the system have been made. It is common understanding that the storage of the content in a repository will have priority in the near future and that in general copies of the content stored in the

system should be deposited at all reference libraries as a matter of safety. Later on also refreshed versions of the content should be exchanged accordingly. It has been also approved that the partners of the initiative will provide their own achievements to support the aims mentioned above as far as possible. But this will become important in a later phase of the project.

An important step in the first phase of the initiative consists of the step-wise transfer of the available electronic content from the content providers to the reference libraries. There it will be checked if the files still can be used for the archiving, adjustments will be made in the case of files which are unsuitable for this and recommendations will be developed how the content providers could care about a more convenient delivery in future cases. Also new archiving related meta-data have to be defined, and an integrated access structure satisfying the needs of all kind of experts who want to work with the archive will be one of the central achievements of the further work in the future. Though links from reference databases could satisfy many of the needs of the mathematicians to get access, the professional handling of the archives will require more than just their meta-data.

For controlling the further progress of EMANI work-packages have been established and working groups to care about them. They address basic questions like input formats as well as new options like investigating MathML as a mark-up language for future publishing in mathematics. Later these activities will fit together to establish a more concrete version of the EMANI-project as a prototype for long-term preservation of digital publications in mathematics.

6. Other archiving projects

To keep the article short only a rough survey should be given here. Clearly, several approaches to deal with the digital archiving problem are possible, and they have to involve all parties, publishers, libraries and authors. Only a few people still believe, that just copying and storing the articles with their whole web-environment where they are posted is a promising solution. 2001 was the year where several of such co-operations started on a more advanced level, trying to attack the problem with different models. Most of them involve libraries. Here are some examples.

Most prominent is the co-operation between Elsevier and the libraries at Yale University, caring about the digital preservation of all publications of this big publisher. Harvard University works on the same with Wiley, Blackwell Science and Chicago University Press. LOCKSS is a system of archiving sites co-ordinated by Stanford University. Through the project Harvest Cornell University is involved in the archiving of publications in agriculture. MIT has dedicated some efforts to a special type of electronic publications, the dynamic documents. The New York Public Library is working on the digital preservation of arts journals. The American Institute of Physics and the American Physical

Society have established an archiving system for their publications which involves the automatic conversion of files when a new release of the reader is distributed. What all of these projects have in common is, that they represent a first approach only and that nobody has a comprehensive solution.

7. ERAM - combining a database with an archive

Also for older documents searchability will be an important requirement to enable the researcher to find his way in the huge knowledge base of mathematical achievements. Admittedly, no current search engine is able to locate a statement in its abstract meaning. Names for some of them will help, and classification codes of special subject areas will restrict the set of documents where to look for the desired information considerably. Hence literature databases for the classical period of mathematics are desirable. They should offer the same facilities like the current literature information services in mathematics, and even more, they should also provide links to the future given by modern mathematics. This is the starting point for the project ERAM which also will be called the Jahrbuch-project for short.

The acronym ERAM stands for "Electronic Research Archive for Mathematics". The project is funded by the Deutsche Forschungsgemeinschaft (DFG). The institutions caring about the project are the Staats- und Universitaetsbibliothek Goettingen (SUB) and the Technische Universitaet Berlin (TUB). Supervisors of both parts of the project are Prof. Dr. Elmar Mittler (SUB) and the author of this article (TUB). The aim of the project is the installation of a (digital) archive of articles relevant for mathematical research, full searchability and access through a database, captured from the "Jahrbuch ueber die Fortschritte der Mathematik" (1868-1943). The most comprehensive current literature database in mathematics, Zentralblatt MATH, was founded at the end of the Jahrbuch period.

Hence, the first step of the ERAM-project is the production of a bibliographic database, the JFM-database, capturing the content of the Jahrbuch ueber die Fortschritte der Mathematik (JFM). Modern literature databases provide several search options for which the information could not easily be extracted from the text of the JFM. Hence, editorial enhancements are under preparation, and moreover historical links are provided to modern research as far as possible. The only formalised subject information in the JFM consists of the subject headings which are stored in the database like a raw classification. A more precise description of their subjects will be obtained by additional intellectual indexing work. The corresponding experts provide an English translation of the title of the single document, they add a subject classification according to the MSC2000 scheme and assign some English keywords.

Another set of enhancements of the JFM-database will be the result of the editing of data by librarians. They will care about the standardisation of the information available and the provision of links to digital versions of the corre-

sponding article or a library where the article can be ordered using a document delivery service. The standardisation cares about normalised sources. Here additional names of the sources are given like for journals with varying titles of journals in order to provide standard forms of the journal titles and the corresponding abbreviations.

All data from the Jahrbuch will have been keyboarded until end of 2002. The are made accessible in this form in the web, and though for many items the enhancements are still missing the databse has found a lot of grateful users. In addition to its usage as high-quality source for information on classical mathematics, the JFM-database will provide access to a digital archive to be built up within the project. For this selected publications are scanned (as gif-images) and stored in a document management system. Currently there are no conversions of the images into text files. To allow text searches in the archive, text files will be an important addition to the scanned images. But the generation of these data will be a matter of a later phase of the project, hoping that conversion programmes will improve and be able to tackle the problems which occur with formulas in mathematical texts. A first step in this direction is made by a project based on the co-operation of experts from Japan, Germany and the United States (see [7]).

The scanned material includes some collected works and classical handbooks, monographs which are difficult to find in library holdings, mathematical doctoral theses, publications on paper with bad preservation properties, whole series of journal volumes etc. For example, ERAM haS the licence to put digital versions of the "Mathematische Annalen" into the archive, covering all the back volumes until the journal was posted electronically. Most of the journals which have installed recent electronic versions in EMIS (European Mathematical Information Service) agreed that all of their print-only back volumes could be digitised and offered within ERAM, and this also has been done.

In ERAM, about 800.000 pages have been scanned so far, and the capacity of the project will be sufficient to go for about 1.2 million pages. For more details see the references [3] and [8], or the ERAM-homepage under http://www.emis.de/projects/ clicking on the box for the Jahrbuch.

8. The global digital mathematics library - DML and RusDML

ERAM could be considered as a part of a global initiative to have all mathematics digitally available. It has a lot of overlap with EMANI and both projects a tightly linked with each other. But in contrast to EMANI the global initiative at first will concentrate on retro-digitisation, i.e. the preparation of digital versions of texts which are not yet digitally available. Long-term preservation is a secondary aspect of the DML at present. Clearly, in addition to ERAM there are several other digitisation projects on the way, general projects like JSTOR, DIEPER, and the Elsevier backfiles system, and projects in mathematics like

NUMDAM [4] or the national heritage activity in Colombia by Victo Albis [1]. This has to be taken into account for the DML.

In 2001 John Ewing prepared his White Paper [5] in which a rough estimate has been made how much money would be needed to develop global digital mathematics library (DML) containig all mathematics in digital form. This estimate was in the order of 100 million US Dollars. But that was not the main achievement of that paper. It contained a lot of structural considerations for such a library, and it also addressed the immense problems we will be confronted with when we really want to pursue such a project. As a caveat when reading this paper, one should be aware that it describes an ideal solution, and some parts like a central repository (by intention) do not reflect very well what has been developed already. For example, at present only a system of distributed repositories could be imagined, because proprietes and aspects of cultural heritage have to be respected. Furthermore, a distributed system can hook on existing providers like libraries, and this will be more efficient than the installation of an extra infrastructure to manage the DLM, as far as the costs will be concerned.

As a consequence a planning grant had been given to Cornell University by the National Science Foundation of the U.S.A. to make a feasibilty study for the DML. This will be done during two workshops, where the first one took place already in Washington D.C. at the end of July 2002.

The 25 participants from different kinds of institutions set up a scheme to develop a plan for the DML. An initiative has been formalised, working groups have been designed and a Steering Committee has been chosen to guide the progress of the discussion during the next future. More or less the scheme reflects a part of the project administration for EMANI, and indeed DML may profit a lot from the preparations in EMANI.

It will the subject of an article of its own to go into all the details to be addressed by the working groups, but one of them should be explained here, because it is basic for the definition of the global project as well as for the description of the environment for similar national or local projects.

How can we determine what has to be considered as the content of mathematics? Talking to mathematicians it will be noticed rather soon that the idea what should be covered by the DLM is quite vague. There are ongoing projects which have selected items for retrodigitization according to different aspects. These patches of the global DLM can be defined easily, but they cannot serve as a model for a comprehensive coverage of mathematical publications. Hence some more concrete questions arise naturally:

- Do we really have the chance and the interest to cover all mathematical publications world-wide by the DLM? If not so, the selection criteria have to be discussed. But also in the other case we have to decide on selection criteria, because not everything could be done immediately and a time schedule for building up the DLM step by step requires an order and hence a selection. As a first

tool we have to develop a list of the kinds of document to be covered by DLM, where the following list is oriented at printed publications:

1. Articles in refereed journals (in the narrower sense)
2. Articles in newsletters and other non-refereed journals
3. Articles in series of collections of publications
4. Articles in conference proceedings and other non-periodic collections of publications
5. Series of advanced level monographs
6. Single advanced level monographs
7. Series of textbooks
8. Single textbooks
9. Collected works, handbooks, encyclopaedias, bibliographies and similar publications
10. Publications dealing with education in mathematics (including curricula), popularisation of mathematics
11. Dissertations
12. Reports, preprints and other grey literature

Probably the items 1 and 5 are the easiest to be handled systematically.

- How can we determine all documents belonging to one of these items? Proposals are:

1. Relying on the archival information provided by publishing houses and academic publishers
2. Consulting catalogues provided by national reference libraries
3. Consulting catalogues provided by comprehensive reference libraries for mathematics
4. Consulting the databases and printed versions of comprehensive reviewing services like Jahrbuch Эber die Fortschritte der Mathematik, Mathematical Reviews, Referativnyi Zhurnal Matematika, and Zentralblatt MATH
5. Checking special bibliographies and historical surveys in mathematics for older material which is not covered by these reviewing services What else? Probably all these methods will have to be applied to be really comprehensive.

- Which publications may be considered as a part of mathematics according to subject area? There are a lot of choices:

1. Publications and serials dealing with pure and applied mathematics. (That is obvious.).
2. Serials with mixed content, but containing a relevant amount of mathematical publications
3. Serials publishing articles on the borderline of mathematics with applications to other sciences
4. Statistics
5. Logics
6. Theoretical computer science
7. Theoretical physics

8. Theoretical mechanics

8+n. A lot of more areas in the applications of mathematics.

It will need a lot of efforts and patience to arrange such a list of contents and somebody has to administrate this. People are most likely to escape from this by deciding not to care about such a list at all and digitise what will be just in their mind or easily available. This is good for the patchwork, but it will ruin the global idea. To work on the global solution, four dimensions have to be considered:

T - Time: When do we start and how far back should we go?

M - Side to side: Scope of the literature (borderlines to economics, statistics, physics, etc,). How much mathematics is supposed to be in the document?

L - Top to bottom: Different kinds of levels have to be considered: Impact on research, potential user interest in having the document available, depending also on different user communities (research, education, applications, history etc.), quality, availability. Where should be the priorities?

G - Back to front: There is a geographical dimension which may be associated with priorities for the DLM-actions. How should the DLM project spread out from current initial activities covering content from all over the world?

But there is also a cultural dimension. Though the gobal approach is a challenging idea, the development of the repositories should take national interests and funding possibilities into account. Hence distributing the content to single projects has to respect what had been covered already and what should remain under the guidance of a special mathematical community. Only the remaining content may be open for adoption for retro-digitisation. To distinguish this will be one of the main tasks during the content determination and it will be a delicate task, because very quickly there may be the impression that one party wants to buy out the mathematical heritage from another one.

For example, before the discussion in Washington took place, first proposals for the handling of Russian mathematics already had been developed, involving different partners who agreed to pursue that matter consequently. Hence there is no need that this part should be adopted by a third party. The project, which is called Russian Digital Mathematics Library (RusDML), will have to deal with similar problems like the global project, but on a smaller scale. It is designed as a Russian/German cooperation on the side of the partners and on the funding side, but there are no ideas about "buying" and controlling content exclusively at all. The group consists on the first level of GPNTB, RFBR (as provider of a current digital library) and the Mathematical Institute of RAS on the Russian side and SUB Goettingen, TIB Hannover and TU Berlin on the German side. The evaluation the content has started to be able to apply for funding of the digitisation of the core Russian journals in mathematics. Hopefully the project application will be in the refereeing procedure already, when this confernce will

have started. This will bring Russia on a good way as their contribution to the DML will be concerned.

References

[1] Victor Albis, Conservacion del patrimonio matematico colombiano. http://www.accefyn.org.co/historia-matematica/histmatcol.htm; http://www.accefyn.org.co/proyecto/conservacion.htm; http://168.176.37.80/matepro.html

[2] Andrea Asperti; Bernd Wegner: MOWGLI - A new approach for the content description in digital documents. Ninth International Conference "Crimea 2002" Libraries and Associations in the Transient World: New Technologies and New Forms of Cooperation. Conference Proceedings. Sudak, Autonomous Republic of Crimea, Ukraine, June 8-16, 2002, Volume 1: 215-219.

[3] Hans Becker, Bernd Wegner: ERAM - Digitisation of Classical Mathematical Publications, Proc. ECDL 2000, Lecture Notes in Computer Science 1923, 424-427 (2000).

[4] Pierre Berard: Presentation at the San Diego DML-meeting, Joint Mathematics Meeting, January 2002 (see also http://www-mathdoc.ujf-grenoble.fr/NUMDAM/).

[5] John Ewing: Twenty Centuries of Mathematics: Digitizing and disseminating the past mathematical literature. http://www.ams.org/ewing/Twenty_centuries.pdf

[6] Joachim Heinze, presentation at the first EMANI workshop in Heidelberg, February 2002 (article to appear in the Proceedings of the EIC-Satellite Conference to the ICM 2002, Tsinghua University, Beijing)

[7] Gerhard Michler: How to build a prototype for a distributed digital mathematics archive library. Proceedings MKM 2001, Linz, http://www.emis.de/proceedings/MKM2001/.

[8] Bernd Wegner: ERAM - Digitalisation of Classical Mathematical Publications. Seventh International Conference Crimea 2000O Libraries and Associations in the Transient World: New Technologies and New Forms of Cooperation. Conference Proceedings. Sudak, Autonomous Republic of Crimea, Ukraine, June 3-11, 2000, Volume 1: 268-272.

[9] Bernd Wegner: ELibM in EMIS - A Model for Distributed Low-Cost Electronic Publishing. Eight International Conference Crimea 2001O Libraries and Associations in the Transient World: New Technologies and New Forms of Cooperation. Conference Proceedings. Sudak, Autonomous Republic of Crimea, Ukraine, June 9-17, 2001, Volume 1: 317-320.