TeX at *Mathematical Reviews*

D.C. Latterner and W.B. Woolf

Mathematical Reviews
P.O. Box 8604
Ann Arbor, MI 48107-8604
dcl@math.ams.com
wbw@math.ams.com

ABSTRACT

A brief description of the history of *Mathematical Reviews* (MR) is followed by a detailed discussion of the use of TeX in the current MR production system. The flow of a sample item through the MR "pipeline" is traced, showing how TeX is used to produce in-house tracking and proofreading documents as well as the MR journal and its related publications. The design and use of generically tagged data files extracted from the MR database are described, with an explanation of how this approach takes advantage of the powerful formatting capabilities of TeX. Finally, the use of TeX in the on-line version of MR is demonstrated.

1. Introduction

Mathematical Reviews (MR) is the world's pre-eminent secondary journal covering research in pure and applied mathematics.[1] It was founded in 1940; it has grown from 2,120 items in 1940 to about 50,000 per year currently.

In the early years, MR was produced from bibliographic information maintained on file cards and from review manuscripts prepared in pen and ink or on typewriters by reviewers around the world. Over the last fifty years, there has been some change in the form or manner of reviews submitted by reviewers: the handwriting is still quite varied and occasionally hard to read, the typing is still frequently error-prone and smudgy, but the typewriter has become a word processor. (The future is also beginning to show in the few manuscripts each month which are submitted electronically.) But more dramatic changes have taken place in the way the bibliographic information is maintained. From file cards in the 1940s (from which information was repeatedly re-typed in the process of preparing review forms and typesetting MR issues, indexes, annual indexes and cumulative indexes), and "ditto" masters in the fifties, sixties and seventies (which allowed one keyboarding for file cards and forms, but still required a separate keyboarding for each issue, index, annual index and cumulative index), MR moved to a database management system (SPIRES) and a computer typesetting system (STI, from Science Typographers, Inc.). This proprietary typesetting system allowed the same keyboarded input to be used for cards and forms as was used for all issues and indexes, but only the outputs created by the STI company from its typesetters carried the typeset appearance; cards and forms carried the raw coded input from which the STI typesetting program would create camera-ready copy. In 1983, MR changed to a CODASYL database management system (SEED), and yet another migration is under way at present, to a relational database management system (INGRES).

While MR was still using STI, it began experimenting with TeX. A program was written to convert the STI code into TeX, and a few macro files were written to format in-house forms. The advantages of TeX over STI soon became apparent. Outputs could be had in typeset rather than raw coded form

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[1] A secondary journal carries abstracts and/or reviews (with bibliographic information) of articles published in primary journals and collections, as well as of monographs.

and, most importantly, MR was no longer dependent on an outside source for its typesetting needs. By 1985, MR had fully adopted TeX as its typesetting language.

The following sections detail the ways in which TeX is used to provide multiple outputs from the MR database, and the efficiencies and economies that this implies.

2. The MR Production System

From the time an article is received at MR to the time a review is actually published (and even beyond, to its appearance on-line in MathSci), the bibliographic data and the review undergo much examination and correction. Along the way, a variety of programs extract information from the MR database for proofreading purposes and report generation. These database extraction programs, along with the TeX macro files ("headers") that format the extracted data, form the backbone of the MR TeX production system.

2.1 The MR Database and Extraction Programs

The MR database is currently managed by a CODASYL-type database management system running on one of the DEC-20 machines at the headquarters of the American Mathematical Society (AMS) in Providence, RI; it contains bibliographic information on about 300,000 items reviewed in MR from 1985 to the present or awaiting publication. These several years of information are kept on-line to support referencing and author identification functions. Older material is available on archived copies of the database. The database is bibliographic only, i.e., it contains only author, reviewer, title, journal and publisher information, and a variety of flags for tracking purposes. Due to space considerations, the reviews themselves are not stored in the database, but rather as text files linked to the bibliographic information in the database by means of unique accession numbers, on-line before publication and on tape thereafter.

While the database resides on the DEC mainframe, much of the production work, particularly the typesetting, is off-loaded to a network of Apollo workstations located at the MR offices in Ann Arbor, MI. Data files from the mainframe are transferred to the Apollos via FTP or KERMIT. Most proof output is printed on an Imagen 5320, with an Imagen 8/300 serving as a secondary printer. Camera-ready copy is obtained from an Autologic APS-$\mu5$ in Providence.

Although the idea of generically tagged files is certainly not a new one, particularly in the TeX arena, the use by MR of the principle provides a good illustration of the advantages of this approach in a TeX-based production system. Since the format of the extracted data files is central to the way in which TeX is used in production at MR, a brief discussion of the design principles behind the extraction programs follows.

The database extraction programs retrieve information from the database and format it in a manner easily manipulable by an appropriate set of TeX macros. Figure 1[2] shows the output of the extraction program MAKMRB (MRB refers to <u>MR</u> <u>b</u>ibliographic file) and an example of one type of TeX document produced from this mrb file. This example illustrates the characteristics of an MR extracted data file:

1. Each data entity is individually tagged. Volume, year and issue, for example, are each tagged separately rather than combined into one field.
2. Data elements are tagged with unique, descriptive control sequence names and terminated with the control sequence \endx.
3. All data associated with a particular item are pulled, even though certain elements may not actually be typeset in a given document. Figure 1 shows the element \etype in the tagged file, although that element is not used in the output shown. Other documents, however, may typeset this field.
4. The tagged data do not contain formatting instructions.

Since most TeX documents generated from an extracted file include only a subset of the data pulled, MR uses a system whereby the first macro file \input is a "tags" file. The tags file contains macro definitions instructing TeX to ignore all the possible tagged data fields associated with a particular

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[2] All figures can be found at the end of the article —Ed.

extraction program. It is followed by a document-specific header which re-activates and formats the desired fields. For example, the line

$$\def \etype #1\endx{}$$

is found in the file makmrb.tags, in effect "nullifying" the \etype field. In the header for a "daily box proof", this field is re-activated with the definition

$$\def \etype #1\endx{\qquad \hbox{{\tt ET =} #1}}$$

while in the MR issue header, there is no re-activation and the definition supplied by makmrb.tags remains in effect. Thus, the tags file is an efficient way to provide TeX with a definition for every tagged field, so that undefined control sequences can be avoided.

This approach to the design of the data files has allowed MR to take advantage of TeX's tremendous formatting capabilities. The same generically tagged file can be formatted into literally any type of document simply by writing or modifying a set of TeX macros.

2.2 The Spine

Perhaps the best way to illustrate the production system at MR is to track the flow of a reviewed item through the MR "pipeline". The process begins with the receipt of a "spine" — a book or an issue of a journal — into the MR library. An identification number, called a spine number, is assigned to the spine and certain basic bibliographic elements such as the book title or issue volume and number are keyed into the database.

To take a real example, suppose that Vol. 91, no. 8 of *The American Mathematical Monthly* arrives at the MR office. The next unused spine number, S117 897, is assigned and the issue volume and number are input into the database, along with flags indicating how the bibliographic information should be displayed in print.

After a day's worth of spines has been entered in the database, several TeXed documents are generated using an extraction program called SPINES. The first, a "spine form", displays all the current information held in the database for a particular spine. The spine form is physically attached to the spine; any corrections or comments about the spine are recorded on the form and the database is later updated to reflect these changes. Figure 2 shows the output of the SPINES program and a sample spine form.

An interesting aspect of this particular form is the barcode at the bottom. Generated by TeX macros, it represents the spine number (Issue cno: on the form). Barcodes are used on a variety of MR documents for tracking purposes. Every four months, an inventory of items at various stages in the pipeline is conducted in order to identify old or lost items. Barcodes enable this function to be performed quickly and efficiently.

Mail logs are produced along with the spine sheets using the same extracted input files. These are lists of all spines added to the database on a particular day, separated into books and journal issues. The issue of *The American Mathematical Monthly* would appear on the log along with all the other journal spines that were added to the database that day, as in the following excerpt:

S117 893   Acta Math. Hungar. **53** (1984), no. 1–2

S117 896   Comm. Math. Phys. **120** (1984), no. 4

S117 897   Amer. Math. Monthly. **91** (1984), no. 8

S117 901   Bull. Calcutta Math. Soc. **80** (1984), no. 6

Next, spines are arranged into an "editors' box" and routed to the MR editorial staff for decisions on whether they are within the scope of the areas of mathematics reviewed in MR, and for classification according to the Mathematics Subject Classification scheme. Travelling with the editors' box is another TeXed document based on the output of the SPINES program — an editors' box log that lists the spines contained in the box. To continue the example, the editors scan *The American Mathematical Monthly*,

Vol. 91, no. 8, assigning preliminary 2- or 3-digit classifications to those articles they consider to be of interest to the mathematical community.

2.3 The Bibliographic Item

After the editors finish with the spines, they return them to the library where the staff provide a bibliographic "set-up" for the selected articles. The spines containing the selected articles are collected together into a "daily box" and a daily box log is generated using the SPINES program. New paper-specific accession numbers — called control numbers — are assigned to the chosen articles, and the bibliographic information for those items is keyed into temporary files using a program called MRPADD (MR paper add).[3] An extraction program called PADGAL is then used to pull the information from the MRPADD files, and a daily box proof is produced, using the output of PADGAL in combination with a TeX header file (see Figure 3). The daily box proof is proofread and corrected and the information is loaded into the database.

Now that the complete bibliographic data for the items in a daily box are held in the database, the real workhorse of the extraction programs — MAKMRB — is used. Its first task is to create the input file for generating "editor assignment forms", forms that are used by the editors to record their assignments of reviewers to the items in the daily box that will eventually be reviewed (see Figure 4). The editor adds the first three letters of the reviewer's last name and his reviewer code (a unique number assigned to the reviewer, used internally at MR) to the form. There are also numeric codes on the form for those items that the editor suggests be reviewed from the author's summary, from the preface, etc. The forms are routed back to data entry staff and the assignments are keyed into the database. The example shows that M.S. Cheema, with a reviewer code of 03162, was assigned to review "The toilet paper problem".

2.4 The CMP Issue

After three weeks' worth of daily boxes have been added to the database (this amounts to 3000+ items), an issue of *Current Mathematical Publications* (CMP) is ready to be produced. The process begins with the creation of a giant mrb file containing the bibliographic information for all the items entered over the three-week period. Much of the CMP is generated in one way or another from this mrb file or parts of it, although some sections require further "massaging" by other programs in order to combine entries, add cross-references and section heading information, and provide some formatting instructions to TeX. The source file for the CMP "Books Listed in This Issue" section, for example, is actually an unembellished mrb file, while that of the "Complete Bibliographic Listing by Subject Classification" section requires further mrb file processing. Figure 5 shows the familiar example as it appears in the "Bibliographic Listing" section along with its TeX source. For illustration purposes, a fictional co-author has been introduced to show how cross-references are added to the source file.

The various sections of the CMP issue are actually TeXed twice. The first run generates output that is designed to make the job of proofreading easier: it is set in single-column format (or in some cases double column, if the section is ultimately printed in more than two columns) with plenty of space in the margins for marking. Also, the output is magnified, since the type size used in CMP is quite small. After proofreading and correction, the issue is re-TeXed (this time in the format of the published CMP), camera-ready copy is ordered off the APS-μ5, and the issue is delivered to the printer.

Because MR tends to use fairly small type in its publications, the scenario just described — a first run that generates enlarged output for proofreading and a final run that produces copy as it will appear in print — is an often repeated one at MR. This ability to switch from one output mode to another is a feature of many of the TeX macro files used in MR production. Horizontal spacing (i.e., line breaking) remains the same from the first run to the final run; it is only the placement of the material on the page and the page length that changes. All of this is accomplished with switches built into the macros: a \FirstRun switch generates proofreading copy, a \FinalRun switch produces final

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[3] The MRPADD interface was designed to facilitate input and to make the correction process easier. Inputting the bibliographic information directly into the database would be cumbersome.

copy. For the most part, the output routines used to produce final copy are fine-tuned enough so that re-runs for bad page or column breaks are rare.

2.5 Review Forms

Once the database has been updated with the reviewer assignment, a "review form" is printed and mailed to the reviewer along with a copy of the article to be reviewed. A detailed look at this form demonstrates the great versatility of TEX in the MR production environment. The form consists of several parts (see Figure 6):

1. An overlay that partitions the form into various sections. (The macros for this overlay consist of a variety of rule boxes and some text which are put into a box the size of the page and \copy'd for each new form produced.)
2. The bibliographic information in the top left-hand corner derived from the mrb file.
3. The reviewer's address, also taken from the mrb file, at the bottom left-hand corner, positioned so that it appears in the window of the envelope when the form is folded.
4. The barcode at the very bottom of the form.

An interesting sidelight to the production of review forms has to do with so-called "pre-publication" items. These are articles from selected journals that have been accepted for publication by the editors of those journals but have not yet appeared in print. In order to accommodate this type of item efficiently, a new tag — \isprepubl — was added to MAKMRB. The presence of this tag in the mrb file for a review form will (1) add the phrase "to appear" to the bibliographic heading on the review form and (2) generate a separate attachment describing the treatment of pre-publication articles at MR. This example points out the ease with which new tagged fields can be introduced into the MR production stream. In this particular case, all that was needed after MAKMRB was programmed to output the tagged field was the addition of the line to ignore the field in makmrb.tags, and a re-definition of \isprepubl in the header that produces the review form.[4]

MR strives to be as timely a publication as possible through procedures such as the pre-publication process just described and periodic inventories of items in the MR office. Another method used to keep MR up-to-date is the mailing of reminder letters to reviewers who have not returned their written reviews for a significant period of time. Every three weeks a list of such reviewers is compiled along with a TEX source file containing their addresses and a list of the items they have not returned. The letters are then TEXed and mailed.

2.6 The Review

There are two ways in which a review is received back at the MR office. Since January of 1988, MR has been accepting manuscripts through the electronic mail system; currently, several dozen reviews a month are received electronically. Most reviewers, however, still type, typeset or write their reviews on the review forms provided and return them to MR by mail. Once received back at MR, the reviews are routed to the copy editors for copy editing and verification of references, and to the editors for substantive editing. They are then passed on to keyboarders in Providence and Ann Arbor. Reviews are input using the macros of $\mathcal{AMS}$-TEX as a standard, although there are a few cases where conflicts between $\mathcal{AMS}$-TEX and plain.tex are resolved in favor of plain.tex (for instance, MR uses \. for the dot accent as defined in plain.tex rather than \D of $\mathcal{AMS}$-TEX). However, since MR is a journal of abstracts rather than complete papers, the mathematics generally is not difficult to code and there are relatively few instances where such conflicts occur. As noted earlier, the review text is not entered into the database but rather is written to a text file and tied to its bibliographic information by means of its control number. Thus, the name of the example review text file is 761401.msr (msr refers to manuscript review).

After the review text has been keyed, the file is merged with its bibliographic information, re-named to be an mrg file (merge), and TEXed to produce an "item proof" (see Figure 7). At this point, the

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[4] In the CMP "Complete Bibliographic Listing by Subject Classification" section, the \isprepubl tag also produces the phrase "to appear" for the entry. Later, after the article is actually published, the item appears a second time in CMP followed by the symbol ○, triggered by the presence of the tag \wasprepubl in the mrb file.

item actually begins to look like an entry in an MR issue. In fact, the same TEX headers used to process the MR issue are used here to generate item proofs. Like the CMP headers, they contain a set of switch options for producing several different output types. Thus, there is an \ItemProofSwitch, a \FinalRunSwitch that calls up the macros for typesetting the MR issue as it appears in print, a \ClippingsSwitch for preparing "clippings" of reviews be sent to publishers of books, and a number of others.

Item proofs are routed to the editorial staffs for proofreading and editing, and then back to the keyboarding staff for correction. On the average, an item is run through TEX twice before it is declared "clean" and ready for the issue "pool".

2.7 The MR Issue

Once a month, reports are run on the approximately 4000 items ready for publication to give the editors a final opportunity to remove from, add to, or substitute for, items in the issue pool. After any necessary adjustments have been made, the MR issue is created: MR numbers are assigned (recall that up to this point there have been only control numbers), cross-reference information is created, and bibliographic information is extracted (using MAKMRB) and merged with the review text files in the issue pool. This process results in 61 mrg files, one for each subject area.

Next, TEX is run on each of the 61 section files to produce a first set of page proofs that are then scanned by editorial staff. An author index, a "key" index (a list of "unauthored" items such as collections or conference proceedings) and a list of new serials being reviewed in MR are also produced and proofread. After all corrections have been made, there is a final page proof run, this time in three or four large chunks, rather than section by section. Once again the proofs are scanned and, if there are no further corrections to be made (generally there are none at this stage), camera-ready copy is ordered off the APS-μ5.

2.8 MR Sections

MR provides mathematicians with the option of subscribing to a section or sections of MR in which their main interests lie. For instance, a combinatorialist who subscribes to MR Sections for section 05 is provided every month with a "mini" version of MR consisting of reviews from section 05 along with an author and key index for that section. Although MR has looked at the possibility of re-TEXing the individual sections of MR and using laser printer output for MR Sections, it has so far been more cost-effective simply to re-use the camera copy from the MR issue. The author and key indexes for MR Sections, however, must be generated from scratch, since they represent only those authors and unauthored items within that section (whereas the indexes in the MR issue are alphabetized lists of names and keys taken from the issue as a whole).

2.9 The Annual Index

After the items in the December issue of MR have been assigned MR numbers (even before that issue is TEXed), production of the Annual Index of MR begins. The Annual Index consists of a number of parts:

1. a bibliographic index by author name
2. a bibliographic index by "key"
3. a list of all serials appearing in MR
4. a list of journals that are translations of other journals
5. the complete list of author institution codes used in MR
6. some information on the transliteration of Cyrillic in MR
7. a bibliographic index by subject classification
8. the MR subject classification scheme

Mrb files containing all items that have been reviewed over the past year, as well as items that will not be reviewed but have appeared in CMP, are extracted. The format of the items in the bibliographic indexes is much like that of the "Complete Bibliographic Listing by Subject Classification" section of CMP. In fact, the same programs used to generate that section of CMP are employed here with only a few minor changes.

Thus, the Knuth paper mentioned earlier would be found in the author index under the letter

"K" along with any other papers Knuth may have written that were reviewed in the same year, and under section "05" of the subject index. Information on the journal in which the paper appeared could be looked up under "*Amer. Math. Monthly*" in the serials list; Knuth's institutional address could be obtained from the author institution code list under "1-STF-C"; and a description of the article's classifications, 05A10 and 05A15, could be found in the subject classification scheme (see Figure 8a-e).

The process of producing an Annual Index is spread over a period of about three months. Annual section indexes, including subject, author and key indexes, are also produced for MR Sections subscribers.

2.10 MathSci and MathSci Disc

Since 1982, the AMS has provided the mathematical community with the information contained in MR and CMP in an on-line database now called MathSci. Users of MathSci can find information on any item published in MR since 1959 (the review text is available only for the years 1980 to the present), as well as those items from CMP not yet in MR. With the adoption of TeX as its typesetting language in 1985, MR was able to add a new dimension to the MathSci database: users equipped with a TeX software package (MathSciTeX, obtainable from the AMS) can print or preview the results (for items from 1985 or later) of their MathSci sessions in typeset form rather than as encoded on-line records (see Figure 9a-b).

MathSci Disc makes available a subset of the MathSci database (MR 1985–1988, plus 68,000 CMP entries) on CD-ROM. Search records can be downloaded to hard disk for typesetting with TeX software.

3. Conclusion

The advantages to a bibliographic database operation of a typesetting language that provides input for all manner of outputs — from office forms to issues and indexes — cannot be overstated. That the language is in the public domain and has been widely adopted by the mathematical community, and that it can be used to drive many varied output devices and fonts is of substantial additional value. While the current mode of operation at MR seems standard and routine to those who work there, it is useful to reflect on how modern, state-of-the-art, and efficient this mode is, compared to what was available only a decade ago.

```
\paper 761 401\endx
\mrnum 86a:05006\endx
\cno 761 401\endx
\hdyr 84\endx
\etype J\endx
\status PUBL\endx
\cv 17\endx
\ci 2\endx
\editor AG\endx
\psubj 05A15\endx
\ssubj 05A10\endx
\authno \endx
\namepub Knuth, Donald E.\endx
\inst 1-STF-C\endx
\instname Department of Computer Science, Stanford University\endx
\instaddr Stanford, California, 94305\endx
\mtitle The toilet paper problem.\endx
\lang English\endx
\mrabr Amer. Math. Monthly\endx
\jname The American Mathematical Monthly\endx
\vol 91\endx
\yr (1984),\endx
\iss no.~8,\endx
\pp 465--470.\endx
\jorissn 0002-9890\endx
\jorcoden AMMYAE\endx
\tyrevtext Signed review\endx
\revf Cheema, M. S.\endx
\revr M. S. Cheema\endx
\revl (1-AZ)\endx
\revcode 03162\endx
\endpaper
```

86a:05006 05A15
Knuth, Donald E. (1-STF-C)
The toilet paper problem.
Amer. Math. Monthly **91** (1984), *no.* 8, 465–470.

Figure 1: `MAKMRB` output and sample TeX document

```
\spines \endx
\isscno S117 897\endx
\maillog AA\endx
\issindate 841012\endx
\isszero \blanks \endx
\counttag \blanks\endx
\jorcolltype \blanks\endx
\jorkey AMEMM\endx
\jorabbrev Amer. Math. Monthly\endx
\pubkey 0-88385B\endx
\pubname Mathematical Association of America\endx
\pubstitle Math. Assoc. America\endx
\publoc Washington, DC\endx
\pgprf N\endx
\issvol 91\endx
\volsl N\endx
\issyr 84\endx
\yhd N\endx
\issno 8\endx
\ord N\endx
\issname \blanks\endx
\jctitle \blanks\endx
```

Issue cno: S117 897   Count: _____

Entry date: 84/10/12   Journal collection type: _____

Issue zero: Related cno: _____

****

AMEMM/Amer. Math. Monthly

0-88385B/Mathematical Association of America, Washington, DC

Pageproof flag: N

****

Volume: 91	Paren. number:
Volume slash flag: N	Part number:
Issue year: 84	Supplement:
Year hanging date: N	Hanging date:
Issue number: 8	Order flag: N
Multi issue number:	Duplication:

Issue name: _____

JC title: _____

Figure 2: SPINES output and spine form

```
\dbox 841015\endx
\isscno S117 897\endx
\jorkey AMEMM\endx
\cno 761 401\endx
\etype J\endx
\pp 465--470\endx
\ioflag N\endx
\psubj 05A\endx
\mtitle The toilet paper problem.\endx
\namepub Knuth, Donald E.\endx
\inst 1-STF-C\endx
\instname Department of Computer Science, Stanford University\endx
```

S117 897   761 401   ET = J
            PP = 465–470
            IO = N
            PCLASS = 05A
            T = The toilet paper problem
            A = Knuth, Donald E.
            INST = 1-STF-C   Department of Computer Science, Stanford University

Figure 3: Daily box proof input and output

761 401
et : J   CMP 17 : 2   05A

Knuth, Donald E. (1-STF-C)
  The toilet paper problem.
  Amer. Math. Monthly **91** (1984), *no.* 8, 465–470.

☐☐☐   ☐☐☐☐

(reviewer last name - first 3 letters)(reviewer code)

DATE :   EDITOR :

☑ Summary . . . . (2)   ☐ From text . . . . (9)
☑ From sum . . . . (4)   ☑ From preface . . . . (10)
                                     ☑ EDS . . . . (1)

☑ Introduction . . . . (5)   ☑ Title . . . . (12)
☐ From intro . . . . (7)   ☐ . . . . (11)
                                     Date Produced : 1/26/85

‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖
761 401

Figure 4: Editor assignment form

```
\newaut Knuth, Donald E.\endx
\inst 1-STF-C\endx
\others ({\it with\/} Drofnats, R. J. \instc{1-ABC-D})\endx
\mtitle The toilet paper problem.\endx
\mrabr Amer. Math. Monthly\endx
\vol 91\endx
\yr (1984),\endx
\iss no.~8,\endx
\pp 465--470.\endx
\cmpclass 05A\endx
\endpaper
\newaut Drofnats, R. J.\endx
\see Knuth, Donald E.\endx
```

Knuth, Donald E.(1-STF-C) (*with* Drofnats, R. J. (1-ABC-D)) The toilet paper problem. *Amer. Math. Monthly* **91** (1984), *no.* 8, 465–470. 05A
Drofnats, R. J. *See* **Knuth, Donald E.**

Figure 5: CMP "Complete Bibliographic Listing by Subject Classification" TEX input and output

MATHEMATICAL REVIEWS

761 401   AG

et : J   CMP 17 : 2   05A

Knuth, Donald E. (1-STF-C)
  The toilet paper problem.
  Amer. Math. Monthly **91** (1984), *no.* 8,
465–470.

TOG: RP

REVIEWER: Please give 5-character classification(s) according to
1980 Subject Classification (1985 Revision). (See the most recent
MR Annual Subject Index.)

— — — — — , — — — — —

— — — — — , — — — — —

Conventions (use colored pencil):

Greek   : underline in red
German Fraktur   : print or type roman letter, underline in green
Script   : print or type roman letter, encircle in blue
Boldface   : underline with a wavy blue line

Do not underline for italics. (Letters used as mathematical symbols are automatically
italicized by our printer.)

PLEASE TYPE WITH EXTRA SPACE BETWEEN LINES

T

C1

C2

L

E1

E2

Q

Professor M. S. Cheema
Department of Mathematics
University of Arizona
Tucson, AZ 85721

CONTINUE ON SEPARATE SHEET IF NECESSARY.

If the paper is in Russian or Chinese, and you consider it to have
exceptional merit warranting translation, check here. ☐

Figure 6: Reviewer form

761 401

99a:99999 05A15
Knuth, Donald E. (1-STF-C)
The toilet paper problem.
Amer. Math. Monthly **91** (1984), *no.* 8, 465–470.

The toilet paper dispensers are designed to hold two rolls of tissues, and a person can use either roll. There are two kinds of users. A big chooser always takes a piece from the roll that is currently larger, while a little chooser does the opposite. When the two rolls are the same size, or when only one is nonempty, everybody chooses the nearest nonempty roll. Assume that people enter the toilet stalls independently at random, with probability p that they are big choosers and probability $q = 1 - p$ that they are little choosers. If two fresh rolls of toilet paper, both of length n are installed, let $M_n(p)$ be the average number of portions left on one roll when the other one first empties. The purpose of this paper is to study the asymptotic value of $M_n(p)$ for fixed p as $n \to \infty$. Let $M(z) = \sum_{n \geq 1} M_n(p) z^n$, and $C(z) = \sum_{n \geq 1} c_n z^n$, $c_n = \binom{2n-2}{n-1}/n$ (Catalan numbers) be the generating functions. It is proved that $M(z) = (z/(1-z)^2)((q - C(pqz))/q)$. Let r be any value greater than $4pq$; then $M_n(p) = p/(p-q) + O(r^n)$ if $q < p$, $M_n(p) = ((q-p)/q)n + p/(q-p) + O(r^n)$ if $q > p$, and $M_n(\frac{1}{2}) = 2\sqrt{n/\pi} - \frac{1}{4}\sqrt{1/\pi n} + O(n^{-3/2})$.

M. S. Cheema (Tucson, Ariz.)

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761 401

Figure 7: Item proof

Knuth, Donald E. The toilet paper problem. *Amer. Math. Monthly* **91** (1984), *no.* 8, 465–470. **86a:05006** 05A15 (05A10)

Figure 8a: Excerpt from annual author index

Amer. Math. Monthly The American Mathematical Monthly. Math. Assoc. America, Washington, DC.

Figure 8b: Excerpt from annual serials list

1-STF-C
Department of Computer Science
Stanford University
Stanford, CA 94305

Figure 8c: Excerpt from annual institution code list

Knuth, Donald E. The toilet paper problem. **86a:05006**

Figure 8d: Excerpt from annual subject index

05A10   Factorials, binomial coefficients, combinatorial functions
         [See also 11B65.]
05A15   Combinatorial enumeration problems, generating functions

Figure 8e: Excerpt from subject classification scheme

```
AN- 1541094|
AN- <MR Number> 86a#05006|
AN- <Paper Number> CMP 761 401|
TI- The toilet paper problem.|
AU- Knuth, Donald E.
     (Department of Computer Science, Stanford University,
     Stanford, 94305, California)|
CS- 1-STF-C|
JN- Amer. Math. Monthly, 91, no. 8, 465--470.|
PY- 1984|
SN- 0002-9890|
CO- AMMYAE|
LA- English|
DT- Journal|
SF- MR (Mathematical Reviews)  AMS|
RL- MEDIUM (20 lines)|
AB- The toilet paper dispensers are designed to hold two rolls of tissues,
     and a person can use either roll. There are two kinds of users. A big
     chooser always takes a piece from the roll that is currently
     larger, while a little chooser does the opposite. When the two rolls
     are the same size, or when only one is nonempty, everybody chooses
     the nearest nonempty roll. Assume that people enter the toilet stalls
     independently at random, with probability $p$ that they are big
     choosers and probability $q=1-p$ that they are little choosers. If
     two fresh rolls of toilet paper, both of length $n$ are installed,
     let $M\sb n(p)$ be the average number of portions left on one roll
     when the other one first empties. The purpose of this paper is to
     study the asymptotic value of $M\sb n(p)$ for fixed $p$ as
     $n\to\infty$. Let $M(z)=\sum\sb {n\ge1}M\sb n(p)z\sp n$, and
     $C(z)=\sum\sb {n\ge1}c\sb nz\sp n$, $c\sb n={2n-2\choose n-1}/n$
     (Catalan numbers) be the generating functions. It is proved that
     $M(z)=(z/(1-z)\sp 2)((q-C(pqz))/q)$. Let $r$ be any value greater than
     $4pq$; then $M\sb n(p)=p/(p-q)+O(r\sp n)$ if $q<p$, $M\sb
     n(p)=((q-p)/q)n+p/(q-p)+O(r\sp n)$ if $q>p$, and $M\sb n({1\over
     2})=2\sqrt{n/\pi}-\frac 14\sqrt{1/\pi n}+O(n\sp {-3/2})$.|
RE- <Name> Cheema, M. S.|
RE- <Location> (Tucson, Ariz.)|
RT- Signed review|
DE- *COMBINATORICS  -Classical combinatorial problems --Combinatorial
     enumeration problems, generating functions (05A15); COMBINATORICS
     -Classical combinatorial problems --Factorials, binomial coefficients,
     combinatorial functions (05A10)|
```

Figure 9a: MathSciTeX input file

Title: The toilet paper problem.

Author: Knuth, Donald E. (Department of Computer Science, Stanford University, Stanford, 94305, California)

Corporate Source: 1-STF-C

Journal: Amer. Math. Monthly, 91, no. 8, 465–470.   *Year*:   1984   *ISSN*   0002-9890

    CODEN: AMMYAE

    Language: English   *Document Type*: Journal

    Subfile: MR (Mathematical Reviews) AMS   *Length*: MEDIUM (20 lines)

Review:

The toilet paper dispensers are designed to hold two rolls of tissues, and a person can use either roll. There are two kinds of users. A big chooser always takes a piece from the roll that is currently larger, while a little chooser does the opposite. When the two rolls are the same size, or when only one is nonempty, everybody chooses the nearest nonempty roll. Assume that people enter the toilet stalls independently at random, with probability p that they are big choosers and probability $q = 1 - p$ that they are little choosers. If two fresh rolls of toilet paper, both of length n are installed, let $M_n(p)$ be the average number of portions left on one roll when the other one first empties. The purpose of this paper is to study the asymptotic value of $M_n(p)$ for fixed p as $n \to \infty$. Let $M(z) = \sum_{n \geq 1} M_n(p) z^n$, and $C(z) = \sum_{n \geq 1} c_n z^n$, $c_n = \binom{2n-2}{n-1}/n$ (Catalan numbers) be the generating functions. It is proved that $M(z) = (z/(1-z)^2)((q - C(pqz)/q)$. Let r be any value greater than $4pq$; then $M_n(p) = p/(p-q) + O(r^n)$ if $q < p$, $M_n(p) = ((q-p)/q)n + p/(q-p) + O(r^n)$ if $q > p$, and $M_n(\frac{1}{2}) = 2\sqrt{n/\pi} - \frac{1}{4}\sqrt{1/\pi n} + O(n^{-3/2})$.

    Reviewer: Cheema, M. S. (Tucson, Ariz.)

    Review Type: Signed review

Descriptors:

*COMBINATORICS -Classical combinatorial problems –Combinatorial enumeration problems, generating functions (05A15); COMBINATORICS -Classical combinatorial problems –Factorials, binomial coefficients, combinatorial functions (05A10)

Figure 9b: MathSciTEX output