MINI-UNIX Summary

A. Hardware

MINI-UNIX runs on a DEC PDP11/10, 11/20 or 11/40 with at least the following equipment:

> 28K words of memory: parity not used,
> disk: RK05(preferably 2) or equivalent,
> console typewriter,
> clock: KW11-L or KW11-P,

The system is normally distributed on 9-track tape or RK05 packs.

The following equipment may be supported:

> communications controllers such as DL11, DC11 or DH11,
> full duplex 96-character ASCII terminals,
> RP03, RP04 disks,
> 9-track tape, or extra disk for system backup.

The memory and disk space specified is enough to run and maintain MINI-UNIX. More will be needed to keep all source on line, or to handle a large number of users, big data bases, diversified complements of devices, or large programs. MINI-UNIX does swapping to provide multi-programming support. The resident code of MINI-UNIX occupies 12-16K depending on configuration. The system as distributed occupies 12K words of memory, allowing 16K words of memory for the user programs. Some editing of source code is required to add new disk, tape or communication device drivers, as the system size will likely expand beyond 12K words. Keep in mind that the C compiler requires a minimum of 12K words of memory to run.

An 11/10, 11/20 or 11/40 is not advisable for heavy floating point work, as MINI-UNIX on this hardware uses interpreted 11/45 floating point.

B. Software

All the programs available as MINI-UNIX commands are listed. Every command, including all options, is issued as just one line, unless specifically noted as "interactive". Interactive programs can be made to run from a prepared script simply by redirecting input.

File processing commands that go from standard input to standard output are noted as usable as filters. The piping facility of the Shell may be used to connect filters directly to the input or output of other programs. Note: pipes are not supported in the system as in standard UNIX. However "pseudo-pipes" are supported in the Shell to enable using commands as filters.

Software listed in Section 6, "Typesetting", is distributed separately as an enhancement to MINI-UNIX. Source code is included except as noted.

1 Basic Software

This package includes the time-sharing operating system with utilities, a machine language assembler and a compiler for the programming language C—enough software to write and run new applications and to maintain or modify MINI-UNIX itself.

1.1 Operating System

☐ MINI-UNIX The basic resident code on which everything else depends. Supports the system calls, and maintains the file system. A general description of UNIX design philosophy and system facilities appeared in the Communications of the ACM, July, 1974. The following UNIX capabilities are *not* included in MINI-UNIX:
- Separate instruction and data spaces on 11/45 and 11/70.
- "Group" access permissions for cooperative projects, with overlapping memberships.

- Timer-interrupt sampling and interprocess monitoring for debugging and measurement.
- Unbuffered physical record I/O.

☐ Manual   Printed manuals for MINI-UNIX and all its software, except where other manuals exist.
- UNIX Programmer's Manual.
- The UNIX Time-Sharing System, reprint setting forth design principles.
- UNIX for Beginners.
- The UNIX I-O System.
- On the Security of UNIX.

☐ (DEV)   All I/O is logically synchronous. Normally, invisible buffering makes all physical record structure transparent and exploits the hardware's ability to do overlapped I/O.
- Asynchronous interfaces: DC11, DH11, DL11. Support for most common ASCII terminals.
- Synchronous interface: DP11.
- Automatic calling unit interface: DN11.
- Line printer: LP11.
- Magnetic tape: TU10 and TU16.
- DECtape*: TC11.
- Paper tape: PC11.
- Fixed head disk: RS11, RS03 and RS04.
- Pack type disk: RP03 and RP04, one or more logical devices per physical device, minimum-latency seek scheduling.
- Cartridge-type disk: RK05, one or more physical devices per logical device.
- Null device.
- Physical memory of PDP11, or mapped memory in resident system.
- Phototypesetter: Graphic Systems System/1 through DR11C.

☐ BOOT   Procedures to get MINI-UNIX started.

☐ MKCONF   Tailor device-dependent system code to hardware configuration. Other changes, such as optimal assignment of directories to devices, inclusion of floating point simulator, or installation of device names in file system, can then be made at leisure. (As distributed, MINI-UNIX can be brought up directly on any acceptable CPU with any acceptable disk, 28K words of memory and either clock.)

☐ Manual   Printed manual on setting up MINI-UNIX.

1.2 User Access Control

☐ LOGIN   Sign on as a new user.
- Verify password and establish user's individual and group (project) identity.
- Adapt to characteristics of terminal.
- Establish working directory.
- Announce presence of mail (from MAIL).
- Publish message of the day.
- Start command interpreter or other initial program.

☐ PASSWD   Change a password.
- User can change his own password.
- Passwords are kept encrypted for better security.

1.3 File Manipulation

☐ CAT   Concatenate one or more files onto standard output. Particularly used for unadorned printing, for inserting data into a pipeline, and for buffering output that comes in dribs and drabs.
- Usable as filter.

☐ CP   Copy one file to another. Works on any file without distinction as to contents.

☐ PR   Print files with title, date, and page number on every page.
- Multicolumn output.
- Parallel column merge of several files.
- Usable as a filter.

☐ OPR   Off line print. Spools arbitrary files to the line printer.
- Usable as a filter.

☐ SPLIT   Split a large file into more manageable pieces. Occasionally necessary for editing (ED).

☐ ED   Interactive context editor. Random access to all lines of a file.
- Find lines by number or pattern. Patterns may include: specified characters, don't care characters, choices among characters, repetitions of these constructs, beginning of line, end of line.
- Add, delete, change, copy or move lines.
- Permute or split contents of a line.
- Replace one or all instances of a pattern within a line.
- Combine or split files.
- Escape to Shell (MINI-UNIX command language) during editing.
- Do any of above operations on every pattern-selected line in a given range.

☐ Manual   Introductory manual for ED.

☐ STTY   Set up options for optimal control of a terminal. In so far as they are deducible from the input, these options are set automatically by LOGIN.
- Half vs. full duplex.
- Carriage return+line feed vs. newline.
- Interpretation of tabs.
- Parity.
- Mapping of upper case to lower.
- Raw vs. edited input.
- Delays for tabs, newlines and carriage returns.

☐ SUM   Sum the words of a file.

1.4 Manipulation of Directories and File Names

☐ RM   Remove a file. Only the name goes away if any other names are linked to the file.

☐ LN   "Link" another name (alias) to an existing file.

☐ MV   Move a file. Used for renaming files or directories.

☐ CHMOD   Change permissions on one or more files. Executable by files' owner.

☐ CHOWN   Change owner of one or more files.

☐ MKDIR   Make a new directory.

☐ RMDIR   Remove a directory.

☐ CHDIR   Change working directory.

☐ FIND   Prowl the directory hierarchy finding every file that meets specified criteria.
- Find files that satisfy one of these criteria:
  spelling of name matches a given pattern,
  creation date in given range,
  date of last use in given range,
  given permissions,
  given owner,
  given special file characteristics,
  boolean combinations of above.
- Any directory may be considered to be the root.
- Perform specified command on each file found.

☐ DSW   Interactively step through a directory, deleting or keeping files.

1.5 Running of Programs

☐ SH   The Shell, or command language interpreter.
- Supply arguments to and run any executable program.
- Redirect standard input or standard output.
- Compose compound commands using these operators:
  ';' for sequential execution,
  '|' for sequential execution with output of one process 'piped' to the input of another,
  '&' for asynchronous operation,
  parentheses for grouping.
- Perform 'Shell programs', command scripts with substitutable arguments.
- Construct argument lists from all file names satisfying specified patterns.
- Collect command usage statistics.

☐ IF   Conditionally execute command on basis of:
- String comparison.
- File accessibility.

☐ GOTO   Go to a label in a Shell program.

☐ WAIT   Wait for termination of asynchronously running processes.

☐ EXIT   Terminate a Shell program. Useful with IF.

☐ ECHO   Print remainder of command line. Useful for diagnostics or prompts in Shell programs, or for inserting data into a pipeline.

☐ SLEEP   Suspend execution for a specified time.

☐ NOHUP   Run a command immune to hanging up the terminal.

☐ NICE   Run a command in low (or high) priority.

☐ KILL   Terminate named processes.

☐ CRON   Perform an action at specified times.
- Actions are arbitrary Shell (SH) programs.
- Times are conjunctions of month, day of month, day of week, hour and minute. Ranges are specifiable for each.

☐ TEE   Pass data between processes and divert a copy into a file. Used as a filter.

1.6 Status Inquiries

☐ LS   List the names of one, several, or all files in one or more directories.
- Alphabetic or temporal sorting, up or down.
- Optional information: size, owner, date last modified, date last accessed, permissions, i-node number.

☐ FILE   Try to determine what kind of information is in a file by consulting the file system index and by reading the file itself.

☐ DATE   Print today's date and time. Has considerable knowledge of calendric and horological peculiarities.
- May set MINI-UNIX's idea of date and time.

☐ DF   Report amount of free space on file system devices.

☐ DU   Print a summary of total space occupied by all files in a hierarchy.

☐ WHO   Tell who's on the system.
- List of presently logged in users, ports and times on.
- Optional history of all logins and logouts.

☐ PS   Report on active processes.
- List your own or everybody's processes.
- Tell what commands are being executed.
- Optional status information: state, attached terminal, what it's waiting for, size.

☐ TTY   Print name of your terminal.

☐ PWD   Print name of your working directory.

1.7 Backup and Maintenance

☐ MOUNT   Attach a device containing a file system to the tree of directories. Protects against nonsense arrangements.

☐ UMOUNT   Remove the file system contained on a device from the tree of directories. Protects against removing a busy device.

☐ MKFS   Make a new file system on a device.

☐ MKNOD   Make an i-node (file system entry) for a special file. Special files are physical devices, virtual devices, physical memory, etc.

□ TP   Manage file archives on magnetic tape or DECtape.
- Collect files into an archive.
- Update DECtape archive by date.
- Replace or delete DECtape files.
- Print table of contents.
- Retrieve from archive.

□ DUMP   Dump the file system stored on a specified device, selectively by date. or indiscriminately.

□ RESTOR   Restore a dumped file system, or selectively retrieve parts thereof.

□ SU   Temporarily become the super user with all the rights and privileges thereof. Requires a password.

□ DCHECK   Check consistency of file system.
□ ICHECK
□ NCHECK
- Print gross statistics: number of files, number of directories, number of special files space used, space free.
- Report duplicate use of space.
- Retrieve lost space.
- Report inaccessible files.
- Check consistency of directories.
- List names of all files.

□ CLRI   Peremptorily expunge a file and its space from a file system. Used to repair damaged file systems.

□ SYNC   Force all outstanding I/O on the system to completion. Used to shut down gracefully.

1.8 Accounting

These routines use floating point. The timing information on which the reports are based can be manually cleared or shut off completely.

□ AC   Publish cumulative connect time report.
- Connect time by user or by day.
- For all users or for selected users.

□ SA   Publish Shell accounting report. Gives usage information on each command executed.
- Number of times used.
- Total system time, user time and elapsed time.
- Optional averages and percentages.
- Sorting on various fields.

1.9 Inter-user Communication

□ MAIL   Mail a message to one or more users. Also used to read and dispose of incoming mail. The presence of mail is announced by LOGIN.

□ WRITE   Establish direct terminal communication with another user.

□ WALL   Write to all users.

□ MESG   Inhibit receipt of messages from WRITE and WALL.

1.10 Basic Program Development Package

A kit of fundamental programming tools. Some of these utilities are used as integral parts of the higher level languages described below.

☐ AR   Maintain archives and libraries. Combines several files into one for housekeeping efficiency.
- Create new archive.
- Update archive by date.
- Replace or delete files.
- Print table of contents.
- Retrieve from archive.

☐ AS   Assembler. Similar to PAL-11, but different in detail.
- Creates object program consisting of
  code, possibly read-only,
  initialized data or read-write code,
  uninitialized data.
- Relocatable object code is directly executable without further transformation.
- Object code normally includes a symbol table.
- Multiple source files.
- Local labels.
- Conditional assembly.
- "Conditional jump" instructions become branches or branches plus jumps depending on distance.

☐ Manual   Printed manual for the assembly language.

☐ Library   The basic run-time library. These routines are used freely by all system software.
- Formatted writing on standard output.
- Time conversions.
- Number conversions.
- Elementary functions: sin, cos, log, exp, atan, sqrt, gamma.
- Password encryption.
- Quicksort.
- Buffered character-by-character I/O.
- Random number generator.
- Floating point interpreter for non-floating point machines.

☐ (LIBP)   An elaborated I/O library.
- Formatted input and output.
- Ability to put characters back into input streams.

☐ Manual   Printed manual for LIBP.

☐ DB   Interactive post-mortem debugger. Works on core dump files, such as are produced by all program aborts, on object files, or on any arbitrary file.
- Symbolic addressing of files that have symbol tables.
- Octal, decimal or ASCII output.
- Symbolic disassembly.
- Octal or decimal patching.

☐ OD   Dump any file.
- Output options include: octal or decimal by words, octal by bytes, ASCII, opcodes, hexadecimal, any combination thereof.

● Range of dumping is controllable.

☐ LD   Link edit. Combine relocatable object files. Insert required routines from specified libraries.
  - ● Resulting code is automatically relocated to start execution at beginning of user's address space.
  - ● Resulting code may start execution at absolute zero.

☐ NM   Print the namelist (symbol table) of an object program. Provides control over the st· ? and order of names that are printed.

☐ SIZE   Report the core requirements of one or more object files.

☐ STRIP   Remove the relocation and symbol table information from an object file to save space.

☐ TIME   Run a command and report timing information on it.

1.11 The Programming Language "C"

☐ CC   Compile and/or link edit programs in the C language. The MINI-UNIX operating system, most of the subsystems and C itself are written in C.
  - ● General purpose language designed for structured programming.
  - ● Data types:
    - character,
    - integer,
    - float,
    - double,
    - pointers to all types,
    - functions returning above types,
    - arrays of all types,
    - structures of all types.
  - ● Operations intended to give machine-independent control of full machine facility, including to-memory operations and pointer arithmetic.
  - ● Macro preprocessor for parameterized code and inclusion of standard files.
  - ● All procedures recursive, with parameters by value.
  - ● Natural coercions.
  - ● Object code uses full addressing capability of the PDP11.
  - ● Runtime library gives access to all system facilities.

☐ Manuals   Printed manual and tutorial for the C language.

☐ CDB   A debugger tailored for use with C.
  - ● Usable post-mortem.
  - ● The debugger is a completely separate process from the debuggee. No debugging code is loaded with debuggee.
  - ● Prints in natural notation: characters, integers (octal and decimal), floating-point numbers, double precision numbers, machine instructions (disassembled).
  - ● Stack trace and fault identification.

2 Other Languages

2.1 FORTRAN

☐ FC   Compile and/or link-edit FORTRAN IV programs. Object code is "threaded". Relies heavily on floating point.

- Idiosyncracies:
    - free form, lower-case source code,
    - no arithmetic statement functions,
    - unformatted I/O requires record lengths agree,
    - no BACKSPACE,
    - no P FORMAT control on input.
- Handles mixed-mode arithmetic, general subscripts and general DO limits.
- 32-bit integer arithmetic.
- Free format numeric input.
- Understands these nonstandard specifications:
    - LOGICAL*1, *2, *4,
    - INTEGER*2, *4,
    - REAL*4, *8,
    - COMPLEX*8, *16,
    - IMPLICIT.

□ RC   Compile and/or link edit 'Ratfor' programs. Ratfor adds rational control structure à la C to FORTRAN.
- Else, for, while, repeat...until statements.
- Symbolic constants.
- File insertion.
- Compound statements.
- Can produce genuine FORTRAN to carry away.

□ Manual   Printed manual for Ratfor.

2.2 Other Algorithmic Languages

□ BAS   An interactive interpreter, similar in style to BASIC. Interpret unnumbered statements immediately, numbered statements upon 'run'.
- Statements include:
    - comment,
    - dump,
    - for...next,
    - goto,
    - if...else...fi,
    - list,
    - print,
    - prompt,
    - return,
    - run,
    - save.
- All calculations double precision.
- Recursive function defining and calling.
- Builtin functions include log, exp, sin, cos, atn, int, sqr, abs, rnd.
- Escape to ED for complex program editing.
- Usable as a filter.

⊏ DC   Interactive programmable desk calculator. Has named storage locations as well as conventional stack for holding integers or programs.
- Unlimited precision decimal arithmetic.
- Appropriate treatment of decimal fractions.
- Arbitrary input and output radices, in particular binary, octal, decimal and hexadecimal.
- Reverse Polish operators:

```
+ - * /
remainder, power, square root,
load, store, duplicate, clear,
print, enter program text, execute.
```
- Usable as a filter.

☐ BC   A C-like interface to the desk calculator DC.
- All the capabilities of DC with a high-level syntax.
- Arrays and recursive functions.
- Immediate evaluation of expressions and evaluation of functions upon call.
- Arbitrary precision elementary functions: exp, sin, cos, atan.
- Go-to-less programming.
- Usable as a filter.

☐ Manual   Printed manual for BC.

☐ SNO   An interpreter very similar to SNOBOL 3.
- Limitations:
  function definitions are static,
  pattern matches are always anchored,
  no built-in functions.
- Usable as a filter.

2.3 Macroprocessing

☐ M6   A general purpose macroprocessor.
- Stream-oriented, recognizes macros anywhere in text.
- Integer arithmetic.
- Usable as a filter.

☐ Manual   Printed manual for M6.

2.4 Compiler-compilers

☐ TMG   A classical top-down compiler-compiler language. Provides a formalism for syntax-directed translation. Produces driving tables to be loaded with a standard interpreter.
- Resulting compilers can have arbitrary tables kept in paged secondary store.
- Integer arithmetic capability.
- Syntactic function capability (similar to ALGOL 68 metaproductions).

☐ Manual   Printed manual for the TMG compiler-writing system.

☐ YACC   An LR(1)-based compiler writing system. During execution of resulting parsers, arbitrary C-language, Ratfor or FORTRAN functions may be called to do code generation or semantic actions.
- BNF syntax specifications.
- Precedence relations.
- Accepts formally ambiguous grammars with non-BNF resolution rules.

☐ Manual   Printed manual for the YACC compiler-writing system.

3 Word Processing

☐ ROFF   A typesetting program for terminals. Easy for nontechnical people to learn, and good for most ordinary kinds of documents. Input consists of data lines intermixed with con-

trol lines, such as

        .sp 2   insert two lines of space
        .ce   center the next line

- Justification of either or both margins.
- Automatic hyphenation.
- Generalized running heads and feet, with even-odd page capability, numbering, etc.
- Definable macros for frequently used control sequences (no substitutable arguments).
- All 4 margins and page size dynamically adjustable.
- Hanging indents and one-line indents.
- Absolute and relative parameter settings.
- Optional legal-style numbering of output lines.
- Multiple file capability.

☐ CREF   Make cross-reference listings of a collection of files. Each symbol is listed together with file, line number, and text of each line in which it occurs.
- Assembler or C language.
- Gathering or suppressing references to selected symbols.
- Last symbol defined may replace line number.
- Various ways to sort output available.
- Selective print of uniquely occurring symbols.

☐ FORM   Form letter generator. Remembers any number of forms and stock phrases such as names and addresses. Output usually intended to be ROFFed.
- Anything that is typed in can be remembered for later use.
- Runs interactively, querying only for those items that are not in its memory.
- Any item may call for the inclusion of other items. For example, full name, address, first name, title, etc., may be separately retrieved from one name key.

☐ FED   Edit the memory used by FORM. Extract any item, turn it over to context editor ED for editing, and put it back when done.
- List names of selected items.
- Print contents of selected item.

☐ SORT   Sort or merge ASCII files line-by-line.
- Sort up or down.
- Sort lexicographically or on numeric key.
- Multiple keys located by delimiters or by character position.
- May sort upper case together with lower into dictionary order.
- Usable as a filter.

☐ UNIQ   Collapse successive duplicate lines in a file into one line.
- Publish lines that were originally unique, duplicated, or both.
- May give redundancy count for each line.
- Usable as a filter.

☐ USORT   SORT and UNIQ at the same time. Saves substantial time over sequential execution.

☐ TR   Do one-to-one character translation according to an arbitrary code.
- May coalesce selected repeated characters.
- May delete selected characters.
- Usable as a filter.

☐ DIFF   Report line changes, additions and deletions necessary to bring two files into agreement.
- May produce an editor script to convert one file into another.

□ COMM   Identify common lines in two sorted files. Output in up to 3 columns shows lines present in first file only, present in both, and/or present in second only.

□ CMP   Compare two files and report disagreeing bytes.

□ GREP   Print all lines in a file that satisfy a pattern of the kind used in the editor ED.
              • May print all lines that fail to match.
              • May print count of hits.
              • Usable as a filter.

□ WC   Count the lines and "words" (blank-separated strings) in a file.
              • Usable as a filter.

□ TYPO   Find typographical errors. Statistically analyzes all the words in a text, weeds out several thousand familiar ones, and publishes the rest sorted so that the most improbably spelled ones tend to come to the top of the list.

□ GSI   Simulate Model 37 Teletype facilities on GSI-300, DASI and other Diablo-mechanism terminals.
              • Gives half-line and reverse platen motions.
              • Approximates Greek letters and other special characters by overstriking.
              • Usable as a filter.

□ COL   Canonicalize files with reverse line feeds for one-pass printing.
              • Usable as a filter.

4 Novelties

Source code for game-playing programs is not distributed.

□ CHESS   This chess-playing program scored 1-2-1 and 3-0-1 in the 1973 and 1974 Computer Chess Championships.

□ CAL   Print a calendar of specified month and year.

□ UNITS   Convert amounts between different scales of measurement. Knows hundreds of units. For example, how many km/sec is a parsec/megayear?

□ QUIZ   Test your knowledge of Shakespeare, Presidents, capitals, etc.

5 Text Preparation

5.1 Formatters

High programming skill is required to exploit the formatting capabilities of NROFF, although unskilled personnel can easily be trained to enter documents according to canned formats.

□ NROFF   Advanced typesetting for terminals. Style similar to ROFF, but capable of much more elaborate feats of formatting, at a price in ease of use.
              • All ROFF capabilities available or definable.
              • Completely definable page format keyed to dynamically planted "interrupts" at specified lines.
              • Maintains several separately definable typesetting environments (e.g. one for body text, one for footnotes, and one for unusually elaborate headings).
              • Arbitrary number of output pools can be combined at will.

- Macros with substitutable arguments, and macros invocable in mid-line.
- Computation and printing of numerical quantities.
- Conditional execution of macros.
- Tabular layout facility.
- Multicolumn output on terminals capable of reverse line feed, or through the post-processor COL.
- Usable as a filter.

☐ Manual   Printed manual for NROFF.

☐ NEQN   A mathematical typesetting preprocessor for NROFF similar to EQN (see Section 6). Prepares formulas for display on Model 37 Teletypes with half-line functions and 128 character font.
- For Diablo-mechanism terminals, filter output through GSI.
- Same facilities as EQN within graphical capability of terminal.

☐ Manual   Printed manual for NEQN/EQN.

☐ TBL   A preprocessor for NROFF/TROFF that translates simple descriptions of table layouts and contents into detailed typesetting instructions.
- Computes column widths.
- Handles left- and right-justified columns, centered columns and decimal-point alignment.
- Places column titles.

☐ MS   A standardized technical manuscript layout for use with NROFF/TROFF.
- Page numbers and draft dates.
- Cover sheet and title page.
- Automatically numbered subheads.
- Footnotes.
- Single or double column.
- Paragraphing, display and indentation.
- Numbered equations.

☐ Manual   Printed manual for MS.

5.2 UNIX Programmer's Manual

☐ MAN   Print specified manual section on your terminal.

☐ Manual   Machine-readable version of the UNIX Programmer's Manual.
- System overview.
- All commands.
- All system calls.
- All subroutines in assembler, C and FORTRAN libraries.
- All devices and other special files.
- Formats of file system and kinds of files known to system software.
- Boot procedures.

6 Typesetting

This software generates output on a Graphic Systems System/1 phototypesetter. It is distributed separately as an enhancement to MINI-UNIX.

High programming skill is required to exploit the formatting capabilities of TROFF, although unskilled

personnel can easily be trained to enter documents according to canned formats. TROFF and EQN are sufficiently similar to NROFF and NEQN that it is usually possible to define interchangeable formats to produce approximate proof copy on terminals. The preprocessors MS and TBL are fully compatible with TROFF as well as NROFF.

☐ TROFF   Provides facilities like NROFF, augmented as follows. This Summary was typeset by TROFF.
- Vocabulary of several 102-character fonts (4 simultaneously) in 15 sizes.
- Positions expressible in inches, centimeters, ems, points, machine units or arithmetic combinations thereof.
- Access to character-width computation for unusually difficult layout problems.
- Overstrikes, built-up brackets, horizontal and vertical line drawing.
- Dynamic relative or absolute positioning and size selection, globally or at the character level.
- Terminal output for rough sampling of the product, usually needs a wide platen. Not a substitute for NROFF.
- Usable as a filter.

☐ Manuals   Printed manual and tutorial for TROFF.

☐ EQN   A mathematical typesetting preprocessor for TROFF. Translates easily readable formulas, either in-line or displayed, into detailed typesetting instructions. Formulas are written in a style like this:

sigma sup 2 ˜=˜ 1 over N sum from i=1 to N (x sub i _ x bar) sup 2

which produces this:

$$\sigma^2 = \frac{1}{N} \sum_{i=1}^{N} (x_i - \bar{x})^2$$

- Automatic calculation of size changes for subscripts, sub-subscripts, etc.
- Full vocabulary of Greek letters, such as 'gamma', 'GAMMA'.
- Automatic calculation of large bracket sizes.
- Vertical "piling" of formulae for matrices, conditional alternatives, etc.
- Integrals, sums, etc, with arbitrarily complex limits.
- Diacriticals: dots, double dots, hats, bars.
- Easily learned by nonprogrammers and mathematical typists.
- Usable as a filter.

☐ TMAN   Typeset specified portions of UNIX manual.
- Same capabilities as MAN (see Section 5.2).

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