UNIX Summary (DRAFT)

A. Hardware

UNIX runs on a DEC PDP11/40*, 11/45 or 11/70 with at least the following equipment:

48K to 124K words of managed memory: parity not used,
disk: RP03, RP04, RK05(preferably 2) or equivalent,
console typewriter,
clock: KW11-L or KW11-P,
extended instruction set KE11-E, on 11/40 only.

The system is normally distributed on 9-track tape or RK05 packs.
The following equipment is strongly recommended:

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

The minimum memory and disk space specified is enough to run and maintain 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. UNIX does swapping and reentrant sharing of user code to minimize main memory requirements. The resident code of UNIX occupies 20-22K depending on configuration.

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

B. Software

All the programs available as 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.

Commercially distributed UNIX normally excludes software listed in Section 5, ‘‘Typesetting.’’ Source code is included except as noted.

1 Basic Software

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

1.1 Operating System

□ 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. Further capabilities include:
- Automatically supported reentrant code.
- Separate instruction and data spaces on 11/45 and 11/70.
- ‘‘Group’’ access permissions allow cooperative projects, with overlapping memberships.
- Timer-interrupt sampling and interprocess monitoring for debugging and measurement.

□ Manual — Printed manuals for 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. Unbuffered physical record I/O is available for unusual applications. Drivers for these devices are available; others can be easily written:
- 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.
- Voice synthesizer: VOTRAX* through DC11. Includes TOUCH-TONE® input.

□ BOOT Procedures to get UNIX up on a naked machine.

□ Manual Setting up UNIX.

□ 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, UNIX can be brought up directly on any acceptable CPU with any acceptable disk, any sufficient amount of core and either clock.)

□ Manual Printed manual on setting up 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.

□ NEWGRP Change working group (project). Protects against changes to unauthorized projects.

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. Is occasionally necessary for editing (ED).
□ ED	Interactive context editor. Can work on single lines, blocks of lines, or all pattern-selected lines in a given range. • Finds lines by number or pattern. • Random access to lines. • 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 (UNIX command language) during editing. • Patterns may include: specified characters, don't care characters, choices among characters, repetitions of above, beginning of line, end of line. • All operations may be done globally on every pattern-selected line in a given range.
□ Manual	Introductory manual for ED.
□ DD	Physical file format translator, for exchanging data with foreign systems, especially OS/360.
□ STTY	Sets 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.

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.

□ CHGRP Change group (project) to which a file belongs.

□ 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.
• These criteria are understood:
  spelling of name matches a given pattern,
  creation date in given range,
  date of last use in given range,
  permissions,
  owner,
  characteristics of device files,
  boolean combinations of above.
• Any directory may be considered to be the root.
• Specified commands may be performed on every file found.

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

1.5 Running of Programs

□ SH The Shell, or command language interpreter. Provides ‘‘background’’ and macro capability when run with a file of commands as input.
• Any executable object file is automatically a command.
• Redirect standard input or standard output.
• Operators to compose compound commands:
  ‘;’ for sequential execution,
  ‘|’ for functional composition with output of one command taken directly as input to another running simultaneously,
  ‘&’ for asynchronous operation,
  parentheses for grouping.
• Substitutable arguments.
• Construction of argument lists from all file names satisfying specified patterns.
• Collects command usage statistics.

□ IF A conditional statement for Shell programs.
• String comparison.
• Querying file accessibility.

□ GOTO A ‘‘go-to’’ statement for Shell programs.

□ WAIT Wait for termination of asynchronously running processes.

□ EXIT Terminate a Shell program. Useful with IF.

□ ECHO Print remainder of command line. Useful for diagnostic or prompting data 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 A table of actions to be taken at specified times.
• Actions are arbitrary Shell (SH) scripts.
• 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, group, date last modified, date last accessed, permissions, i-node number.

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

□ DATE System date routine. Has considerable knowledge of calendric and horological peculiarities.
• Print present date, day of week, local time.
• May set 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 all active processes attached to a terminal.
• Gives all commands being executed.
• Can also report on other terminals.
• Extended status information available:
state and scheduling info,
priority,
attached terminal,
what it's waiting for,
size.

□ TTY Find name of your terminal.

□ PWD Print name of your working directory.

□ PFE Print type of last floating exception.

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 DEC tape.
• Collect files into an archive.
• Update DECtape archive by date.
• Replace or delete DECtape files.
• 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
□ ICHECK
□ NCHECK — Check consistency of file system.
• Gross statistics:
  number of files,
  number of directories,
  number of special files,
  spaced used,
  space free.
• Report of duplicate use of space.
• Retrieval of lost space.
• Report of inaccessible files.
• Check consistency of directories.
• List names of all files.

□ CLRI — Peremptorily expunge a file and its space from a file system. Used in putting damaged file systems together again.

□ 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 — Archive and library maintainer. Combines several files into one for housekeeping efficiency. Archive files are used by the link editor LD as libraries.
- Create new archive.
- Update archive by date.
- Replace or delete files.
- 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.
- Combines 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.
- Convert integer and floating numbers to ASCII and vice versa.
- 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 11/40's and 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 of the above.
• Range of dumping is controllable.

□ LD — Link edit. Combine relocatable object files. Insert required routines from specified libraries.
• Resulting code may be sharable.
• Resulting code may have separate instruction and data spaces.

□ NM — Print the namelist (symbol table) of an object program. Provides control over the style 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.

□ PROF — Construct a profile of time spent per routine from statistics gathered by time-sampling the execution of a program. Uses floating point.
• Subroutine call frequency and average times for C programs.

1.11 The Programming Language "C"

□ CC — Compile and/or link edits programs in the C language. The UNIX operating system, most of the subsystems and C itself are written in C.
• Full general purpose language designed for structured programming.
• Data types:
  character,
  integer,
  float,
  double,
  pointers to all types,
  arrays of all types,
  structures of all types,
  functions returning all types.
• Operations intended to give access to full machine facility, including to-memory operations and data-sensitive pointer arithmetic.
• Macro preprocessor for parameterized code and inclusion of standard files.
• All procedures recursive, with parameters by value.
• Natural coercions.

- True compiled object code capitalizing on addressing capability of the PDP11.
- Runtime library gives access to all system facilities.

□ Manuals — Printed manual and tutorial for the C language.

□ CDB — An interactive debugger tailored for use with C.
- Usable in real time or post-mortem.
- The debugger is a completely separate process from the debuggee. No debugging code is loaded with debuggee.
- Prints all kinds of data in natural notation:
  - character,
  - integer (octal and decimal),
  - float,
  - double,
  - machine instructions (disassembled).
- Stack trace and fault identification.
- Breakpoint tracing.

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 — "Ratfor", a preprocessor that 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 interpreter, similar in style to BASIC, that allows immediate execution of unnumbered statements, or deferred execution of numbered statements.
- 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 — Programmable reverse Polish 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.
• Operators include:
+ − * /
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, J_n.
• 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.

□ Manual — Reprint of basic article.

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.
• Handles precedence relations.
• Accepts formally ambiguous grammars with non-BNF resolution rules.
• Optimizes space taken by driving tables.

□ 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 control lines, such as

• 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.

□ INDEX Make cross-reference indexes of English text.
• Handles lists of specific index terms or excluded terms.
• Handles words hyphenated across lines.
• Understands TROFF and NROFF output, so can gather references according to final pagination.
• Output capabilities like CREF.
• Frequency counts.

□ 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 — Editor for 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.
• Publishes lines that were originally unique, duplicated, or both.
• May give redundancy count for each line.
• Usable as a filter.

□ 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.

□ SPEAK — Driver for Vocal Interface's VOTRAX speech synthesizer. Reads input text and utters it.
- Associative memory allows pronunciation rules for whole words or word fragments to be added, changed, deleted or queried.
- Can use different memories for different languages.
- Usable as a filter to make the output of any other program audible.

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

□ BJ — A blackjack dealer.

□ CUBIC — An accomplished player of 4×4×4 tic-tac-toe.

□ MOO — A fascinating number-guessing game.

□ CAL — Prints a calendar of specified month and year.

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

□ TTT — A tic-tac-toe program that learns. It never makes the same mistake twice.

□ QUIZ — Tests your knowledge of Shakespeare, Presidents, capitals, etc.

□ WUMP — Hunt the wumpus, thrilling search in a dangerous cave.

5 Typesetting

This software is distributed separately as an enhancement to UNIX.

5.1 Formatters

High programming skill is required to exploit the formatting capabilities of these programs, although unskilled personnel can easily be trained to enter documents according to canned formats. Terminal-oriented and typesetter-oriented formatters are sufficiently compatible that it is usually possible to define interchangeable 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 postprocessor COL.
- Usable as a filter

□ Manual — Printed manual for NROFF.

□ TROFF — Advanced phototypesetting for the Graphic Systems System/1. 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.

□ Manual — Printed manual for EQN.

□ NEQN — A mathematical typesetting preprocessor for NROFF. 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.

□ 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 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.

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.

May, 1975

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