Administrative Advice for UNIX

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The material presented here is based on the author's experiences and opinions. Nevertheless, it may prove useful. The material on phototypesetting was contributed by D. W. Smith.

1. ADMINISTRATOR'S ROAD MAP

Getting started as a UNIX† system administrator is hard work. There are no real shortcuts to a working knowledge of the system. You will need time for reading, study and hands-on experimenting. Don't commit yourself to "going live" with your system until you have had two weeks to teach yourself your job, and get the initial hardware quirks ironed-out.

Don't consign the *Setting Up UNIX* document to oblivion after your initial system "gen". In addition to needing it again whenever you add/change equipment, you will find that it contains valuable material about system tuning (buffers, *clist*s, etc.) that appears nowhere else.

As an administrator, you should be familiar with a lot of the distributed documentation. The *Internals, Operations, and Administration* papers from *Documents for UNIX* should all be studied, as well as the *Introduction*, *How to Get Started*, and most of the entries of the *UNIX User's Manual*. In that manual, you should pay special attention to: *acct*∗(1M), *chmod*(1), *chown*(1), *config*(1M), *cpio*(1), *date*(1), *df*(1), *du*(1), *ed*(1), *env*(1), *find*(1), *fsck*(1M), *kill*(1), *mail*(1), *mkdir*(1), *mkfs*(1M), *ncheck*(1M), *ps*(1), *rm*(1), *rmdir*(1), *shutdown*(1M), *stty*(1), *su*(1), *sync*(1M), *time*(1), *volcopy*(1M), *wall*(1M), *who*(1), and *write*(1) in Section 1; all of Section 4; *acct*(5) in Section 5; and *crash*(8) and *vaxops*(8) in Section 8.

2. SYSTEM CAPACITY

The figures below are approximations based on our experience over several years:

Hardware Configuration	*Number of Simultaneous Users*
PDP-11/23; 256K-byte memory; 2 RL01 disks*	4
PDP-11/34; 256K-byte memory with cache; 2 RL01 disks*	8
PDP-11/45; 248K-byte memory; RP03 disk*	16
Above with RP06 (RP04, RP05) disk*	20
Above with memory cache	25
PDP-11/70; 512K-byte memory; RP06 (RP04, RP05) disks* (2 or more drives)	32
Above with 768K-byte memory and a disk drive (or fixed-head disk) set aside for the root file system	40
VAX-11/780; 1M-byte memory; at least 3 RP06 disks*	48

* Or equivalent.

See *Setting Up UNIX* for the list of supported hardware options.

† UNIX is a Trademark of Bell Laboratories.

3. DISK FREE SPACE

Making files is easy under UNIX. It has been said that the only standard thing about all UNIX systems is the message-of-the-day telling users to clean up their files. Administratively, both free disk blocks and free inodes (UNIX talk for file headers) can be a problem. If the free inode count falls below 100, the system spends most of its time rebuilding the free inode array. If a file system runs out of space, the system prints "no-space" messages and does little else. To avoid problems, the following start-of-day free counts should be maintained:

- The file system containing */tmp* (temporary files):
  - — 16-user system: 1,500 free blocks.
  - — 40-user system: 3,000 free blocks.
- The file system containing */usr*:
  - — 3,000 to 6,000 free blocks, depending on load.
- Other user file systems:
  - — 6% to 10% free, depending on user habits (3,000 blocks minimum).

This brings up an associated problem: how big should file systems be? Our preference is to set aside space on each drive for a copy of root/swap and use the rest of the pack for a single file system. However, if you have user groups that fight over disk space, it may be better to split them up arbitrarily (i.e., divide a pack into more than one file system). Warning: if you set up different disk drives with differing cylinder partitions between file systems, it will probably lead to an operations goof someday.

4. A VERY FEW WORDS ABOUT SYSTEM TUNING

- As shipped, UNIX has *no* programs with the text-bit mode set (see *chmod*(1)). The top contenders for the *t*-bit are *nroff* and *troff* followed (generally) by the larger phases of the C compiler (including the assembler and loader). The *t*-bit is only meaningful with pure text programs (*ld*(1) options −*i* or −*n*). Don't overdo it, and keep *t*-bit programs in the root file system.
- File system reorganization (described below) can help throughput, but at the expense of down time. If you do it when your users are all asleep, it can help.
- If you use normal *shutdown* and *filesave.u* procedures, the file system check program (*fsck*(1M), −*S* option) will help keep the disk free list in reasonable order.
- Try to keep disk drive usage balanced. If you have over 20 users, the *root* file system (*/bin*, */tmp*, */etc*, and *swap*) deserves a drive of its own.
- If you have a noisy modem (poorly executed do-it-yourself null-modem) or a disconnected modem cable, UNIX will spend a lot of CPU time trying to get it logged in. A random check of systems uncovers a lot of this going on.

5. WHY YOU MUST HAVE A SPARE DISK DRIVE

- Without a spare disk drive, the system will be *down* when a drive is *down*.
- Without a spare drive, it is difficult to reorganize file systems or to restore user files.

6. DISK PACKS

- Buy only fully ECC correctable packs and test them.
- If a pack develops uncorrectable errors, recondition it, or get rid of it.

RP06 disk packs used with UNIX need not be totally error-free, but must be "flag-free". The term flag-free means that there should be no unrecoverable ECC (Error Correcting Code) errors. Technically, proper ECC handling can recover from 11-bit error bursts. However, we hear that the length of bursts can grow as a pack ages. We recommend that no pack that has more than 8-bit error bursts be accepted. For the PDP-11, the following explanation may help (paraphrased from a DEC source).

In reading the formatter printout, ECC correctable errors are identified by the headings "DATA

ERROR DURING WRITE CHECK.” Error-register values are printed below the message. The two registers of interest are RPER1 and RPEC2. A RPER1 value of 1000000 indicates ECC (no other bits on). The RPEC2 register describes the bit span of the error. For example, RPEC2=003774 means that there was an unacceptable 9-bit (binary 0000011111111100) error burst; RPEC2=000240 is an acceptable 3-bit span (0000000010100000there may be zero bits mixed in). If such acceptable errors account for all “unrecoverable” errors reported (and there aren’t too many of them), then you have a flag-free pack.

On the VAX, even this scant information was not available, so we have written our own formatter (it tells its tale in English); see *rp6fmt*(8). We plan to make this program available in the future (along with other UNIX-oriented diagnostics) for the PDP-11 as well.

7. PROTECTING USER FILES

Users, especially inexperienced ones, occasionally remove their own files. Open files are sometimes lost when the system crashes. Once in a great while, an entire file system will be destroyed (picture a disk controller that goes bad and writes when it should read). Here is a suggested file backup procedure:

- Each day, copy all user file systems to backup packs. Keep these packs 3 to 5 days before re-using them.
- Once a week, copy each file system to tape. Keep weekly tapes for 8 weeks.
- Keep bi-monthly tapes “forever” (they should be re-copied once a year).

The most recent weekly tapes should be kept off premises. The other tapes should be in a fireproof safe, if you can afford one.

When UNIX goes down, active files can get scrambled. Your users will not want to start the day over every time your system fails. In addition to good backup, you *must* have file-system patching expertise available (on-site or on-call). If you ever re-boot the system for general use without checking out the file systems, terrible things will happen (we once had five duplicate entries on a file-system free list−this ruined over 100 new files in just three days). Study *fsck*(1M) and *crash*(8), as well as *FSCK−The UNIX/TS File System Check Program*.

8. UNIX FILE SYSTEM BACKUP PROGRAMS

The following backup programs are distributed:

- *Dump/restor*: This is a familiar tape-based system that has been used for several years. Full dumps are usually taken when the *dump* program warns that an incremental dump will run to more than one reel.
- *Find/cpio*: UNIX is distributed in *cpio* format. The *−cpio* option of the *find* command has made it time-competitive with *dump/restor*. However, it does not produce a “perfect” restore from a full dump plus incremental dump (new and changed files are OK, but file removal information is lost). Because of this, full dumps should be taken fairly often (weekly/bi-weekly). *Cpio* is the only program listed here that makes system-independent copies. It can be used to move files between various versions of UNIX/RT and UNIX, and can be used in system conversion.
- *Volcopy*: physical file system copying to disk or tape. For those who can afford a spare drive, *volcopy* to disk provides convenient file restore and quick recovery from disk disasters (remember the spare drive). Tape *volcopy* provides good long-term backup because the file system can be read-in fairly quickly, mounted, and browsed over. Disk and tape *volcopy* are generally used together for short- and long-term backup. *Volcopy* can also be used for full dumps with either *dump/restor* or *cpio/find*.

The table below summarizes attributes of these programs. The file system size is 65,500 blocks in all cases; times are in minutes; judgements are subjective.

	dump/restor	*find/cpio*	*volcopy (disk)*	*volcopy (tape)*
Full dump time	40	40	2	15
Incremental dump time	6	7	–	–
Full restore time	40(?)	80	2	15
Incremental restore time	8	10	–	–
Ease of restoring:				
one file	fair	fair	good	fair
a directory	poor	fair	good	good
scattered files	poor	poor	good	good
full restore	fair	fair	very good	good
Needs tape drive	yes	yes	no	yes
Needs spare file system				
(only when restoring)	no	no	–	yes
Needs spare disk drive				
(two CPUs can share)	–	–	yes	–
Maintains pack/tape labels	no	no	yes	yes
Handles multi-reel tape	yes	yes	–	yes
512 blocks per record	1,10	1,10	88	10
Interactive				
(i.e., ties up console)	no(?)	yes	yes	yes
May require separate				
ID space	no	no	no*	no

* Blocks per record are cut to 22 without separate I/D space.

We strongly recommend the spare disk drive: as explained in Section 5 above, the speed and convenience of *volcopy* are by no means the only advantage of a spare drive.

9. CONTROLLING DISK USAGE

If your UNIX system is a success, you will soon run out of disk space:

- During the considerable delay before you can get more drives, you will need to control usage:
  - — Try to maintain the start-of-day counts recommended above. Watch usage during the day by executing the *df* command regularly.
  - — The *du*(1) command should be executed (after hours) regularly (e.g., daily) and the output kept (in an accessible file) for later comparison. In this way you can spot users who are rapidly increasing their disk usage.
  - — The *find*(1) can be used to locate inactive (or large) files. Example:

    ```
    find / −mtime +90 −atime +90 −print >somefile
    ```

    records in “somefile” the names of files neither written nor accessed in the last 90 days. Of course, this works best if you are super-user.
- You will also have to balance usage between file systems. To do this you will have to move user directories. Users should be taught to accept file system name changes (and to program around them−preferably ahead of time). The user’s login directory name (available in the shell variable *HOME*) should be utilized to minimize path name dependencies. User groups with more extensive file system structures should set up a shell variable to refer to the file system name (e.g.: *FS*).
- The *find*(1) and *cpio*(1) commands can be used to move user directories and to manipulate the file system tree. The following sequence is useful (it moves, via magnetic tape, the directory trees *userx* and *usery* from file system *filesys1* to file system *filesys2* where, presumably, more space is available):

```
cd /filesys1
find userx usery −cpio /dev/rmt0
cd /filesys2
mkdir userx usery
chown userx userx
chown usery usery
cpio −idmB </dev/rmt0
#    Make sure new copy is OK
#    Change userx and usery login directories in the /etc/passwd file
rm −rf /filesys1/userx /filesys1/usery
```

When moving more than one user in this way:

— Keep users with common interests in the same file system (they may have linked files).
— Move groups of users who may have linked files with a single *cpio* (otherwise linked files will be unlinked and duplicated).

10. REORGANIZING FILE SYSTEMS

The procedure for moving users described above can be expanded to provide a way to reorganize whole file systems. Reorganization can improve system response time. This is particularly true of the *root* file system (which must be reorganized with all other file systems unmounted) and */usr*. Unfortunately, reorganization of large file systems is slow.

11. KEEPING DIRECTORY FILES SMALL

Directories larger than 5K bytes (320 entries) are very inefficient because of file system indirection. A UNIX user once complained that it took the system ten minutes to complete the login process; it turned out that his login directory was 25K bytes long, and the login program spent that time fruitlessly looking for a non-existent *.profile* file. A large */usr/mail* or */usr/spool/uucp* directory can also really slow the system down. The following will ferret out such directories:

```
find / −type d −size +10 −print
```

Removing files from directories does not make the directories get smaller (the empty directory entries are available for reuse). The following will "compact" */usr/mail* (or any other directory):

```
mv /usr/mail /usr/omail
mkdir /usr/mail
chmod 777 /usr/mail
cd /usr/omail
find . −print | cpio −plm ../mail
cd ..
rm −rf omail
```

12. ADMINISTRATIVE USE OF "CRON"

The program *cron*(1M) is useful in the administration of the system; it can be used to:

- Turn off the programs in directory */usr/games* during prime time.
- Run programs off-hours:
  — accounting;
  — file system administration;
  — long-running, user-written shell procedures (using the *su*(1) command), for example:

```
su − userx userx_shell arg ...
```

13. WATCH OUT FOR FILES AND DIRECTORIES THAT GROW

- Accounting files:
  - — */usr/adm/wtmp*login information;
  - — */usr/adm/pacct*process accounting; gets big quickly.
- Other files:
  - — */usr/lib/cronlog*status log of commands executed by *cron*(1M);
  - — */usr/spool*spooling directory for line printers, *uucp*(1C), etc., and whose sub-directories should be compacted as described above.

14. ALLOCATING RESOURCES TO USERS

A prospective user should obtain connect-time and file-space authorization through appropriate channels. Once this is done, the user should apply for a login by providing the following information to the "system administrator":

- User's name.
- Suggested login name (not more than 8 characters, beginning with a lower-case letter).
- Relationships to other users (this influences the choice of the file system).
- Estimate of required file space (this also influences the choice of the file system).

Users should be forced to have passwords (not more than 8 characters long, but more than 5, and *not* in Webster's Unabridged); *passwd*(5) explains how to do that.

15. THE MATTER OF ACCOUNTING AND USAGE

You should run the accounting programs even if you do not "bill" for service. Otherwise, your users' habits (especially *bad* habits) will be a mystery to you. Accounting information can also help you find performance bottlenecks, unused logins, bad phone lines, etc.

16. DIAL LINE UTILIZATION

If prime-time dial line utilization gets much over 70%, users will start to encounter busy signals when dialing in. This, in turn, will lead to "line hogging". The only solutions are to get a larger (another) machine, or to get rid of users. Manual policing will help some, but "automatic" policing will be *invariably* subverted by users.

17. "BIRD-DOGGING"

When the system is busy (lines busy and/or slow response), someone should determine why this is so. The *who*(1) command lists the people logged in. The *ps*(1) command shows what they are doing. (The */etc/whodo* command combines the output of *who* and *ps*.) Unfortunately, *ps* operates from heuristics that can consistently fail to report certain processes in a busy system. That is, one must be careful about hanging up an apparently inactive line. The *acctcom*(1M) command can read the shell accounting file */usr/adm/pacct* backwards from the most recent entry. It will print entries for selected lines or login names.

18. 300/1,200-BAUD TERMINALS

Don't use upper-case-only terminals. Get full-duplex, full-ASCII terminals. Hardware horizontal tabbing is very desirable, because it increases output speed and lowers system overhead. A fair proportion of your terminals should provide for correspondence-quality hard-copy output to take advantage of the UNIX word-processing capabilities; see *term*(7).

19. LINE PRINTERS

Most line printers are troublesome and impose considerable overhead on the system. Most also lack hardware tabs, character overstrike capability, etc. A printer that will work over an asynchronous link (DC1/DC3 protocol required) may be the best bet.

20. SECURITY

The current UNIX is not tamper-proof. You can't keep people from "breaking" the system, but you can usually detect that they have done so. The following command will mail (to root) a list of all "set user ID" programs owned by *root* (super-user):

```
find / −user root −perm −4100 −exec ls −l { } \; | mail root
```

Any surprises in *root*'s mail should be investigated. Related advice:

- Change the super-user password regularly. Don't pick obvious passwords (choose 6-to-8 character nonsense strings that combine alphabetics with digits or special characters).
- If you have dial ports and do not *require* passwords, you are courting trouble.
- The *chroot*(1M) ans *su*(1) commands are inherently dangerous, as are *group* passwords; consider removing them from "production" systems.
- Login directories, *.profile* files, and files in */bin*, */usr/bin*, */lbin*, and */etc* that are writable by others than their respective owners are security weak spots; police your system regularly against them.
- Remember, no time-sharing system with dial ports is really secure. Don't keep top-secret stuff on the system.

21. COMMUNICATING WITH YOUR USERS

The directory */usr/news* and the *news*(1) command are provided as a way to get *brief* announcements to your users. More pressing items (one-liners) can be entered in the */etc/motd* (message of the day) file; *motd* and (new to the user) *news* are announced at login time.

To reach users who are already logged in, use the *wall*(1M) (write all) command. Don't use *wall* while logged-in as super-user, except in emergencies.

The */usr/news* directory should be cleaned out every few weeks so that nothing older than, say, three months is ever found there. The *motd* file should be cleaned out daily.

We have found that, on most systems, a file in */usr/news* will reach 50% of the users within a day and over 80% of the users within a week.

22. TROUBLESHOOTING

It would be easy to write a book on this topic. The following are some of the key items:

a. Dealing with the hardware service contractor:

   - Before you take out a hardware service contract (with DEC or with someone else), be sure that the contractor agrees to get along with the UNIX software ("It's the hardware," says you; "It's the software," says the hardware service contractor).
   - Keep on top of problems. For instance, DEC has a problem-aging priority scheme. Find out about any such scheme that your contractor may have, and make them prove that it is being followed. Remember that an unreported problem is getting no priority at all. If a problem persists, escalate it up your contractor's local management chain; it may also be effective to complain to your contractor's sales representative.
   - If you are serious about service to your users, you should have an extended-period service contract (e.g., 16 hours/day, 6 days/week). Arrange for preventive maintenance, non-critical repair, and add-on installation work to be done before or after prime time.
   - If you have a service contract, learn the details. In particular, make sure that preventive maintenance is scheduled in advance and that it is completed.
   - Ask the hardware service contractor to provide and maintain a "site log". You will

have to work on the log, as well.

- Make sure that your hardware vendor (as well as your hardware service contractor, if the two are different) agrees to the presence of non-DEC equipment on your system (even if you have none to start with).
- Run error logging. Keep console sheets. Make sure error messages are shown to your contractor's Customer Engineers.
- Take core dumps after system crashes and interpret results for Customer Engineers.
- Keep down-time records and make sure that your hardware service contractor knows about them.

b. Dealing with the telephone services vendor:

You are most apt to have telephone problems when you rearrange or add equipment. You may also have occasional central office, trunking, and modem failures:

- Be specific with repair operators: tell them that the trouble involves *data* equipment.
- If your first call fails to get results, ask for the "supervisor" on the second call, and, if necessary, escalate further to get the problem solved.

c. Some obvious problem areas:

- Disk Drives−Over 50% of your problems are likely to be related to the disk subsystem. As mentioned earlier, the way to keep your system *up* is to have a spare disk drive. Remember:
  - — Preventive maintenance of disk drives is very important.
  - — Make sure that the Customer Engineers who service your hardware see the error-logging printouts and console error messages produced by UNIX (and that they understand them).
  - — Disk failure can ruin a UNIX file system. The *only* defense is to make a complete, daily file backup! (See *Protecting User Files* above.)
  - — Many administrators believe the the RP04 disk drives fail more often than RP06s and take longer to fix.
- Dial Ports−In this area, as well as in the area of synchronous data interfaces, there is room for finger-pointing among all your vendors. Check for obvious things:
  - — Is the system in "multi-user" mode?
  - — Is the */etc/inittab* file OK?
  - — Are any cables loose (*both* ends)?
  - — In some telephone offices, trunk-hunting is based on 10-number groups. Hunting *between* such groups can fail independently of anything else.

  The possibilities for trouble are many. The "decision table" below attempts to describe some alternatives; it is meant primarily for users of DH11/DZ11 asynchronous devices. If you are unfamiliar with the format, (vertical) Rule 3 reads: "If line rings *and* ring light shows *and* computer does *not* answer *and* switching the modem solves the problem, then it is likely to be a telephone company problem; also, busy out that line."
- Early experience with the DZ11 has been poor. Several different problems have cropped up including bad line units and a stuck interrupt bit that crashes the system. Don't install DZs without giving them the full diagnostic treatment.
- Synchronous Ports−High-speed synchronous interface devices are even more trouble than dial equipment. The following is a list of potential trouble spots:
  - — Your UNIX software.
  - — Your interface device (e.g., DQS11B).
  - — Cable to your modem.
  - — Your modem.
  - — The communications line.

— Other modem.
— Other cable.
— Other interface device.
— Other system's software.

Think of the finger-pointing possibilities. The best defense is a good line monitor.

- Power Supply Modules−There are a lot of them, and they do fail, more or less regularly. Hard failure can be detected at the console; voltage drift is tougher. Failure of the FP11 (floating-point unit) power supply can be slow to fix, because Customer Engineers are likely to work back from the far end of the "bus", taking a long time to find the problem.

Asynchronous Line Problems

Rules:	1	2	3	4	5	6	7	8	9	0
Condition:										
Line rings	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ring light shows on telephone console	−	N	Y	Y	Y	Y	Y	Y	Y	Y
Computer answers	−	−	N	N	Y	Y	Y	Y	Y	Y
Login message received on terminal	−	−	−	−	N	N	Y	Y	Y	Y
Switching modem solves problem	−	−	Y	N	Y	N	−	−	−	−
User can login	−	−	−	−	−	−	N	N	N	Y
Telephone console shows data received	−	−	−	−	−	−	Y	Y	N	−
Problem affects whole DH/DZ (up to 16 lines)	−	−	−	−	−	−	Y	N	−	−
Diagnosis and/or Action:										
No problem	−	−	−	−	−	−	−	−	−	X
PDP-11 hardware problem likely	−	−	−	X	−	X	X	−	−	−
Telephone problem likely	X	X	X	−	X	−	−	−	X	−
May be a problem with user's terminal	−	−	−	−	−	−	−	X	−	−
Busy out bad line(s)	X	X	X	X	X	X	X	−	X	−

23. DATASET OPTIONS

The following dataset options seem to work with UNIX:

The 801C-L1 (Auto-Call Unit):
Jumpers:
E2 to *E3*
E6 to *E5*

Options:
Y, X, T, B,
ZG, ZP, G,
R, ZT

Switches (0 = open, 1= closed, i.e., side next to number is down):
S1 = 1000[1] (Bracketed switches are missing on some models.)
S2 = 0101
S3 = 11010
S4 = 11[00]

The 212A-L1 (1,200-baud full-duplex):
Options:
E, ZF, YF, YC,
YG, YJ, YK,
S, V, A, T, ZH,
W, YP, YR

Switches:

S1	=	[0]001
S2	=	110001000
S3	=	11110000
S5	=	00

24. NULL MODEM WIRING

Improperly wired null modems can cause spurious interrupts, especially at higher baud rates. A single bad modem on a 9,600-baud line can waste 15% of your CPU power. The following (symmetrical) wiring plan will prevent such problems:

pin 1 to 1
pin 2 to 3
pin 3 to 2
strap pin 4 to 5 in the same plug
pin 6 to 20
pin 7 to 7
pin 8 to 20
pin 20 to 6 and 8
ground unused pins

25. 113D, 103J DATA SET PROBLEMS

The DH11 and DJ11 multiplexers normally have a jumper connecting pin 25 to pin 4 (request to send), thus asserting pin 25 when the line is opened. This jumper should be removed for any lines connected to 113Ds or 103Js (also applies to 103Js with 801s).

26. PHOTOTYPESETTING EQUIPMENT AND SUPPLIES

Read this section if you plan to use the phototypesetting software of UNIX.

Phototypesetter. The phototypesetter and fonts currently supported by UNIX are manufactured by:

Wang Graphic Systems, Inc.
Executive Drive
Hudson, NH 03051 (603-889-8550)

The phototypesetter is an on-line C/A/T System 1 with a high-speed turret. The external paper tape reader on the typesetter is not needed, because the typesetter is connected to the PDP-11 CPU via a DR11C.

PDP 11/45 Only. The following modification (developed by DEC Field Service) should be made to the DR11C (without this modification, the system may crash when the typesetter is powered down): “Add two 390-ohm resistors−from E-18 pin 6 to ground, and from E-18 pin 3 to ground. Put a piece of insulating tubing over the leads so that they do not short out the ‘etch’ runs that they cross.”

Fonts. There are eight fonts that are normally used, as shown in the table below. The first three of the these provide the most-often used (serif) typeface. The last three are used when a sans-serif typeface is desired. The fourth font contains a number of Greek characters and mathematical symbols; see *NROFF/TROFF User's Manual* by J. F. Ossanna. The fifth font is useful for typesetting text that you wish to look like terminal or printer output, e.g., for examples of programs. Wang Graphic Systems, Inc. offers a variety of other fonts. For *troff* to be able to use these fonts, corresponding font tables must be built and compiled into the directory */usr/lib/font*.

Name	*Part Number*	*Troff Name*
BT Times Roman	802-016A	R
Times Italic	802-013A	I
Times Bold	802-014A	B
BT PI Font #4 Special Characters	829-021B	S
BT PI Font #6 Constant Width	829-046A	CW
Geneva (Helvetica) Regular	803-032B	G or H
Geneva (Helvetica) Regular Italic	803-033B	GI or HI
Geneva (Helvetica) Medium	803-034B	GM or HM

Other fonts for which the source font tables are supplied are:

Name	*Troff Name*
Boston Condensed	BC
News Condensed	C
Century Schoolbook Expanded	CE
Century Schoolbook Italic	CI
Century Bold Italic	CK
Century Schoolbook	CS
Futura (Utica) Demibold	FD or UD
Text Greek	GR
Geneva Light	L
Geneva Light Italic	LI
Palatino	PA
Palatino Bold	PB
Palatino Italic	PI
Stymie Bold	SB
Stymie Medium Italic	SI
Stymie Medium	SM

Paper and Chemicals. The phototypesetter “prints” onto photo-mechanical paper, which can be obtained from a photographic supply house and is specified as:

- Kodak Ektamatic Paper, Grade S, Type 2250, 8 in.×150 ft., Spec. 175 (or equivalent).

Also obtainable from such a supply house are the chemicals for the developing process:

- Kodak Ektamatic A10 Activator (or equivalent).
- Kodak Ektamatic S40 Stabilizer (or equivalent).

These chemicals should be ordered in 9.5-liter (2.5-gallon) containers for the circulator.

Developer. A Kodak Ektamatic Processor Model 214K (or equivalent) is used to process the paper from the typesetter. A light-proof box attached to the 214K (to hold the output cassette from the typesetter) is called an “Autofeeder” and can be obtained from:

Peripheral Graphics, Inc.
Andover Industrial Center
York Street
Andover, MA 01810 (617-475-9005)

Circulator and Dryer. A circulator and a paper dryer, as well as a shelf for the dryer can be obtained from:

Mohr Enterprises
8015 North Ridgeway Ave.
Skokie, IL 60076 (312-674-8890)

The needed parts are:

- ME-8 Mohrflow: circulator to increase the usability of the chemicals.
- ME-5 Mohrdry: dryer for the photo-mechanical paper.
- Dryer Extension: shelf to support the dryer; it connects to the circulator cabinet.

Also obtainable from Mohr Enterprises are cleaners for the developer and circulator. Such cleaning is needed every 2 to 4 weeks, depending on the volume of work:

- R-53 Mohrchem Activator Cleaner Concentrate.
- R-57 Mohrchem Stabilizer Cleaner Concentrate.

Each quart bottle makes 9.5 liters (2.5 gallons) of reusable cleaner to clean the tubing, rollers, and tray of the developer and circulator. Equivalent cleaners can also be obtained elsewhere.

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