symbolics™

Volume 4B
Program Development Tools

Volume 4B. Program Development Tools

#996042

Design: Schafer/LaCasse
Cover and title page typography: Litho Composition Co.
Text typography: Century Schoolbook and Helvetica produced on a Symbolics 3600
Lisp Machine from Bitstream, Inc., outlines; text master printed on Symbolics
LGP-1 Laser Graphics Printer.

The first Lisp Machine system was a product of the efforts of many people at the M.I.T. Artificial Intelligence Laboratory, and of the unique environment there. Portions of earliest versions of many of the documents in this documentation set were written at the AI Lab.

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Program Development Tools

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ZMACS Zmacs Manual

Cambridge, Massachusetts

Zmacs Manual

# 990050

February 1984

This document corresponds to Release 5.0.

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Printing year and number: 87 86 85 84 9 8 7 6 5 4 3 2 1

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Introduction

Overview

Scope

The *Zmacs Manual* is primarily a reference manual and is intended for all users of Zmacs on the Lisp Machine. It contains both conceptual overview and reference material that together describe the Zmacs editor. We assume that you have already read the *Lisp Machine Summary*.

Organization

The first three chapters contain introductory material for users who are unfamiliar with Zmacs concepts. Experienced users can skim the remaining chapters, which are organized according to editing function, and use them as reference material.

"Introduction" gives an overview of Zmacs and describes Zmacs documentation conventions in this manual.

"Getting Started" introduces basic Zmacs concepts and commands, such as how to enter text, move the cursor, and make simple corrections.

"Getting Help" describes ways to get out of trouble and how to get Zmacs information during editing.

"Moving the Cursor" includes descriptions of both mouse and keyboard motion commands.

"Deleting and Transposing Text" explains Zmacs deletion and text retrieval concepts, as well as the ways to delete and transpose text.

"Working With Regions" tells how to manipulate blocks of text.

"Searching, Replacing, and Sorting" describes the commands for locating and replacing character strings in one or many files.

"Manipulating Buffers and Files" gives more information on manipulating blocks of text, inserting files, keeping track of everything, and editing your directory.

Overview, *cont'd.*

"Setting the Major Mode" documents the major editing modes and their characteristics.

"Changing Case and Indentation" includes many commands for changing code, comments, or text to uppercase or lowercase, as well as commands for handling white space, indentation, and formatting.

"Editing Lisp Programs" the ways in which Zmacs is tailored for use in writing and editing programs in Lisp.

"Customizing the Zmacs Environment" describes how to fine tune your Zmacs environment using modes to set it up, keyboard macros to perform special editing tasks, binding keys to the commands of your choice, setting Zmacs variables to alter your standard system defaults, and saving the customized environment in init files.

Appendix A summarizes Zmacs help commands according to the context in which they are available.

Introduction to Zmacs

Overview

Zmacs, the Lisp Machine editor, is built on a large and powerful system of text-manipulation functions and data structures, called *Zwei.*

Zwei is not an editor itself, but rather a system on which other text editors are implemented. For example, in addition to Zmacs, the Zmail mail reading system also uses Zwei functions to allow editing of a mail message as it is being composed or after it has been received. The subsystems that are established upon Zwei are:

- Zmacs, the editor that manipulates text in files
- Dired, the editor that manipulates directories represented as text in files
- Zmail, the editor that manipulates text in mailboxes
- Converse, the editor that manipulates text in messages

Since these subsystems share Zwei in the dynamically linked Lisp environment, many of the commands available as Zmacs commands are available in other editing contexts as well.

In this manual, we discuss Zmacs commands in the context of Zmacs only. We also describe Dired, the directory editor, since it is used within Zmacs.

Commands

Zmacs *commands* are Lisp functions that perform the editing work. Every Zmacs command has a *name*, and many commands are bound to keys. When a command is bound to a *keystroke combination*, you invoke it by pressing those keys. For example, the Forward Word command is invoked by typing the keystroke m-F. When a command is not bound to a set of keystrokes, Zmacs calls it an *extended* command and you invoke it using its name preceded by m-X. For example, the command View Mail, an extended command, is invoked View Mail (m-X). *Command tables* assign keystrokes and names to commands. Each time you press a key, Zmacs looks up the function associated with that key. For ordinary characters, the function **com-standard**, in the standard command table, inserts the character once.

Keystrokes

A keystroke has a character component and a modifier component, and is performed by pressing a *primary key* (alphanumeric), possibly while holding down a *shift key* or a group of shift keys. The primary key held down with either the SHIFT or SYMBOL keys determines the *character* part of a keystroke. Whether you hold

Introduction to Zmacs, *cont'd.*

down the other shift keys, CONTROL, META, HYPER, and SUPER, determines the *modifier* part of the keystroke.

In general, commands that begin with a CONTROL (c-) key modifier operate on single characters, commands that begin with a META (m-) key modifier operate on words, and commands that begin with a CONTROL META (c-m-) modifier operate on Lisp code.

Prefix character commands consist of more than one keystroke per command. For example, to invoke the command c-X F, you first type the prefix character c-X and then the primary key F. Prefix character commands are not case-sensitive — that is, Zmacs converts a lowercase character following a prefix character command (like c-X) to uppercase. For example, c-X f is equivalent to c-X F.

Zmacs commands are self-delimiting. Unless otherwise specified, you do not need to type a carriage return or other terminating character to finish typing a command.

Extended Commands

Extended commands extend the range of commands past the one-or-two-keystroke limitation. You invoke Zmacs extended commands by name using the m-X command:

m-X Extended Command

Prompts for the name of a Zmacs command and executes that command.

Command completion is provided. (See "Completion" on page 12.)

Command Tables

There is always a currently active command table (*comtab*). When you invoke a command, Zmacs looks it up in the associated command table, checks to see if it is valid in the current context, and performs the function. Zmacs uses many comtabs, a few of which are the standard comtab, a comtab for commands that begin with the c-X prefix, and a comtab for reading pathnames in the minibuffer.

Many commands have no meaning outside their own limited context. Sometimes you may get a message or see online documentation about a command that says `Not available in current context.` Those commands that are not accessible via a keystroke and not accessible via m-X are likely to be commands that do not work in the current context. For example, a command that is part of Dired is only available on a key when you are in Dired.

Introduction to Zmacs, *cont'd.*

You can invoke a command that is not available in the current comtab with the c-m-X command. c-m-X works like m-X: you press the keys and then type the command name in the minibuffer. This is primarily intended for debugging new editor commands that have not yet been installed on any key. Using c-m-X to invoke a command that is not in the current comtab because it only works in some other context is a sure way to get into trouble.

c-m-X Any Extended Command

Prompts for the name of a Zmacs command and executes that command.

Command completion is provided.

Additional Notation Conventions

Documentation Conventions for Commands

The word *current*, when describing a word, line, paragraph, page, or any Zmacs-recognizable piece of text, refers to the text that currently contains (or immediately follows) the cursor.

The *invocation* of a command shows exactly what keys you must press to invoke, or call, a command. We use the following format to describe Zmacs commands:

```
invocation                                  Name
alternate invocation
alternate invocation
```

Formal description of command

Since each extended (m-X) command contains its name as part of its invocation, we do not repeat the name again on that line.

Example 1

```
m->                                         Goto End
```

Moves point to the end of the buffer.

With a numeric argument *n* between 0 and 10, moves point to a place *n*/10 of the way from the end of the buffer to the beginning.

(The m-> command goes to the end of the buffer — its name is Goto End.)

Example 2

Dired (m-X)

Prompts for the name of a directory to edit with Dired.

(The Dired (m-X) command is an extended command that enters the directory editor.)

Example 3

```
m-M                                         Back To Indentation
c-m-M
m-RETURN
c-m-RETURN
```

Positions point before the first nonblank character on the current line.

(Back to Indentation has several possible invocations that all move back to the first nonblank character on the line.)

Getting Started

Entering Zmacs

Introduction

You can enter, or invoke, the editor in several ways: Press SELECT E, use the mouse, or run either the function (**ed**) or the function **zwei:edit-functions**.

SELECT E

You can invoke the editor by pressing the SELECT key and then the letter E:

- If you have already been in the editor since booting the machine, Zmacs returns you to the same place in the same buffer that you last used.
- If this is the first time you are entering Zmacs since booting the machine, Zmacs puts you in an empty buffer named `*Buffer-1*`.

SELECT E enters or returns you to the editor from anyplace in the system, not just when you are talking to Lisp.

Mouse

You can invoke the editor using the mouse.

Summon a System menu by clicking right twice [(R2)]. Then click left on the Edit option [Edit (L)], which puts you into a Zmacs buffer. The same as for SELECT E above, if you are returning to the editor Zmacs puts you back at the same place in the same buffer, and if you are entering Zmacs for the first time it puts you in an empty buffer.

(ed)

The Lisp function **ed** enters Zmacs from a Lisp Listener.

ed &optional *arg* *Function*

When reentering Zmacs within a login session, **(ed)** enters the editor, preserving its state as it was when you last left. When entering Zmacs for the first time within a login session, **(ed)** initializes Zmacs and creates an empty buffer.

arg can have these values.

Value	*Description*
t	The **ed** function enters the editor, creates an empty buffer, and selects it.
Pathname or string	The **ed** function enters the editor and finds or creates a buffer with the specified file in it.

Entering Zmacs, *cont'd.*

Defined symbol (ed 'giraffe)	The editor tries to find the source definition of that symbol for you to edit. A defined symbol can be, for example, a function, macro, variable, flavor, or system.
The symbol **zwei:reload**	The system reinitializes the editor. This destroys all existing buffers, so use this only if you have to.

zwei:edit-functions

The Lisp function **zwei:edit-functions** also enters Zmacs from a Lisp Listener.

zwei:edit-functions *spec-list* *Function*

zwei:edit-functions is like **ed** in that inside the editor process it throws you back into the editor, whereas from another process it just sends a message to the editor and selects the editor's window. **zwei:edit-functions** gives *spec-list* to the editor in the same way that Edit Callers (see page 169) and similar editor commands would.

This command is useful when you have collected the names of things that you need to change, for example, using some program to generate the list. *spec-list* is a list of definitions; these are either function specs (if the definitions are functions) or symbols.

Zmacs sorts the list into an appropriate order, putting definitions from the same file together, and creates a support buffer called `*Function-Specs-to-Edit-`*n*`*`. It selects the editor buffer containing the first definition in the list.

Getting Help in Zmacs

Introduction

Zmacs has many features that provide information about Zmacs commands, existing code, buffers, and files. Two features are generally useful: the HELP key and completion. (See the chapter "Getting Help", page 32, for details.)

HELP

Pressing the HELP key in a Zmacs editing window gives information about Zmacs commands and variables. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193). The kind of information it displays depends on the key you press after HELP.

HELP ? or help help	Displays a summary of HELP options.
HELP A	Displays names, key bindings, and brief descriptions of commands whose names contain a string you specify. (The A refers to *apropos*, the name of the function that finds the commands and displays their documentation.)
HELP C	Displays the name and description of a command bound to a key you specify.
HELP D	Displays documentation for a command whose name you specify.
HELP L	Displays a listing of the last 60 keys you pressed.
HELP U	Offers to undo the last major Zmacs operation, such as sorting or filling, when possible.
HELP V	Displays the names and values of Zmacs variables whose names contain a string you specify. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).
HELP W	Displays the key binding for a command you specify. (The W refers to where.)
HELP SPACE	Repeats the last HELP command.

Completion

Some Zmacs operations require you to provide names — for example, names of extended commands, Lisp objects, buffers, or files. Often you do not have to type all the characters of a name; Zmacs offers *completion* over some names. When completion is available, the word `Completion` appears in parentheses above the right side of the minibuffer.

Getting Help in Zmacs, *cont'd.*

You can request completion when you have typed enough characters to specify a unique word or name. For extended commands and most other names, completion works on initial substrings of each word. For example, `m-X c SPACE b` is sufficient to specify the extended command Compile Buffer. `SPACE`, `COMPLETE`, `RETURN`, and `END` complete names in different ways. Press `HELP` or click right once, [(R)], on the editor window or minibuffer to list possible completions for the characters you have typed. `c-/` displays every command that contains the substring.

`SPACE`	Completes words up to the current word.
`HELP` or `c-?`	Displays possible completions in the typeout area.
[(R)]	Pops up a menu of possible completions.
`c-/`	Runs Apropos for each of the partially typed words in the name.
`COMPLETE`	Completes as much as possible. This could be the full name.
`RETURN` or `END`	Confirms the name if possible, whether or not you have seen the full name.

Yanking

Yanking helps you to get back any text that you have typed or deleted, by retrieving it from a *history*. A history remembers commands and pieces of text, placing them in a *history list* in stack order, with the newer elements at the top of the history and the older elements toward the bottom. Yanking commands yank back an element of a history from any position in the history list that you specify:

Yanking in the kill history:

`c-0 c-Y`	Displays the elements of the kill history (saved text). Click left on (*N* `more elements in history.`) to display those not shown.
`c-Y`	Yanks the first element in the kill history.
`m-Y`	After `c-Y`, yanks the previous element in the kill history. Subsequent `m-Y`s move down the kill history list.

Getting Help in Zmacs, *cont'd.*

Yanking in the command history:

`c-0 c-m-Y`	Displays the elements of the command history (editor commands that use the minibuffer in any way). Click left on `(`*N* `more elements in history.)` to display those not shown.
`c-m-Y`	Yanks the first element in the command history.
`m-Y`	After `c-m-Y`, yanks the previous element in the command history. Subsequent `m-Y`s move down the command history list.

Killing and yanking are fully described in the chapter "Deleting and Transposing Text", page 60.

Organization of the Screen

Introduction

Zmacs divides its window into several areas — the editor window, the echo area, and the mode line, each of which contains its own type of information.

Editor Window

The biggest area, the *editor window*, shows the text you are editing. You can edit several different items at once with Zmacs; each item is edited in a separate editing environment called a *buffer*.

Buffer

Zmacs gives every buffer a name. At any time you are editing only one of them, the *selected* buffer. When we speak of what some command does to "the buffer", we are talking about the currently selected buffer. Multiple buffers in Zmacs make it easy to switch among several files; the mode line tells you which one you are editing.

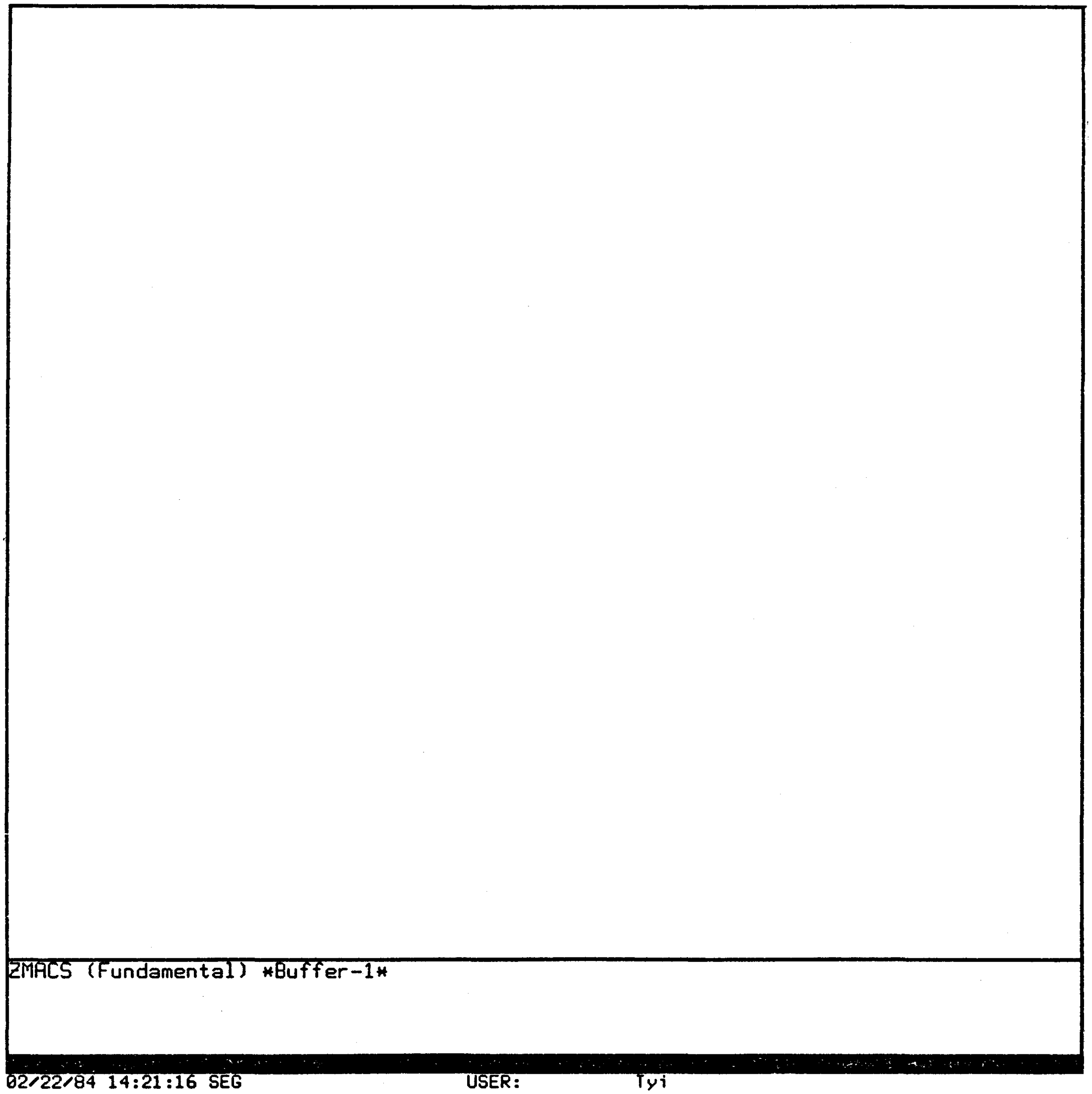
Cursor and Point

The small blinking rectangle, the *cursor*, usually appears somewhere within the buffer, showing the position of *point*, the location at which editing takes place. Although the cursor covers a single character, we consider point to be at the left edge of the cursor, between the character the cursor is blinking on and the previous character.

Typeout

When you request some other information from Zmacs (for example, if you ask for HELP or a listing of a file directory), Zmacs needs room to display this type of information. It prints this *typeout* in a *typeout window* (at the top of the editor window), which temporarily overlays the text in the editor window, using as much room as it needs. Since the typeout is not part of the file you are editing, Zmacs delineates it from the editor buffer by drawing a line across the window between them (if both are present). The typeout window goes away if you type any command; if you want to make it go away immediately but not do anything else, you can press SPACE. The cursor, which appears at the end of the typeout, then moves back to its original location in the buffer.

Organization of the Screen, *cont'd.*



```
ZMACS (Fundamental) *Buffer-1*

02/22/84 14:21:16 SEG                USER:        Tyi
```

Organization of the Screen, *cont'd.*

Echo Area

A few lines at the bottom of the screen make up what is called the *echo area*. *Echoing* means displaying the commands that you type. Zmacs commands are usually not echoed at all, but if you pause in the middle of a multicharacter command, then all the characters (including numeric arguments and prefixes) typed so far are echoed. This is intended to prompt you for the rest of the command. The rest of the command is echoed, too, as you type it. This behavior is designed to give confident users optimum response, while giving hesitant users maximum feedback.

Minibuffer

Many Zmacs commands prompt you for additional information. This prompting happens in a small window within the echo area called the *minibuffer*.

When Zmacs prompts you, the cursor in the main editing window stops blinking and a blinking cursor appears in the minibuffer. Over the minibuffer, in the Zmacs mode line, some prompting text appears, indicating what information Zmacs is prompting you for.

When you type a response to the prompt, that response is inserted in the minibuffer. You can edit text in the minibuffer using the same Zmacs commands used in the main Zmacs window.

When you are done typing (and possibly editing) a response to the prompt, the RETURN key finishes your response.

Mode Line

The line above the echo area is known as the *mode line*. It is the line that usually starts with `ZMACS (Fundamental)`. Its purpose is to display information about the current buffer. The mode line consists of:

- The name of the major mode
- The name of the minor mode(s), if any
- The name of the buffer
- The version number of the file
- The status of the buffer
- A message telling whether the buffer contents extend above and/or below the screen

The mode line has this format:

```
ZMACS (major-mode minor-mode(s)) buffer (version) buffer-status
[position-flag]
```

Organization of the Screen, *cont'd.*

Major-mode

major-mode is always the name of the *major mode* you are in. At any time, Zmacs is in one and only one of its possible major modes. The major modes available include:

- Fundamental mode (which Zmacs starts out in)
- Text mode
- Lisp mode
- Macsyma mode

See the chapter "Setting the Major Mode", page 141, for full details about all the major modes, how they differ, and how to select one.

Minor-mode

minor-mode is a list of the *minor modes* that are turned on at the moment. For example:

Fill	Auto Fill Mode
Electric Shift-lock	Electric Shift Lock Mode
Abbrev	Word Abbrev Mode
Overwrite	Overwrite Mode

See the chapter "Built-in Customization — Zmacs Minor Modes", page 179, for more information.

Buffer

buffer is the name of the workspace that holds the text you are editing. A buffer can be named in one of two ways:

- By Zmacs, with a name that corresponds to the existing file that it contains or with its standard name for an empty buffer
- By you, with any name you like

When a buffer contains a file, the buffer name is the pathname of that file, rearranged with the file name first and the host and directory at the end. (Pathname components are fully described in the *Lisp Machine Summary*.) When a buffer does not contain a file, the buffer name is a string. whatever.lisp >walf H: (5)

Buffers that do not contain files are empty, newly created, or temporary buffers. When Zmacs creates and names a buffer, that name begins and ends with an asterisk. When you create and name a buffer, on the other hand, its name is of your choosing.

Organization of the Screen, *cont'd.*

When you first start up and enter Zmacs, your buffer is either:

- An empty buffer called `*Buffer-1*`, which is the only one that exists when Zmacs starts up
- A buffer containing an existing file, which Zmacs appropriately calls by its name

See the chapter "Multiple Buffers and Windows", page 103, for information on multiple buffers.

Version

(version) is the version number most recently visited or saved. The mode line does not display any version number if the file is on a file system that does not support version numbers, such as UNIX.

... (5)

Buffer-status

If the mode line displays *, then changes have been made in the buffer that have not been saved in the file. If the buffer has not been changed since it was read in or saved, the mode line does not display a asterisk. after version #

Position-flag

When the mode line displays the message `[More above]`, then your screen shows the end of your buffer contents; when the mode line shows `[More below]`, then your screen shows the beginning of your buffer contents. When it says `[More above and below]`, then the buffer contents extend above and below the part that the screen displays. When the display shows the entire buffer contents, this message does not appear at all.

Example

```
ZMACS (Text) text.text /dess/doc/books/ VAX: * [More above and
below]
```

In this sample mode line, we are in Zmacs Text Mode, editing a file named text.text, which resides in the directory /dess/doc/books on the host named VAX. The file has been changed since we last saved it (indicated by the *), and the file contents extend above and below the portion that Zmacs displays on the screen.

Inserting Text

Introduction

To insert new text anywhere in the buffer, position the cursor at the place you want the new text to go and type the new text. Zmacs always inserts characters at the cursor. The text to the right of the cursor is pushed along ahead of the text being inserted.

Inserting Characters

When you type in new text, you are actually issuing Zmacs commands. Ordinary printing characters are called *self-inserting* because when you type one, it inserts itself into the text in your buffer.

You can give numeric arguments to the keystrokes that insert printing characters into the buffer; Zmacs interprets these arguments as repeat counts.

Example: `c-80 *` inserts a line of 80 asterisks at the cursor.

Starting a New Line

Newline characters delimit lines of text. They have no visible printed form, but are present at each line break. You can break one line into two lines by inserting a newline (pressing RETURN) where desired. Similarly, you can merge two lines into one by deleting the intervening newline.

Correcting Typos

To correct text you have just inserted, use the RUBOUT key. RUBOUT deletes the character *before* the cursor (not the one over which the cursor is positioned; that is the character *after* the cursor). The cursor and the rest of that line move to the left.

When the cursor is positioned on the first character on a line and you press RUBOUT, the preceding newline character is deleted and Zmacs appends the text on that line to the end of the previous line.

Wrapping Lines

When you add too many characters to one line without breaking it with a RETURN, the line grows to occupy two (or more) lines on the screen, with an exclamation point at the extreme right margin of all but the last of them. The `!` means that the following screen line is not really a distinct line in the file, but just the continuation of a line too long to fit the screen.

Inserting Text, *cont'd.*

Inserting Formatting Characters

You can insert most characters directly into the buffer by simply typing them, but other characters act as editing commands and do not insert themselves. If you need to insert a character that is normally a command (for example, TAB or RUBOUT), use the c-Q (Quoted Insert) command first to tell Zmacs to insert the following character into the buffer literally. c-Q prompts in the echo area for the character to be inserted and inserts it into the text.

?, maybe not. I can't get it to work

Numeric Arguments

Overview

Many Zmacs commands take numeric arguments, which you type before the main command keystroke. Specify a numeric argument by pressing any combination of any of the modifier keys (c-, m-, s-, or h-) with the number. This way, you can type sequences of commands more easily without frequently alternating keys.

Numeric arguments to commands appear in the echo area when you do not type the command immediately. With no delay, the argument does not appear.

In general, use negative arguments to tell a command to move or act backwards. You can specify a negative argument by pressing any modifier key with the minus sign followed by the number. Most commands treat a numeric argument consisting of just a minus sign the same as -1.

Example

c-F is the command to move the cursor forward one character. c-3 c-5 c-F moves point forward 35 characters; c-- c-3 c-5 c-F moves point backward 35 characters.

Throughout this manual, instead of writing out c-4 c-5 c-F or m-4 m-5 m-B, we will usually abbreviate to c-45F or m-45B.

Defaults

Many commands have default numeric arguments. This means that in the absence of a numeric argument, the command behaves as if the default argument was given. Most commands have a default argument of 1. This includes all the commands that interpret numeric arguments as repeat counts. Some commands have a different default and still others have no default: their behavior in the absence of a numeric argument is different from their behavior with a numeric argument.

c-U Quadruple Numeric Arg

This special command prefixes other commands, usually representing a numeric argument of 4. You can repeat c-U; it multiplies the numeric argument by 4 each time. For example, c-U c-U c-F moves point forward 16 characters. Sometimes instead of representing a numeric argument of 4, c-U alters the action of a command slightly; for example, when used with the command Set Pop Mark, described in "Working with Regions", page 72, c-U takes different actions with the mark.

Moving the Cursor

Description

To do more than insert characters, you have to know how to move the cursor.

The commands listed here and other cursor-moving commands are described in detail in the chapter "Moving the Cursor", page 44.

Summary

`c-A` Beginning of Line
Moves to the beginning of the line.

`c-E` End of Line
Moves to the end of the line.

`c-F` Forward
Moves forward one character.

`c-B` Backward
Moves backward one character.

`m-F` Forward Word
Moves forward one word.

`m-B` Backward Word
Moves backward one word.

`m-E` Forward Sentence
Moves to the end of the sentence in text mode.

`m-A` Backward Sentence
Moves to the beginning of the sentence in text mode.

`c-N` Down Real Line
Moves down one line.

`c-P` Up Real Line
Moves up one line.

`m-]` Forward Paragraph
Moves to the start of the next paragraph.

`m-[` Backward Paragraph
Moves to the start of the current (or last) paragraph.

`c-X ]` Next Page
Moves to the next page.

Moving the Cursor, *cont'd.*

`c-X [` **Previous Page**
Moves to the previous page.

`c-V` **Next Screen**
Moves down to display the next screenful of text.

`m-V` **Previous Screen**
Moves up to display the previous screenful of text.

`m-<` **Goto Beginning**
Moves to the beginning of the buffer.

`m->` **Goto End**
Moves to the end of the buffer.

Erasing Text

Description

Most commands that erase text from the buffer save it so that you can get it back if you change your mind, or move or copy it to other parts of the buffer. These commands are known as *kill* commands. The rest of the commands that erase text do not save it; they are known as *delete* commands. The delete commands include c-D and RUBOUT, which delete only one character at a time, and those commands that delete only spaces or line separators. Commands that can destroy significant amounts of data generally kill. The commands' names and individual descriptions use the words "kill" and "delete" to say which they do.

If you issue a kill command by mistake, you can retrieve the text with c-Y, the Yank command. See the chapter "Working with Regions", page 72, for details on killing and retrieving text.

Summary

c-D Delete Forward
Deletes the character after point.

RUBOUT Rubout
Deletes the character before point.

m-D Kill Word
Kills forward one word.

m-RUBOUT Backward Kill Word
Kills backward one word.

m-K Kill Sentence
Kills forward one sentence.

c-X RUBOUT Backward Kill Sentence
Kills backward one sentence.

c-K Kill Line
Kills to the end of the line or kills an end of line.

c-W Kill Region
Kills region (from point to mark).

c-m-K Kill Sexp
Kills forward over exactly one Lisp expression.

c-m-RUBOUT Backward Kill Sexp
Kills backward over exactly one Lisp expression.

Erasing Text, *cont'd.*

`m-\` Delete Horizontal Space

Deletes any spaces or tabs around point.

`c-X c-O` Delete Blank Lines

Deletes any blank lines following the end of the current line.

`m-^` Delete Indentation

Deletes RETURN and any indentation at front of line.

Creating and Saving Buffers and Files

Description

You do all your text editing in Zmacs *buffers*, which are temporary workspaces that can hold text. To keep any text permanently you must put it in a *file*. Files store data for any length of time.

To edit the contents of a file using Zmacs, you create a buffer and copy the file contents into it. To add text to the end of the buffer, move point to the end of the buffer and type the new text. Editing proceeds in the buffer, not in the file. The file remains unchanged until you explicitly write the modified buffer contents to the file.

If you create multiple buffers, Zmacs keeps track of which files you are editing in which buffers. This association allows you to use completion to switch among buffers while you are editing them; you do not have to type the file name more than once. Zmacs always displays the name of the file you are currently editing.

The information in this section allows you to find or create and save a file; for complete information on buffers and files, see the chapter "Manipulating Buffers and Files", page 100.

Summary

c-X c-F Find File
Reads the specified file into a buffer.

c-X c-S Save File
Saves out the changes to the current file.

c-X B Select Buffer
Selects the specified buffer.

c-X c-W Write File
Writes out the buffer to the specified file.

Creating a Buffer

Zmacs creates your initial buffer when you first enter the editor. To create other buffers, use c-X B, Select Buffer, to create an empty buffer or c-X c-F, Find File, to create either an empty buffer or a buffer containing a file.

c-X B prompts for the name of the buffer to which you want to go. Type the buffer name and RETURN. If the buffer exists, Zmacs switches to that buffer and displays it on the screen. If the buffer does not already exist, Zmacs offers to let you create it by terminating the buffer name with c-RETURN. When you create a new (empty) buffer, the display is blank.

Creating and Saving Buffers and Files, *cont'd.*

The other way to create another buffer is c-X c-F, Find File. (c-X c-F) is described in detail in "Editing Existing Files".) c-X c-F prompts for the name of a file, terminated by RETURN.

When you type c-X c-F for the first time in a Zmacs session, Zmacs offers you, as a default file name, an empty file (with the Lisp suffix native to your host computer) in your home directory on your host computer. For example:

System	*Empty Buffer Name*
Lisp Machine	foo.lisp
UNIX	foo.l
VMS	foo.lsp

The first time you use c-X c-F, you can create an empty buffer using the Zmacs default file name, create an empty buffer using a name that you specify, or create a buffer containing an existing file:

- To create an empty buffer with the initial default file name as the one Zmacs associates with your buffer, press RETURN.
- To create a new empty buffer, respond with any name. Zmacs switches to an empty buffer, gives the buffer the new name, and displays (New File) in the echo area.
- To create a new buffer containing some file, respond to the prompt with the name of that file. Zmacs switches to an empty buffer, reads that file in, and names the buffer appropriately.

Saving a File

Once you have the file in your buffer, you can make changes and then *save* the file with c-X c-S, the Save File command. This makes the changes permanent and actually changes the file. Until then, the changes are only inside your Zmacs buffer and the file itself is not really changed.

Creating a File

The first time you save or write the buffer, Zmacs creates the new file. You can create a new file with c-X c-S. Since a new file does not have a name associated with it yet, Zmacs asks for a name for the new file. It offers a *default pathname*, which is the name of the buffer. If you wish to save the file out to the default pathname, simply type a RETURN in response to the prompt.

If you wish to save the buffer in another file, provide that name as your response. Completion is offered to simplify your response.

Creating and Saving Buffers and Files, *cont'd.*

You can also write the buffer out with `c-X c-W`, Write File. Zmacs prompts in the minibuffer for the name of the place you want to write the buffer's contents. `c-X c-W` also offers a default pathname, in this case, the name you supplied with `c-X c-F`.

Editing Existing Files

To tell Zmacs to edit text in a file, use `c-X c-F`, the Find File command, and give Zmacs a file name. You can enter the *pathname* of any file on any host that is reachable by network connections from your Lisp Machine. If the file already exists, Zmacs locates the file and reads it into your buffer.

Leaving Zmacs

Overview

Use a system-wide command to switch programs, such as SELECT, FUNCTION S, the System menu, or, if you have multiple windows on the screen, position the mouse to another window and click.

SELECT Key

A set of windows is always available by pressing the SELECT key and then one of the following keys:

Key	*Program*
C	Converse, for messages to other users
E	Editor, the Zmacs text and program editor
F	File system editor for access to files and directories
I	Inspector, for inspecting and modifying data structures
L	Lisp
M	Mail reading and sending system
P	Peek, a system status display
T	Telnet, a virtual terminal utility for logging in to other hosts
X	Favor Examiner, for examining the structure of flavors that are defined in the Lisp environment

System Menu

The System menu is a momentary menu that lists several choices for acting upon windows and calling programs (for example, a Lisp Listener, Zmacs, or the Inspector). You can always call the System menu by clicking [(R2)] (the right mouse button twice or holding down the SHIFT key and clicking right once). Use the System menu to do many things, among them:

- Create new windows.
- Select old windows.
- Change the size and placement of windows on the screen.
- Hardcopy a file.

c-Z

The Zmacs command c-Z returns you to the window in which the **(ed)** function was most recently called, usually the Lisp Listener.

Getting Help

Getting Out of Trouble

Overview

Sometimes you type the wrong command. Mostly it is obvious what you have done wrong, and it is a simple matter to undo it. There are, however, some kinds of trouble you can get into that require special remedies. For example, you might accidentally delete large chunks of text you need or you might begin to type a command and then change your mind.

This section tells you how to recover from these situations.

Getting out of Prefixes and Prompts

Most of the commands we have described are single keystrokes, but some keystrokes are prefixes that must be completed with a second keystroke to specify a command. c-X is the most important of these.

Prefixes

If you press a c-X and don't mean it, you can get out by pressing either c-G or ABORT. These are general "get me out of here" commands, which you should use whenever you get yourself into a confused state. ABORT and c-G are, for the most part, synonymous in Zmacs.

Minibuffer Prompts

Sometimes you accidentally type a command that prompts for some additional information, or you type such a command on purpose and change your mind afterwards. When Zmacs prompts and you just want to get out of the minibuffer and back to where you were, press ABORT. If, instead, you wish to cancel and reenter your response, use c-G, which clears any typein but leaves you still in the minibuffer. When the minibuffer is empty, c-G cancels the minibuffer command. (With some echo area prompts, you have to use ABORT.)

ABORT Abort At Top Level

Cancels the last command typed. It also cancels numeric arguments and region marking.

c-G Beep

Cancels the last command. It also cancels numeric arguments, and region marking, except when given an argument. It cancels one thing at a time, so that if you've typed a number of commands or

Getting Out of Trouble, *cont'd.*

responses, you must use use successive c-Gs to cancel each one and return to top level.

Large Deletions

Do not delete large pieces of text by repeatedly pressing RUBOUT and c-D. Apart from being slow, text deleted character-by-character is gone for good.

Instead, use delete and kill commands that save deleted regions in the kill history. c-K, m-K, and the commands that deal with *regions* easily wipe out and save larger chunks. Also, RUBOUT or c-D with a numeric argument erases that many characters all at once and saves them in the kill history. These delete and kill commands are fully described in the chapter "Deleting and Transposing Words", page 60.

Getting Text Back

The system has different histories for different contexts. One of these is always the *current history*. The two histories that you need to use for yanking in Zmacs are the *kill history* and the *command history*. The kill history remembers pieces of text that you killed or copied into it. In the context of Zmacs, the command history remembers all the editor commands that use the minibuffer in any way. Additions to the histories are placed at the top of the list, so that history elements are stored in reverse chronological order — the newer elements at the top of the history, the older elements toward the bottom. A history remembers everything that has been typed to it since the last cold boot — it has no size limit.

Yanking commands pull in the elements of the history. *Top-level commands* start a yanking sequence; for example, c-Y yanks back the last text killed from the kill history, and c-m-Y yanks back the last command performed in the minibuffer. m-Y performs all subsequent yanks in the same sequence; for example, pressing m-Y while the kill history is the current history yanks the next item from that history.

A yanking sequence ends when you type new text, execute a form or command, or start another yanking sequence.

Killing and yanking is fully described in the chapter "Working with Regions", page 72.

Finding Out About Zmacs Commands

Overview

Sometimes you want to know if a Zmacs command exists that performs a certain function. Or, you might think that you know what a certain keystroke does, but you still want to make sure, or refresh your memory about its exact usage. This manual is one resource you might use in these circumstances. Zmacs itself has a number of built-in self-documentation facilities. This section describes some ways to get at this documentation.

HELP

The HELP key is a prefix to a useful group of commands giving various kinds of online help. If you forget what a command does, which keystrokes perform an action, or have no idea how to accomplish something, press HELP.

Whenever you have a question of any kind, press HELP — Zmacs prompts you in the minibuffer for details on what kind of help. If you don't know, press HELP again and it tells you, in the *typeout window*, how to find what you're looking for. The typeout window displays right over the editor window. The actual contents of the buffer are not affected, and the next command you type restores the buffer display.

Finding Out What a Command Does

HELP C

The command HELP C displays "Document Command:" below the mode line and waits for you to type a command. When you do, Zmacs displays the internal documentation for that command.

Example

If you press HELP-C followed by c-F, the response is:

```
c-F is Forward, implemented by COM-FORWARD:
Moves forward one character.
With a numeric argument (n), it moves forward n characters.
```

The first line above tells you the name of the command (in this case Forward), and the name of the internal Lisp function that actually does the work (in this case **com-forward**). (You don't need to know these internal names for basic editing.) The next line is a very short description of what the command does; it usually tells you what the command does without a numeric argument and how a numeric argument modifies that behavior.

Finding Out About Zmacs Commands, *cont'd.*

Prefix Commands

When you ask (with HELP C) for documentation on a prefix command like c-X, Zmacs prompts you, in the typeout window, to complete the command. Zmacs displays the documentation for the prefix command in the typeout window.

Extended Commands

HELP D

When you want to find out what an extended command does, you can display the documentation for the command by pressing HELP D, which prompts in the minibuffer "Describe command:", to which you type the command's name.

Searching for Appropriate Commands

HELP A

When you can only guess at part of the name of a command by the action it performs, there is a command, HELP A, to help you scan all the available Zmacs commands to find the one you want.

Each Zmacs command has a name. The name is almost always exactly what you would expect; that is, the name describes the function of the command in reasonably plain English.

Example

The command you perform when you use m-Q is called "Fill Paragraph", so you might expect a command that counts the number of paragraphs in the buffer to be called something like "Count Paragraphs" or "Paragraphs Count". No matter what, the name is going to have the word *paragraph* in it.

How It Works

To find the command you want, just press HELP A. Zmacs prompts you for a substring, you enter your guess, and then Zmacs displays short descriptions of all the commands whose names contain that substring. If the string that you enter contains a space, then Zmacs displays a short description of all the commands whose names include a similarly positioned space. Each description gives the short documentation for the command and tells what keystrokes invoke it.

Finding Out About Zmacs Commands, *cont'd.*

Finding Out What You Have Typed

HELP L

As you are editing you might find yourself in a hopelessly confused state and not know how to recover.

If this happens to you it is often very enlightening to press HELP L to list the last 60 keystrokes you typed. By examining your own recent activity, it is often possible to find out where you went wrong and how to save yourself.

More HELP Commands

HELP U

Offers to undo the last "major" operation (such as fill or sort).

HELP V

Displays all the Zmacs variables whose names contain a certain substring. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

HELP W

Finds out whether an extended command is bound to a key.

General Information-giving Commands

The following commands display:

- Information about the location of point
- Documentation about a specified Lisp function
- Argument list for the specified Lisp function
- Information about the current Lisp variable
- The number of lines in the region or page
- Possible parenthesis mismatches
- Trace information about the specified Lisp function

The word *current*, when describing a Lisp function or a Lisp variable, refers to (approximately) the function or variable whose name is nearest to the cursor.

Finding Out About Zmacs Commands, *cont'd.*

About Point

`c-X =` Where Am I

Displays various things about where point is. It displays the X and Y positions, the octal code for the following character, the current line number and its percentage of the total file size. If there is a region, it displays the number of lines in it. Fast Where Am I (`c-=`) displays a subset of this information faster.

`c-=` Fast Where Am I

Quickly displays various things about where point is. It displays the X and Y positions and the octal code for the following character. If there is a region, it displays the number of lines in it. Where Am I displays the same things and more.

About Function Documentation

`c-sh-D` Brief Documentation

Displays brief documentation for the specified Lisp function. By default, it displays documentation for the current function. With a numeric argument, it prompts for a function name, which you can either type in or select with the mouse. It displays the first line from the summary paragraph in the echo area.

`m-sh-D` Long Documentation

Displays the documentation for the specified function. It prompts for a function name, which you can either type in or select with the mouse. The default is the current function.

About Displaying Argument Lists

`c-sh-A` Quick Arglist

Displays the argument list for the current function. With a numeric argument, it reads the function name from the minibuffer.

Arglist (`m-X`)

Displays the argument list of the specified function. It reads the name of the function from the minibuffer) and displays the argument list in the echo area.

Finding Out About Zmacs Commands, *cont'd.*

About Describing Lisp Variables

c-sh-V Describe Variable At Point

Displays information in the echo area about the current Lisp variable. The information displayed shows whether it is declared special, whether it has a value, and whether it has documentation put on by **defvar**. When nothing is available, it checks for lookalike symbols in other packages.

About Counting Number of Lines

m-= Count Lines Region

Displays the number of lines in the region.

c-X L Count Lines Page

Displays the number of lines on the current page (or the buffer, if there are no page delimiters). In parentheses, it displays the number of lines up to the line containing point and the number of lines after the line containing point.

About Finding Unbalanced Parentheses

Find Unbalanced Parentheses (m-X)

Finds any parenthesis mismatch error in the buffer. It reads through all of the current buffer and tries to find places in which the parentheses do not balance. It positions point to possible trouble spots, printing out a message that says what the trouble appears to be. This command only finds one such error; if you suspect more errors, run it again.

About Tracing Function Executions

Trace (m-X)

Traces or untraces a function. It reads the name of the function from the minibuffer and then it pops up a menu of trace options. With an argument, it omits the menu step.

The Editor Menu

Overview

Click right in Zmacs to display the *editor menu*, a momentary menu containing editor commands, each of which is a possible choice. Position the mouse cursor over an item and then click the appropriate button to make the choice.

The editor menu command summaries below point to complete descriptions in appropriate chapters of the manual.

Editor Menu Commands

The Editor Menu commands are:

Command	*Description*
Arglist	Prints the argument list of the specified function (see page 37).
Edit Definition	Prepares to edit the definition of a specified function (see the chapter "Editing Lisp Programs", page 153).
List Callers	Lists all functions that call the specified function (see the chapter "Editing Lisp Programs", page 153).
List Definitions	Displays the definitions in a specified buffer (see the chapter "Editing Lisp Programs", page 153).
List Buffers	Prints a list of all the buffers and their associated files (see the chapter "Manipulating Buffers and Files", page 100).
Kill Or Save Buffers	Offers a menu of modified files with choices to kill, save, or remove the modification flag from the file (see the chapter "Manipulating Buffers and Files", page 100).
Split Screen	Makes several windows split among the buffers as specified (see the chapter "Manipulating Buffers and Files", page 100).
Compile Region	Compiles the region, or if no region is defined, the current definition (see the chapter "Editing Lisp Programs", page 153).

The Editor Menu, *cont'd.*

Indent Region	Indents each line in the region (see the chapter "Changing Case and Indentation", page 145).
Change Default Font	Sets the default font (see the chapter "Working With Regions", page 72).
Change Font Region	Changes the font for the region (see the chapter "Working With Regions", page 72).
Uppercase Region	Changes any lowercase characters in the region to uppercase (see the chapter "Working With Regions", page 72).
Lowercase Region	Changes any uppercase characters in the region to lowercase (see the chapter "Working With Regions", page 72).
Indent Rigidly	Shifts text in the region sideways as a unit (see the chapter "Changing Case and Indentation", page 145).
Indent Under	Indents to align under a string read from the minibuffer (see the chapter "Changing Case and Indentation", page 145).

More on the Minibuffer

Response Format

Most commands only expect one line of response. In these cases, the END key has the same meaning as the RETURN key, terminating the response. (In completion, the RETURN key is not exactly the same as the END key — see below.)

However, for commands that expect one or more lines of response, RETURN has its usual significance, inserting a newline in the minibuffer, and END marks the end of the response.

Response Help

While responding to a prompt, you can press HELP to get documentation describing the current situation. Zmacs tells you exactly what input it expects and what the possible responses are.

More Ways to Enter Responses

Yanking and mousing provide quick and simple ways to enter minibuffer responses without having to type them out. Both of these methods are context-sensitive. Yanking works only when you have previously entered a minibuffer response. Mousing works when you click on a name that makes sense in the context of the minibuffer prompt.

Yanking

c-m-Y Repeat Last Minibuffer Command

Repeats a recent minibuffer command. It yanks the displayed default if there is one, otherwise, it yanks the last thing typed in this context. A numeric argument *n* yanks the *n*th previous one. An argument of 0 lists the history of elements typed in the minibuffer.

m-Y Repeat Last Minibuffer Command

After c-m-Y, m-Y replaces what was yanked with a previous element of the same history. A numeric argument of zero displays the history. A positive numeric argument moves to that much older a history element. A negative numeric argument moves to a newer history element; this only makes sense after the history has been rotated.

For more details, see "Retrieving History Elements", page 64.

More on the Minibuffer, *cont'd.*

Mousing

If the mouse is an arrow pointing straight up, you can point at the name of something (for example, a function if the command is reading a function name in the minibuffer) and click the left button. Mouse-sensitive things that could be a valid argument are highlighted with a box. The mouse only works this way when the minibuffer is empty. If you type something and then decide that you would rather use the mouse, erase what you typed with RUBOUT or CLEAR-INPUT.

Completion

Sometimes, when a command prompts you, you have only a limited number of possible responses. The responses themselves can be cumbersome to type. To save you from having to type the entire response, some commands perform *command completion.* *Completing* means presuming the rest of the your response, based on what you have typed already. Each command that offers completion has a list of acceptable answers and it checks what you have typed so far against the list.

When Zmacs is reading a command argument from the minibuffer and some sort of command or file name completion is available, the right-hand side of the mode line says `(Completion)`. You will soon acquire a feeling for the contexts in which Zmacs provides completion.

Completion Commands

The commands described in this section only behave in the indicated manner when completion is allowed.

COMPLETE Complete

Pressing the COMPLETE key asks Zmacs to try to complete the response you have typed so far.

Three things could happen:

1. In the optimal case, the response you have typed so far will have exactly one completion. In this case, Zmacs performs the completion. You can then press END to terminate the response and continue the execution of the prompting command. Or, you can choose to continue editing the response.

2. Often you will find that you have not yet typed enough to specify a valid response unambiguously. When there is more than one valid completion, Zmacs completes as far as it can and

More on the Minibuffer, *cont'd.*

then waits for more input from you since your response is not yet complete. You can then complete your response by typing more letters to clearly specify your desired response, thereby disqualifying any other valid ones.

3. In the worst case, the response you have typed so far has no valid completion. In this case, Zmacs beeps (audibly on the LM-2) and continues to wait for additional input in the minibuffer. You can continue to edit your response.

END — Complete And Exit If Unique

Pressing the END key tries to complete your response so far. If the completion is successful, it terminates the response and continues executing the prompting command. If the completion is unsuccessful (if the response was ambiguous or cannot be completed in its present form), Zmacs waits for you to continue editing it.

Impossible-is-OK Completion

Each command that provides completion has a list of valid responses. These are not always the *only* possible responses: It might make sense for you to type a response the command had never heard of. When this is true, the command does a special kind of completion called *impossible-is-OK* completion. This is implemented with the RETURN key.

RETURN — Complete And Exit

Pressing the RETURN key tries to complete your response so far. If we are doing impossible-is-OK completion, RETURN terminates the response and returns to the prompting command *whether or not the completion was successful.* Otherwise, it behaves exactly like END.

Completing Responses in Chunks

Often the desired response has several components separated by spaces or punctuation marks (for example, parentheses or hyphens). The components are called *chunks*. Zmacs, rather than always trying to complete the response as a unit, completes all the chunks separately and in parallel. For example, `co b` completes to `Compile Buffer` in spite of other possible completions of co, such as Copy File and Count Lines. When the response is ambiguous, Zmacs completes the chunks that it can and positions the minibuffer's cursor at the leftmost chunk that needs further clarification.

More on the Minibuffer, *cont'd.*

SPACE Self Insert and Complete
)

When you press the SPACE bar, a close parenthesis, or any chunk delimiter (chunk delimiters are context-dependent) you have finished typing one chunk of your response. Zmacs then tries to complete that chunk as part of the command name. If it does not succeed, it assumes that you are not finished specifying your entire response. If at any point it cannot supply a possible completion, it beeps.

Example

The following command completes to Source Compare instead of to Source Compare Merge:

```
m-X so SPACE co SPACE RETURN
```

The following commands complete to Source Compare Merge:

```
m-X so SPACE co SPACE m END

m-X so SPACE co SPACE m RETURN
```

Enumerating Possible Completions

c-? List Completions
[Mouse (R)]

Enumerates the possible completions of your response so far. Zmacs lists the possible completions in the typeout window. The completions are mouse-sensitive, so you can select one by pointing at it with the mouse and clicking left. [Mouse (R)] pops up a menu, which also lists the possible completions.

c-/ Completion Apropos

Enumerates the commands whose names contain the response as a substring. The command names are mouse-sensitive and you can select one by clicking on it.

Getting Help While Completing

When completion is provided, the HELP key provides a summary of the completion commands and a mouse-sensitive list of possible completions, in addition to the standard documentation for whatever command is prompting you.

Moving the Cursor

Overview

Introduction

To make changes at some particular place in a Zmacs buffer, you must move the cursor to that place, since most commands that modify the buffer do so immediately around the cursor.

This section describes the commands that:

- View the contents of the buffer
- Redisplay the editor window
- Move the cursor around the buffer using mouse commands
- Move the cursor around the buffer using keystroke commands

The Editor Window

The *editor window* displays either a portion of your buffer or the whole buffer, depending on the size of the buffer and your current location in it.

When the current buffer is smaller than the exact size of the editor window, Zmacs displays the contents of the buffer at the top of the window and leaves the bottom of the window blank. You cannot tell whether the buffer actually comes to an end where the text stops, since there could be white space and newline characters after the last visible piece of text.

When the buffer is too large to fit on the screen, the editor window shows only a section of the buffer. The part that shows always contains the cursor, so it never vanishes off the top or bottom of the editor window. Zmacs changes the position of the editor window inside the buffer as seldom as possible — usually only when you try to move the cursor off the top or bottom of the screen.

Wraparound Lines

Lines that are too long to fit across the editor window are displayed on as many physical lines as are necessary. An exclamation point (!) in the (normally blank) last column means that the next physical line is part of the same logical line.

Redisplaying the Window

Introduction

Whenever you modify the buffer's contents or move point or the mark (see the chapter "Working With Regions", page 74, for a discussion of the mark), Zmacs updates the display to reflect the change. This updating can be as simple as moving the cursor or as involved as figuring out the whole display from scratch. These operations are called *redisplay* and Zmacs performs them automatically.

For example, when you move the cursor off the top or bottom of the editor window, a complete redisplay is required. The window has to shift to show a different part of the buffer in order to keep the cursor visible.

You can explicitly tell Zmacs to do a redisplay with the Recenter Window command, invoked by c-L. You might want to do this if the cursor gets too close to the top or the bottom of the editor window, and you want to redisplay with the cursor closer to the center so that you can see more context in one direction or the other.

It is important to remember that redisplay operations change only the *display*, not the actual contents of the buffer.

Recentering Window

c-L Recenter Window

Completely redisplays the screen, leaving the cursor near the middle of the editor window.

With a positive numeric argument of *n*, it leaves the cursor *n* lines from the top of the window. With a negative numeric argument of -*n*, it leaves the cursor *n* lines from the bottom of the window.

Next Screen

c-V Next Screen

Moves the cursor to the beginning of the last visible line in the editor window and redisplays the screen with that line at the top of the window.

With a numeric argument of *n*, it moves the text up *n* lines. With a negative numeric argument -*n*, it moves the text down *n* lines. The cursor does not move (with respect to the text) unless the numeric argument is large enough to slide it off the screen. In that case the cursor remains at the top.

Redisplaying the Window, *cont'd.*

Previous Screen

m-V Previous Screen

Moves the cursor to the beginning of the first visible line in the editor window and redisplays the screen with that line at the bottom of the window.

With a numeric argument of *n*, it moves the text down *n* lines. With a negative numeric argument -*n*, it moves the text up *n* lines. The cursor does not move (with respect to the text) unless the numeric argument is large enough to slide it off the screen. In that case the cursor remains at the bottom.

Positioning Window Around Definition

c-m-R Reposition Window

Redisplays, trying to get all of the current function definition in the window. It puts the beginning of the current definition at the top of the window with the current position of the cursor still visible. Doing c-m-R twice pushes comments off the top of the window, making more of the code of a large function visible.

Moving to Specified Line

m-R Move To Screen Edge

Moves to the beginning of a specified line on the screen. With no argument, it moves to the beginning of a line near the middle of the screen. The exact line is controlled by the Zmacs variable Center Fraction. A numeric argument specifies a particular line to move to. Negative arguments count up from the bottom of the window. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

Using the Mouse

Introduction

The easiest way to get the cursor where you want it is with the *mouse*. (The mouse is fully documented in the *Lisp Machine Summary*.)

Mouse Documentation Line

The mouse documentation line:

- Appears just above the bottom line of the screen
- Normally stands out in reverse video
- Contains documentation on the current meaning of mouse clicks

In a regular Zmacs buffer, the mouse documentation line offers the following options:

Notation — *Description*

L:Move point — Performs two separate actions:

- Relocates the cursor: position the mouse cursor to the desired location and click left.
- Makes a region: position mouse cursor to desired location, click left (keeping the button down), move mouse cursor to end of region and lift the button up.

L2:Move to point — Relocates the mouse cursor near the cursor: click left twice.

M:Mark thing — Marks a small region: position mouse cursor on either side or in the middle of a word, Lisp expression, or after the end of a line, and click middle. (*Marking* regions is fully described in the chapter "Working with Regions", page 72.)

M2:Save/Kill/Yank — Performs one of four related actions:

- If there is a region, it saves the region in the kill history while leaving it in the buffer (like m-W)
- If the last command saved the region, it wipes it from the buffer (like c-W except it does not save)
- If the above two conditions do not apply, it yanks the first element from the kill history (like c-Y)
- If the last command was a yank command, it yanks the next item from the kill history (like m-Y)

Using the Mouse, *cont'd.*

	(*Saving*, *killing*, and *yanking* regions is fully described in the chapter "Working with Regions", page 72.)
R:Menu	Displays a Zmacs menu offering mouse-sensitive Zmacs commands.
R2:System Menu	Displays a System menu.

Motion Commands

Introduction

Zmacs word, sentence, and paragraph motion commands all have strict definitions for where words, sentences, and paragraphs begin and end. These definitions can all be modified by the user.

Numeric Arguments

All of the motion commands allow numeric arguments. For the most part, these numeric arguments are interpreted as repeat counts.

Example

`m-F` moves the cursor forward one word, whereas `m-13F` moves the cursor forward 13 words.

Negative Numeric Arguments

Most of the motion commands come in pairs, with one command for forward motion over a particular unit and one command for backward motion. Both kinds of commands often interpret negative numeric arguments by reversing the direction of motion.

These conventions — that Zmacs interprets numeric arguments as repeat counts, and that negative numeric arguments reverse the direction of motion — together make up the *motion convention.*

Example

`m- -13F` moves point backward 13 words. `m-13B` has exactly the same effect.

Motion by Character

A Zmacs *character* can be any letter, number, or punctuation character.

Forward Character

`c-F` Forward

Moves the cursor forward over one character. `c-F` interprets numeric arguments as repeat counts.

Negative numeric arguments reverse the direction of motion. For example, `c-3B` and `c- -3F` both move the cursor backwards three characters.

Motion Commands, *cont'd.*

Backward Character

c-B Backward

Moves the cursor backward over one character. c-B interprets numeric arguments as repeat counts.

Negative numeric arguments reverse the direction of motion. For example, c-3 c-B and c-- c-3 c-F both move the cursor backwards three characters.

Motion by Word

Zmacs generally considers a *word* to consist of a sequential string of alphanumeric characters, that is, any combination of the characters a-z, A-Z, and 0-9. Different major modes define their own delimiter characters. For example, in Text Mode an apostrophe (') is part of a word, but in other modes it is a delimiter (see the chapter "Setting the Major Mode", page 141, for mode descriptions).

Forward Word

m-F Forward Word

Moves the cursor forward one word. Numeric arguments are interpreted as repeat counts; negative numeric arguments reverse the direction of motion.

m-F always places the cursor at the end of a word. If the cursor is in the middle of a word, m-F moves the cursor to the end of that word.

Backward Word

m-B Backward Word

Moves the cursor backward one word. Numeric arguments are interpreted as repeat counts; negative numeric arguments reverse the direction of motion.

m-B always places the cursor at the beginning of a word. If the cursor is in the middle of a word, m-B moves the cursor to the beginning of that word.

Motion by Sentence

According to Zmacs, sentences can end with question marks, periods, and exclamation points. Furthermore, these punctuation marks only end a sentence when followed by:

1. a newline
2. a space followed by either a newline or another space.

Motion Commands, *cont'd.*

However, Zmacs allows any number of *closing characters*, which are ", ',), and], between the sentence-ending punctuation and the white space that follows it. A sentence also starts after a blank line.

This corresponds pretty closely to standard typing conventions. Zmacs does not recognize a period followed by one space as the end of a sentence, for example, as in "e.g." or "Dr.".

Forward Sentence

`m-E` Forward Sentence

Moves the cursor forward one sentence.

Numeric arguments are interpreted as repeat counts; negative numeric arguments reverse the direction of motion.

`m-E` always places the cursor at the end of a sentence. If the cursor is in the middle of a sentence, `m-E` moves the cursor to the end of that sentence.

Backward Sentence

`m-A` Backward Sentence

Moves the cursor backward one sentence.

Numeric arguments are interpreted as repeat counts; negative numeric arguments reverse the direction of motion.

`m-A` always places the cursor at the beginning of a sentence. If the cursor is in the middle of a sentence, `m-A` moves the cursor to the beginning of that sentence.

Motion by Lisp Expression

The next several pages deal with moving the cursor according to Lisp code delimiters: *lists* and *expressions*. A list is something enclosed in balanced parentheses. A Lisp expression is any readable printed representation of a Lisp object — a list or the printed representation of an atom.

`c-m-N` Forward List

Moves forward over one list. It accepts a numeric argument for repetition count.

Motion Commands, *cont'd.*

`c-m-P` Backward List

Moves backward over one list. It accepts a numeric argument for repetition count.

Motion Along One Nesting Level

Point always sits either between two expressions or in the middle of an atom.

`c-m-F` Forward Sexp

Moves point to the end of a surrounding atom if there is one, or past the Lisp expression immediately to the right if not.

If parentheses are unbalanced to such an extent that it doesn't make sense to talk about "the expression on the right", this command gives an error message and does not move point at all.

`c-m-F` observes the motion convention for numeric arguments.

`c-m-B` Backward Sexp

Moves point to the beginning of a surrounding atom if there is one, or to the beginning of the Lisp expression immediately to the left if not.

If parentheses are unbalanced to such an extent that it doesn't make sense to talk about "the expression on the left", this command gives an error message and does not move point at all.

`c-m-B` observes the motion convention for numeric arguments.

Motion Up and Down Nesting Levels

`c-m-D` Down List

Moves point forward past any intervening atoms to the next nonatomic expression and leaves point just to the right of the open parenthesis of that expression.

With a numeric argument of *n*, it moves down *n* nesting levels.

Motion Commands, *cont'd.*

c-m-U Backward Up List
c-m-(

Backs up out of nesting levels. It moves backward one level of list structure. It searches for an open parenthesis and leaves point to the left of that open parenthesis. Also, if called inside of a string, it moves back up out of that string, leaving point to the left of its starting quote. It accepts numeric arguments for repetition count.

With a numeric argument of *n*, it moves up *n* nesting levels.

c-m-) Forward Up List

Moves forward out of nesting levels. It moves forward one level of list structure. It searches for a close parenthesis and leaves point to the right of that close parenthesis. Also, if called inside of a string, it moves up out of that string, leaving point to the right of its ending quote. It accepts numeric arguments for repetition count.

With a numeric argument of *n*, it moves up *n* nesting levels.

Motion Among Top-Level Expressions

A Lisp file contains a sequence of expressions that we call *top-level expressions*, to distinguish them from their own subexpressions. Zmacs assumes that top-level expressions begin with an open parenthesis against the left margin. It does *not* parse top-level expressions by balancing parentheses, since parentheses do not always balance while programs are being written. The indentation represents the *programmer's* conception of program structure, and provides a better guide. So by *top-level expression*, we mean a section of text delimited by open parentheses at the beginning of two lines.

In code that includes a string containing a carriage return followed by an open parenthesis, show that the open parenthesis does not start a top-level expression by putting a slash in front of it.

c-m-A Beginning Of Definition
c-m-[

Moves point to the beginning of the current top-level expression.

With a positive numeric argument *n*, it moves back *n* top-level expressions. With a negative numeric argument -*n*, it moves forward *n* top-level expressions.

Motion Commands, *cont'd.*

c-m-E
c-m-] End Of Definition

Moves point to the end of the current top-level expression.

With a positive numeric argument *n*, it moves forward *n* top-level expressions. With a negative numeric argument -*n*, it moves back *n* top-level expressions.

m-) Move Over)

Moves past the next close parenthesis, then does Indent New Line. It removes any whitespace between point and the close parenthesis before moving over it. With a positive argument *n*, after finding the next close parenthesis and deleting whitespace before it, it moves past *n*-1 additional close parentheses before doing Indent New Line. It ignores numeric arguments that are less than 1.

Motion by Line

Lines are delimited by special characters called *newlines*.

Down Line

c-N Down Real Line

Moves the cursor straight down to the corresponding column of the next line. If the cursor is positioned in the middle of the line, c-N moves it to the middle of the next one.

With a numeric argument *n*, it moves the cursor down *n* lines. Moving down a negative number of lines is the same as moving up.

Up Line

c-P Up Real Line

Moves the cursor straight up to the corresponding column of the previous line. If the cursor is positioned in the middle of the line, c-P moves it to the middle of the previous one.

With a numeric argument of *n*, it moves the cursor up *n* lines. Moving up a negative number of lines is the same as moving down.

Motion Commands, *cont'd.*

Beginning of Line

c-A Beginning of Line

Moves the cursor to the beginning of the current line.

With a numeric argument of *n*, it moves the cursor to the beginning of the *n*th line after the current one, where the current line is numbered 1, the preceding line is numbered 0, and so on.

End of Line

c-E End Of Line

Moves the cursor to the end of the current line.

With a numeric argument of *n*, it moves the cursor to the end of the *n*th line after the current one, where the current line is numbered 1, the preceding line is numbered 0, and so on.

Goal Column

c-X c-N Set Goal Column

Sets the default column position (*goal column*). The goal column sets point position for c-N and c-P. It disables the default action of matching the goal column to point's current column and sets the goal column to zero instead. With a numeric argument *n*, sets the goal column to *n*. c-U turns it off (sets back to default state of keeping cursor in same horizontal position for c-N and c-P).

Motion by Paragraph

Introduction

A paragraph is delimited by:

- A newline followed by blanks (spaces or tabs)
- A blank line
- A Page character alone on a line
- various other mode-dependent things (for example, a line that does not begin with the fill-prefix)

Forward Paragraph

m-] Forward Paragraph

Moves the cursor forward one paragraph.

Numeric arguments are interpreted as repeat counts; negative numeric arguments reverse the direction of motion.

m-] always places the cursor at the end of a paragraph. If the cursor is in the middle of a paragraph, m-] moves the cursor to the end of that paragraph.

Backward Paragraph

m-[Backward Paragraph

Moves the cursor one paragraph backward.

Numeric arguments are interpreted as repeat counts; negative numeric arguments reverse the direction of motion.

m-[always places the cursor at the beginning of a paragraph. If the cursor is in the middle of a paragraph, m-[moves the cursor to the beginning of that paragraph.

Motion by Page

Introduction

Pages are delimited by Page characters. You can insert a Page character by pressing the PAGE key (on an **LM-2**, press m-CLEAR-SCREEN). The Page delimiter belongs to the page that precedes it and is therefore the last character on that page.

Forward Page

c-X] Next Page

Moves the cursor to the beginning of the next page; that is, puts the cursor immediately after the nearest following Page delimiter. If the buffer does not contain a Page delimiter, it goes to the end of the buffer.

With a positive numeric argument *n*, it repeats this operation *n* times to move forward *n* pages. A negative numeric argument -*n* moves the cursor backward instead.

c-X [always places the cursor immediately to the right of the next Page delimiter. If the cursor is immediately to the left of the Page delimiter, c-X] goes to the beginning of the page after next rather than just moving forward one character.

Backward Page

c-X [Previous Page

Moves the cursor to the beginning of the previous page; that is, puts the cursor immediately after the nearest preceding Page delimiter. If the buffer does not contain a Page delimiter, it goes to the beginning of the buffer.

With a positive numeric argument *n*, it repeats this operation *n* times to move backward *n* pages. A negative numeric argument -*n* moves the cursor forward instead.

c-X [always places the cursor at the beginning of a page. If the cursor is already at the beginning of the page, c-X [moves it to the beginning of the previous page.

Motion with Respect to the Whole Buffer

Beginning/End of Buffer

m-< Goto Beginning

Moves the cursor to the beginning of the buffer.

With a numeric argument *n* between 0 and 10, it moves the cursor to a place *n*/10 of the way (counted in lines) from the beginning of the buffer towards the end.

m-> Goto End

Moves the cursor to the end of the buffer. You can use m-> if you are in doubt as to the exact place on the screen where the buffer stops.

With a numeric argument *n* between 0 and 10, it moves the cursor to a place *n*/10 of the way (counted in lines) from the end of the buffer towards the beginning.

Deleting and Transposing Text

Deleting vs. Killing

Overview

Deleting text merely gets rid of it, but Zmacs deletion commands not only *kill* text but also get it back. These commands save killed text in a *history* stack. Other commands, called *yanking* commands, retrieve elements from the history.

Deletion commands that operate on single characters do not save what they delete. However, by giving them a numeric argument, thus telling them to delete several characters, they too save the deleted text.

The commands that only delete white space do not save it.

Zmacs uses several histories:

Type	*Description*
Kill	History of text deleted or saved. The kill history is shared with the input editor, thus allowing you to move text between files and the Lisp Listener.
Replace	History of arguments to Query Replace (m-X) and related commands. See the chapter "Searching, Replacing, and Sorting", page 84.
Buffer	History of editor buffers visited in this window. See the chapter "Manipulating Buffers and Files", page 100.
Pathname	History of file names that have been typed.
Command	History of editor commands that use the minibuffer, and their arguments. Commands that do not use the minibuffer, for example, m-RUBOUT, are not recorded in the history.
Definition	History of names of definitions that have been typed.

History lengths are limitless but the typeout window displays only the first 25 elements of the history. When the history contains more than 25 elements, the screen displays a mouse-sensitive line: *n* `more elements in history`. Clicking left displays the rest of the history.

Only a single instance of each of these histories exists, shared among all editors, including Zmacs, Zmail, and Dired.

Deleting vs. Killing, *cont'd.*

Kill History

The kill history contains deleted text and is the history that saves the results of the commands described in this chapter. It allows you to move text from one editor window to another, for example, from the editor to a Lisp Listener. The *yanking* commands described below retrieve elements from the kill history.

Viewing Kill History

```
c-0 c-Y
```

Displays the elements of the kill history (saved text) in a typeout window:

```
Kill history:
  1: last piece of killed text
  2: next-to-last piece of killed text
  3: this one is a very long piece of killed text...
  .
  .
  .
(End of history.)
```

Viewing the Editor Command History

```
c-0 c-m-Y
```

Displays the elements of the editor command history (commands typed) in a typeout window:

```
Command history:
  1: Control-X Control-F last-file-read-in
  2: Help A
  3: Control-X Control-F other-file-read-in
  .
  .
  .
(End of history.)
```

This command is context-sensitive. When typed at the Lisp listener level, it lists the recent commands typed there. When typed at the minibuffer, it lists the history appropriate to what is being read in the minibuffer, for example, a pathname or the name of a definition.

Deleting vs. Killing, *cont'd.*

Using the Mouse on History Elements

History elements are mouse-sensitive. Click on an element of the kill history to yank it to point; click on an element of the command history to reexecute it.

Retrieving History Elements

`c-Y` Yank

Yanks back and inserts the last text killed or saved. If you have moved point since you killed the text, put point where you want the killed text to go before pressing `c-Y`. Point ends up after the text, and mark before the text. An argument of `c-U` puts point before the text instead. A numeric argument of zero displays the kill history and does not yank anything. A nonzero numeric argument selects an element of the kill history.

`c-m-Y` Repeat Last Minibuffer Command

Repeats a recent minibuffer command. A numeric argument does the *nth* previous one. An argument of 0 lists the history.

`m-Y` Yank Pop

Corrects a yank to use a different element of its history. The most recent command must be a yanking command (`c-Y`, `m-Y`, or `c-m-Y`). The retrieved text that was yanked by that command is replaced by the previous element of the relevant history. The history is rotated (that is, the elements remain in the same order, but the pointer to the *current* element moves with each successive `m-Y`) to bring this element to the top.

A numeric argument of zero displays the history. A positive numeric argument of *n* moves *n* elements back in the history list. A negative numeric argument moves to a newer history element; this only makes sense after you rotate the history.

Kill Merging

Normally, each kill command pushes a new block onto the kill history. However, two or more kill commands in a row combine their text into a single element on the history, so that a single `c-Y` command gets it all back as it was before it was killed. This means that you do not have to kill all the text in one command; you can keep killing line after line, or word after word, until you have killed it all, and you can still get it all back at once.

Deleting vs. Killing, *cont'd.*

Commands that kill forward from point add onto the end of the previous killed text. Commands that kill backward from point add onto the beginning. This way, any sequence of mixed forward and backward kill commands puts all the killed text into one element without rearrangement.

If a kill command is separated from the last kill command by other commands, it starts a new element on the kill history, unless you tell it not to by saying `c-m-W` (Append Next Kill) in front of it. The `c-m-W` tells the following command, if it is a kill command, to append the text it kills to the last killed text, instead of starting a new element. With `c-m-W`, you can kill several discrete pieces of text and accumulate them to be yanked back in one place.

`c-m-W` Append Next Kill

Makes the next kill command append text to the newest element of the kill history.

Deleting and Transposing Characters

Deleting the Last Character

RUBOUT Rubout

Deletes the character immediately to the left of the cursor.

If the cursor is at the beginning of a line, RUBOUT deletes the newline character at the end of the previous line, thus appending the current line to the previous one.

With a positive numeric argument of *n*, RUBOUT deletes the *n* characters immediately to the left of the cursor. With a negative numeric argument of -*n*, it deletes the *n* characters immediately to the right of the cursor. With any numeric argument, it saves the deleted characters on the kill history.

Deleting the Current Character

c-D Delete Forward

Deletes the character at the cursor.

If the cursor is at the end of a line, c-D deletes the newline character at the end of the line, thus appending the next line to the current one.

With a positive numeric argument of *n*, c-D deletes the *n* characters immediately to the right of cursor. With a negative numeric argument of -*n*, it deletes the *n* characters immediately to the left of cursor. With any numeric argument, it saves the deleted characters on the kill history.

Transposing Characters

c-T Exchange Characters

Transposes two characters (the ones on each side of the cursor).

If the cursor is not at the end of a line, c-T transposes the character at the cursor and the character to the left of the cursor and advances the cursor one character. The result is that the character to the left of the cursor has been "dragged" one character position to the right. Repeated use of c-T continues to pull that character forward.

This is useful when you are typing and enter two characters in the wrong order (for example, teh for the) — just use c-T to correct the error.

If the cursor is at the end of a line, c-T transposes the two preceding characters.

Deleting and Transposing Characters, *cont'd.*

With a nonzero numeric argument of *n*, c-T deletes the character to the left of the cursor, moves forward *n* characters, and reinserts the deleted character. When *n* is negative, the cursor moves backwards.

c-T can only be given a numeric argument of zero when the mark is active. In this case, it exchanges the characters at point and mark.

Deleting and Transposing Words

Introduction

See the chapter "Moving the Cursor", page 52, for a complete description of how words are delimited.

Deleting the Current Word

m-D Kill Word

Kills the word after the cursor and saves it on the kill history. If the cursor is in the middle of a word, m-D kills from the cursor to the end of that word.

With a numeric argument *n*, it kills *n* words forward from the cursor. If *n* is negative, it kills backward.

Deleting the Previous Word

m-RUBOUT Backward Kill Word

Kills the word before the cursor and saves it on the kill history. If the cursor is in the middle of a word, m-RUBOUT kills from the cursor to the beginning of that word.

With a numeric argument *n*, it kills *n* words backward from the cursor. If *n* is negative, it kills forward.

Transposing Words

m-T Exchange Words

Transposes the current word and the previous one. If the cursor is at the end of a line, m-T transposes the last word on that line and the first one on the next, regardless of the amount or type of white space between them.

With a nonzero numeric argument *n*, m-T goes to the beginning of the current word, deletes the previous word, goes forward *n* words, and reinserts the deleted word. Moving forward a negative amount is equivalent to moving backward. An argument of zero transposes the words at point and mark.

Deleting and Transposing Lisp Expressions

Introduction

See the chapter "Moving the Cursor", page 53, for a complete description of how expressions are delimited.

Deleting the Current Expression

c-m-K Kill Sexp

Kills the Lisp expression immediately to the right of point and saves it on the kill history.

With a numeric argument of *n*, it kills the *n* succeeding expressions. It is an error to kill off the end of a containing expression. When the numeric argument is negative, it kills backwards from point the same way.

Deleting the Previous Expression

c-m-RUBOUT Backward Kill Sexp

Kills the Lisp expression immediately to the left of point and saves it on the kill history.

With a numeric argument of *n*, it kills the *n* preceding expressions. It is an error to kill off the beginning of a containing expression. When the numeric argument is negative, it kills forward from point the same way.

Deleting the List Containing Current Expression

Kill Backward Up List (c-m-X)

Deletes the list that contains the Lisp expression after point, but leaves that expression itself.

Deleting and Transposing Lisp Expressions, *cont'd.*

Transposing Expressions

`c-m-T` Exchange Sexps

Point must be between two expressions to use this command.

Exchanges the two expressions on either side of point, preserving current indentation.

With a numeric argument of *n*, it deletes the expression to the left of point, moves forward *n* expressions, and reinserts the deleted expression. With a negative numeric argument, it exchanges expressions in the opposite direction. An argument of zero transposes the expressions at point and mark.

Deleting and Transposing Lines

Introduction

See the chapter "Moving the Cursor", page 56, for a complete description of how lines are delimited.

Deleting the Current Line

c-K Kill Line

Kills a line at a time and saves it on the kill history.

If the cursor is at the end of a line, c-K kills the newline, merging the current line with the next one. If the cursor is elsewhere on the line, c-K kills the text between the cursor and the end of the current line.

With a numeric argument *n*, c-K kills up to the *n*th newline following the cursor. When *n* is negative or zero, c-K kills back to the *1-n*th newline before the cursor. c-0 c-K kills from the cursor back to the beginning of the line that it is on.

Deleting Backward on the Line

CLEAR-INPUT Clear

Kills backward to the start of the current line and saves it on the kill history. If point is already at the beginning of the line, it kills the previous line. With a numeric argument *n*, it kills between point and the start of the *n*th line *above* the current line. Use CLEAR-INPUT when entering a new line of text, to delete the whole line.

Transposing Lines

c-X c-T Exchange Lines

Exchanges the current line with the previous one and leaves the cursor at the beginning of the next line.

With a nonzero numeric argument *n*, c-X c-T deletes the previous line (including the following newline), moves down *n* lines, and reinserts the deleted line.

With a numeric argument of zero, c-X c-T exchanges the lines at point and mark, advancing both point and mark to the beginning of the next line.

Deleting Sentences

Introduction

See the chapter "Moving the Cursor", page 52, for a complete description of how sentences are delimited.

Deleting the Current Sentence

m-K Kill Sentence

Kills the text between the cursor and the end of the current sentence, and saves it on the kill history.

With a numeric argument of *n*, m-K kills the text between the cursor and the end of the *n*th sentence after the cursor, *counting* the current sentence. If the argument is negative, m-K kills -*n* sentences *before* the cursor, counting the current sentence.

Deleting the Previous Sentence

c-X RUBOUT Backward Kill Sentence

Kills backward one sentence and saves it on the kill history.

With a negative argument, c-X RUBOUT kills forward one sentence in a similar manner.

Working with Regions

What is a Region?

Introduction

Many Zmacs commands deal with the region. A region consists of a block of information within the buffer that you want to manipulate as a single entity. You define the area of the region, which can be any size, from characters or chunks of code to pages or the entire buffer.

Zmacs keeps track of one or more locations in a buffer using buffer *pointers*. This section describes:

- The two buffer pointers named *point* and *mark*
- How Zmacs uses them to define the boundaries of a region
- The *point-pdl*, a ring of pointers to saved locations
- *registers*, pointers to locations that you name and save
- The region-manipulating commands

Point

Point (shown by the cursor) is the most important buffer pointer. Most editor commands depend on the position of point. Many editor commands, invoked by either the mouse or the keyboard, can be used to position point to the desired location in the buffer. Point points to one end of the region.

Mark

Mark points to the other end of the region. To *mark* a piece of text means to position point and mark on either side of the text, making it the region. The simplest way to mark some text is to position point (using either the mouse or keystrokes) to one boundary (either the beginning or the end) of the text, set the mark there (using the Set Pop Mark command described below), and then reposition point at the other boundary.

Unlike point, the mark can be *active* or *inactive*. When mark is active, the region is shown on the screen by underlining. When mark is inactive, you cannot see it on the screen unless you reactivate it with c-X c-X. Although normally you cannot see an inactive mark, Zmacs keeps track of mark when it is inactive and sometimes uses mark in its inactive state. For example, c-Y leaves point and mark surrounding what it yanks, but does not activate mark. c-W immediately following c-Y kills the region even though it is not active. c-X c-X after c-Y activates mark, making the region visible. However, most commands will not use mark or the region unless it is active.

What is a Region?, *cont'd.*

You can set the mark three ways: when you create a region using the mouse, explicitly with the command Set Pop Mark (c-SPACE), or with one of the commands to mark regions (see "Commands to Mark Regions", page 79). When you set the mark, you activate it and make the region appear.

Creating a Region

Create a region using either the mouse or keystrokes — everyone determines their own favorite method.

With the Mouse

The most common way to create a region is with the mouse. Hold down the left mouse button and drag the cursor. Let up the button to mark the end of the region.

Mouse middle creates a region too. It marks the "thing" you point the mouse at, "thing" being mode-dependent (a word or Lisp expression if you point with the mouse at text — a line if you point with the mouse at white space before or after all the text on the line).

With Keystrokes

You can also create a region using keystrokes. After setting the mark, you can move point either forward or backward to define a region in either direction; as you do so, Zmacs highlights the region with underlining.

Typing a self-inserting character or c-G deactivates the mark and removes the underlining that highlights the region. The mark does not have an associated cursor like point. When inactive, the mark is invisible, but you can go to it with c-X c-X, Swap Point And Mark.

The Point-pdl

Zmacs maintains a special stack of buffer pointers called the *point-pdl*, where *pdl* stands for *push-down list*, another name for a stack.

Zmacs automatically saves point on the point-pdl as it executes some commands (for example, m-<) that move point great distances. Whenever Zmacs pushes point onto the point-pdl, it displays "Point pushed" in the echo area, moves point to its new location, and pushes the previous point down onto the point-pdl.

What is a Region?, *cont'd.*

By popping the point-pdl, that is, resetting point to its last location as recorded on the point-pdl, Zmacs returns point to where it was when the pdl was last pushed.

Setting/Popping the Mark

`c-SPACE` Set Pop Mark

With no argument, `c-SPACE` does three things:
1. Puts mark where point is
2. Makes mark active
3. Pushes point onto the point-pdl

Other commands can do each of these operations separately. Creating a region with the mouse sets a mark and makes it active but does not push point.

This command does other things depending on how many `c-U`s are typed in front of it:

Argument	*Action Taken*
one `c-U`	Pops the location on the top of the point-pdl into point (typically puts point where it set the last mark).
two `c-U`s	Pops the location on the top of the point-pdl and throws it away.

Moving to Previous Points

`c-m-SPACE` Move to Previous Point

Exchanges point and top of point-pdl. With a numeric argument *n*, it rotates a ring consisting of point and the top *n-1* elements of point-pdl, thus the default argument is 2. With a numeric argument of 1, it rotates the entire point-pdl. A negative numeric argument rotates the ring in the other direction.

`c-X c-m-SPACE` Move to Default Previous Point

Rotates the point-pdl, the same as `c-m-SPACE` above except that `c-X c-m-SPACE` has a default of 3. A numeric argument specifies the number of entries to rotate and sets the new default before rotating the point-pdl.

What is a Region?, *cont'd.*

Showing the Mark

`c-X c-X` Swap Point And Mark

Exchanges point and mark. It works even when no region is active. It highlights the text between point and mark.

Registers

Saving and Moving to Locations in Registers

You can assign one-character "names" to locations in the buffer, which can be helpful for setting up a series of places in your text to which you want to return for some reason — to double-check several items without interrupting your text entry or editing, if you are considering a format change that will affect several parallel points, or simply to return quickly and easily to rough spots that require further work.

c-X S Save Position

Saves the current location in a register. It prompts for a one-character register name.

c-X J Jump to Saved Position

Moves point to a position that was saved in a register. It prompts for a register name and switches buffers to move to the saved position, if necessary.

Saving and Inserting Regions in Registers

c-X X Put Register

Copies the text of the region into a register. It prompts for a register name. With a numeric argument, it deletes the region from the buffer after copying it.

c-X G Open Get Register

Inserts text from a specified register into the buffer. It prompts for the name of the register. It overwrites blank lines in the buffer the way RETURN does (using the command Insert Crs). It leaves the mark before the inserted text and point after it. With a numeric argument, it puts point before the text and the mark after.

List Registers (m-X)

Displays names and contents of all defined registers. It shows the name of the register and whether it contains a position or text. If the register contains a position, it tells which character on the line

Registers, *cont'd.*

the position is at, and shows the first 50 characters on that line. If the register contains text, it shows the first 50 characters on the first line of that text.

```
List of all registers:
D (text)       This text was marked as a region and saved here
1 (position)   Char 0. in "another line containing a position"
Done.
```

View Register (m-X)

Displays the contents of a register in the typeout window. It prompts for a register name and then tells whether the register contains a position or text:

```
Register A contains a position: Character 0 in this line:
this is the line
```

or

```
Register A contains text:
```

Kill Register (m-X)

Kills a register.

Commands to Mark Regions

Overview

To *mark* a piece of text means activating mark and then positioning point and mark on either side of the text, making it the region. The simplest way to mark some text is to go to one end of the text, set the mark there (using the Set Pop Mark command described earlier in this section), and go to the other end of the text. However, there are several convenient commands for marking different amounts of text, which are described below.

By Words

m-@ Mark Word

Puts the mark at the end of the current word. With a numeric argument of *n*, m-@ puts the mark *n* words forward from point.

By Lisp Expressions

c-m-@ Mark Sexp

Marks the current expression by putting mark at the end. With a numeric argument *n*, it moves forward *n* expressions and puts the mark there. See c-m-F for a more detailed description of how to move forward *n* expressions.

c-m-H Mark Definition

Puts point and mark around the current definition.

By Paragraphs

m-H Mark Paragraph

Puts the mark at the end of the current paragraph and moves point to the beginning, so that the current paragraph becomes the region. With a numeric argument *n*, m-H puts point at the beginning of the current paragraph and marks *n* paragraphs forward from there.

Example

m-3H marks the current paragraph and the following two; m- -1H marks the preceding paragraph. When marking preceding paragraphs, point is left at the end of the region, and when marking current and succeeding paragraphs, point is left at the beginning of the region.

Commands to Mark Regions

By Pages

`c-X c-P` Mark Page

Puts the mark at the end of the current page and moves point to the beginning, so that the current page becomes the region.

With a numeric argument of *n*, `c-X c-P` marks the *n*th page after the current one. If *n* is zero, this is the current page; if *n* is negative, this page comes *before* the current page.

By Buffers

`c-X H` Mark Whole

Marks the whole buffer by putting point at the beginning and the mark at the end. With any numeric argument, `c-X H` puts the mark at the beginning and point at the end.

From Here to End of Buffer

`c->` Mark End

Marks from the cursor to the end of the buffer by putting the mark at the end of the buffer.

From Here to Beginning of Buffer

`c-<` Mark Beginning

Marks from the cursor to the beginning of the buffer by putting the mark at the beginning of the buffer.

Region-Manipulating Commands

Saving the Region

`m-W` Save Region

Puts region on kill history list without deleting it. (See also the section "Kill Merging", page 64, including the description of the Append Next Kill command, `c-m-W`.)

Deleting the Region

`c-W` Kill Region

Deletes the region. If there is no region, `c-W` produces an error.

This command ignores numeric arguments and places the deleted text on the kill history list. (See also the section "Retrieving History Elements", page 64, including the description of the Yank command, `c-Y`.)

Compiling the Region

`c-sh-C` Compile Region
Compile Region (`m-X`)

Compiles the region, or if no region is defined, the current definition.

Transposing Regions

`c-X T` Exchange Regions

Exchanges two regions delimited by point and last three marks.

After transposing regions, you can undo the effect of this command by invoking it again.

Hardcopying the Region

Hardcopy Region (`m-X`)

Sends a region's contents to the local hardcopy device for printing.

Region-Manipulating Commands, *cont'd.*

Filling the Region

When Zmacs *fills* text it breaks it up so that it does not extend past the *fill column*. The fill column determines the right margin, and is the first column in which text is not to be placed by m-Q, m-G, or Auto Fill Mode formatting. In addition, the *fill prefix*, if set, is inserted:

- at the beginning of each new line typed in while in Auto Fill Mode
- at the beginning of each line in a paragraph for m-Q and each line in a region for m-G

The fill prefix determines the left margin, and is empty unless set to contain some combination of spaces and characters. If you do not set the fill prefix, the left margin is the left edge of your Zmacs window. For example, to insert five spaces at the beginning of every line, insert them at the beginning of the current line, and with point at column six, use c-X .. To turn this fill prefix off, put point at the beginning of a line, and use c-X . again.

Adjusting or *justifying* text inserts extra spaces between the words to make the right margin come out exactly even.

m-Q Fill Paragraph

Fills the current (or next) paragraph. A positive argument means to adjust rather than fill.

m-G Fill Region

Fills the current region. A positive argument means to adjust rather than fill.

c-X . Set Fill Prefix

Defines Fill Prefix from the current line. All of the current line up to point becomes the Fill Prefix. Fill Region starts each nonblank line with the prefix (which is ignored for filling purposes). To stop using a Fill Prefix, do a Set Fill Prefix at the beginning of a line.

Region-Manipulating Commands

Other Region-related Commands

Name and Invocation	*See Page*
Uppercase Region c-X c-U	148
Lowercase Region c-X c-L	148
Uppercase Code in Region (m-X)	148
Lowercase Code in Region (m-X)	148

Searching, Replacing, and Sorting

Searching

Overview

Like other editors, Zmacs has commands for searching for an occurrence of a string. Zmacs search commands are *incremental*; that is, they begin to search as soon as you type the first character.

This section describes how to search incrementally forward and backward in the buffer, as well as a method for specifying a complete search string first and then specifying a direction in which to search.

Incremental Search

The command to search is c-S (Incremental Search). c-S reads in characters and positions the cursor at the first occurrence of the characters that you have typed. If you type c-S and then t, the cursor moves right after the first t. Type an r, and see the cursor move to after the first tr. Add a y and the cursor moves to the first try after the place where you started the search. At the same time, the try has echoed at the bottom of the screen. Stop typing when you have typed enough characters to identify the place you want.

If you type a mistaken character, you can rub it out. After the try, typing a RUBOUT makes the y disappear from the bottom of the screen, leaving only tr. The cursor moves back to the tr. Rubbing out the r and t moves the cursor back to where you started the search. To exit from the search, press END or ESCAPE (ALTMODE does the same thing on an LM-2). You can also use ABORT to exit from the search. To abort out of the search and return to the original starting point in the buffer, use c-G.

If you want to search for something else, press CLEAR-INPUT to get rid of the current search string. You're still in the search loop, so type another search string.

If the string cannot be found with c-S, type c-R to search backward for the default string. Zmacs remembers the default search string — you can reinvoke the search at any time using c-S c-S, to search forward for it, or c-R c-R to search backward.

c-S Incremental Search

Searches for a character string while you type it, searching forward to the end of the buffer. It prompts for a string in the echo area with I-Search:. As you type characters in, c-S displays the accumulating string in the echo area and searches for it at the same time. If no string is found, it displays Failing I-Search:. When it locates the string, it puts the cursor after it so that repeated c-Ss locate subsequent occurrences of the default string in the buffer.

Searching, *cont'd.*

RUBOUT — Removes a character and backs up the search to the last match.

ESCAPE — When typed before any search characters, switches to String Search (see page 88).

END — Exits the search (ESCAPE also works for the 3600, ALTMODE works for the LM-2).

c-G — Exits the search and returns to original starting point in the buffer.

c-Q — Quotes the next character, to prevent it from terminating the search.

c-S — Repeats the search.

c-R — Reverses the search to search backwards.

If c-S or c-R is the first character typed, the previous search string is used again as the default. Entering any other command character terminates the search (and then executes that command).

Reverse Incremental Search

c-R, Reverse Incremental Search, works exactly the same way as c-S, except that it searches *backward* towards the top of the buffer from point, instead of forward.

c-R — Reverse Incremental Search

Searches for a character string while you type it, searching backward to the beginning of the buffer. It prompts for a string in the echo area with Reverse I-Search:. As you type characters in, c-R displays the accumulating string in the echo area and searches for it at the same time. If no string is found, it displays Failing Reverse I-Search:. When it locates the string, it puts the cursor in front of it so that repeated c-Rs locate previous occurrences of the default string in the buffer.

RUBOUT — Removes a character and backs up the search to the last match.

ESCAPE — When typed before any search characters, switches to Reverse String Search (see page 88).

END — Exits the search (ESCAPE also works for the 3600, ALTMODE works for the LM-2).

c-G — Exits the search and returns to original starting point in the buffer.

Searching, *cont'd.*

c-Q	Quotes the next character, to prevent it from terminating the search.
c-S	Reverses the search to search forward.
c-R	Repeats the search.

If c-S or c-R is the first character typed, the previous search string is used again as the default. Entering any other command character terminates the search (and then executes that command).

String Search

The string search command, invoked by c-S ESCAPE (c-S ALTMODE on an LM-2), lets you type in the entire string and specify the direction in which to search before starting the search.

c-S ESCAPE String Search

Searches for a specified string, according to the arguments given with the special characters below. Another c-S always begins the search. It prompts in the echo area `String Search:`. It saves previous string search commands on a ring, retrievable with c-D. The ring contains three elements and can be rotated with repeated c-Ds. While you are entering the search string, the following characters have special meanings:

c-B	Searches forward from the beginning of the buffer.
c-E	Searches backwards from the end of the buffer.
c-F	Leaves point at the top of the window, if the window must be recentered.
c-G	Aborts the search.
c-D	Gets a string to search for from the ring of previous search strings.
c-L	Redisplays the typein line.
c-Q	Quotes the next character.
c-R	Reverses the direction of the search.
c-S	Does the search, then comes back to the search command loop.
c-U	Erases all characters typed so far (CLEAR-INPUT also works for the 3600).
c-V	Delimited Search: Searches for occurrences of the string surrounded by delimiters.

Searching, *cont'd.*

`c-W` Word Search: Searches for words in this sequence regardless of intervening punctuation, whitespace, newlines, and other delimiters.

`c-Y` Appends the string on top of the string ring to the search string.

`RUBOUT` Rubs out the previous character typed.

`END` Does the search and exits (`ESCAPE` also works on a 3600; `ALTMODE` on an LM-2).

If you search for an empty string, it uses the default. Otherwise, the string you type becomes the default, and the default is saved unless it is a single character.

Locating and Replacing Strings Automatically

Overview

c-%, Replace String, searches forward for a string and replaces that string with another. c-% prompts for the string to be replaced, reads the string from the minibuffer, and then reads the replacement string. After it goes through the buffer trying to make the replacements, it tells you how many replacements it made (`1. replacement.`), or that it made none.

You can also substitute one string for another *selectively* throughout the buffer, with m-%, Query Replace. m-% prompts first for the string to be replaced (`Query-replace some occurrences of:`), and then for the string to replace it with (`Query-replace some occurrences of "string" with:`). Terminate each string you specify with RETURN. m-% locates each occurrence and lets you decide what to do about each one.

Making Global Replacements

c-% Replace String
Replace String (m-X)

Replaces all occurrences of a given string with another, where the string can be characters, words, or phrases. It prompts first for the string to remove and second for the string to replace it with. A numeric argument *n* means to make *n* replacements. By default, it begins at point and replaces all occurrences of the first string that occur *after* point in the buffer. Usually it attempts to match the case of the replacements with the case of the string being replaced. This behavior is controlled by the Zmacs variable Case Replace P (default **t**). When it is null, case matching does not take place. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

Querying While Making Global Replacements

m-% Query Replace
Query Replace (m-X)

Starting at point, replaces a string through the rest of the buffer, asking about each occurrence, where the string can be characters, words, or phrases. It prompts for each string. You first give it STRING1, then STRING2, and it finds the first STRING1, displaying it in context. You respond with one of the following characters:

SPACE	Replaces it with STRING2 and shows next STRING1
RUBOUT	Leaves this STRING1, but shows next STRING1

Locating and Replacing Strings Automatically, *cont'd.*

,	Replaces this STRING1 and shows result, waiting for a SPACE, c-R, or ESCAPE
Period	Replaces this STRING1 and ends query replace
c-G	Leaves this occurrence of STRING1 unchanged and terminates the query replace
ESCAPE	Same as c-G
^	Returns to site of previous STRING1
c-W	Kills this STRING1 and enters recursive edit
c-R	Enters editing mode recursively. Press END to return to Query Replace.
c-L	Redisplays screen
!	Replaces all remaining STRING1s without asking

Entering any other character terminates the command. Usually the command attempts to match the case of the replacements with the case of the string being replaced. This behavior is controlled by the Zmacs variable Case Replace P (default **t**). When it is null, case matching does not take place. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

If you give a numeric argument, it does not consider STRING1s that are not bounded on both sides by delimiter characters.

Querying While Making Multiple Global Replacements

While doing multiple query replacements, you can specify the replacement strings either from the minibuffer or from another buffer altogether.

Replacements from the Minibuffer

Multiple Query Replace (m-X)

Performs query replace (see the description for Query Replace (m-X), page 90) using many pairs of strings at the same time, where the strings can be characters, words, or phrases. Strings are read in alternate minibuffers; when you finish entering all strings, press RETURN twice. An argument means that the strings must be surrounded by delimiter characters. A negative argument means that the strings must be delimited atoms, rather than words.

Locating and Replacing Strings Automatically, *cont'd.*

Replacements from Another Buffer

Multiple Query Replace From Buffer (m-X)

Performs query replace (see the description for Query Replace (m-X), page 90) using many pairs of strings *supplied from the specified buffer*. The current buffer should contain a STRING1, a space, and a STRING2. Put quotation marks around any string that contains a space, tab, backspace, semicolon, or newline character. Lines in the buffer that begin with a semicolon or are blank are ignored. In other words, each string in the buffer is a Lisp string, but quotation marks can be omitted if the string contains no special characters.

Other Types of Replacements

Besides making string replacements in text, Zmacs commands replace:

- A region into the kill history
- Evaluated code into the buffer
- The value of LET into its variable
- A string for delimited atoms

Query Replace Last Kill

Query Replace Last Kill (m-X)

Replaces the first item in the kill history with the region.

Evaluate and Replace Into Buffer

Evaluate and Replace Into Buffer (m-X)

Evaluates the next Lisp expression following point and replaces it with the printed representation of its value.

Query Replace LET Binding

Query Replace Let Binding (m-X)

Replaces variable of LET with its value. Point must be after or within the binding to be modified.

Locating and Replacing Strings Automatically, *cont'd.*

Atom Query Replace

Atom Query Replace (m-X)

Performs query replace (see the description for Query Replace (m-X), page 90) for delimited atoms.

Tags Tables and Search Domains

Introduction

Tags tables, a means of global searching and replacing, allow you to make sweeping changes to groups of files without having to explicitly locate each file. Tags *tables* are sets of buffers and files. Tags *files* provide a list of the names of files that belong together as part of a system and a list of names and locations of definitions within the files. The file names are made into a tags table; the definition names are added to the completion table.

You could use tags tables, for example, to:
- Search for all references to a certain variable and alter them consistently
- Search for all occurrences of an obsolete term and update it
- Search for all functions that send a certain message

How They Work

First, you specify the buffers or files that will make up the tags table (see "Specifying and Listing Tags Tables" below). Then you can perform an operation (see "Performing Operations with Tags Tables" below). Zmacs performs the operation on the files within the tags table that you have specified.

Example

Suppose you want to perform a tags query replace in several files. Use Tags Query Replace (m-X) (described in detail below) to begin. The minibuffer prompts as in Query Replace (m-X) for the string to be replaced and the replacement string. The operation begins and Zmacs displays `Control-. is now Continue query replacement of "string-old" with "string-new"`; as it displays each occurrence, you deal with each one using the appropriate response characters. Tags Query Replace goes through all the files specified in the tags table, listing their names in the minibuffer and stopping at each occurrence of "string-old". When it finishes searching all the files, it displays `No more files`.

Specifying and Listing Tags Tables

Select All Buffers As Tag Table (m-X)

Selects all buffers currently read in. It creates a support buffer (see "Support Buffers" below) called `*Tag-Table-`*N*`*`, which contains a list of the names of all the buffers.

Tags Tables and Search Domains, *cont'd.*

Select Tag Table (m-X)

Makes a tags table current for commands like tags search. It prompts in the minibuffer for the name of the tags table to use.

Select System As Tag Table (m-X)

Creates a tags table for all files in a system defined by **defsystem**. It prompts in the minibuffer for the name of a system — press HELP to see a display of system names. It selects the system but does not read the files in.

List Tag Tables (m-X)

Lists in the typeout window the names of all the tags tables, and for each one shows the files it contains.

Performing Operations With Tags Tables

Tags Search (m-X)

Searches for the specified string within files of the tags table. It prompts in the minibuffer for the search string. If there is no current tags table, it prompts for one.

Zmacs displays in the echo area the name of each of the files in the tags table as it searches each file for the specified string. As Zmacs begins the operation and finds the first occurrence, it displays `Point pushed.` in the minibuffer and moves the cursor to the occurrence. After you deal with that occurrence, use c-., the Edit Definition command (described below), to tell the command to locate the next occurrence. Go through the specified files using c-. to the end.

Tags Query Replace (m-X)

Replaces occurrences of one string with another within the files of the tags table, asking about each occurrence. It prompts first for the string to remove and second for the string to replace it with. You first give it STRING1, then STRING2, and it finds the first STRING1, displaying it in context. You respond with one of the following characters:

SPACE	Replaces it with STRING2 and shows next STRING1

Tags Tables and Search Domains, *cont'd.*

RUBOUT	Does not replace this occurrence, but shows next STRING1
,	Replaces this STRING1 and shows result, waiting for a SPACE, c-R, or ESCAPE
Period	Replaces this STRING1 and terminates the query replace
c-G	Leaves this occurrence of STRING1 unchanged and terminates the query replace
ESCAPE	Same as c-G
^	Returns to site of previous STRING1 (actually, pops the point-pdl)
c-W	Kills this STRING1 and enters recursive edit
c-R	Enters editing mode recursively. Press END to return to Query Replace.
c-L	Redisplays screen
!	Replaces all remaining STRING1s without asking

Entering any other command character terminates the command. Usually the command attempts to match the case of the replacements with the case of the string being replaced. This behavior is controlled by the Zmacs variable Case Replace P (default **t**). When it is null, case matching does not take place. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

If you give a numeric argument, it does not consider STRING1s that are not bounded on both sides by delimiter characters.

Tags Multiple Query Replace (m-X)

Performs tags query replace (see the description for Tags Query Replace above) using many pairs of strings at the same time, where the strings can be characters, words, or phrases. Strings are read in alternate minibuffers; when you finish entering all strings, press RETURN twice. An argument means that the strings must be surrounded by delimiter characters. A negative argument means that the strings must be delimited atoms, rather than words.

Tags Multiple Query Replace From Buffer (m-X)

Replaces occurrences of any number of strings with other strings within the tags table files, asking about each change. The current

Tags Tables and Search Domains, *cont'd.*

buffer should contain a STRING1, a space, and a STRING2. Put quotation marks around any string that contains a space, tab, backspace, semicolon, or newline character. Lines in the buffer that begin with a semicolon or are blank are ignored. In other words, each string in the buffer is a Lisp string, but quotation marks can be omitted if the string contains no special characters.

A positive numeric argument means to consider only the cases where the strings to replace occur as a word (rather than within a word). A negative numeric argument means to consider only delimited atoms, rather than words.

This command has the same options as Tags Query Replace (see above).

Find Files in Tag Table (m-X)

Reads every file in the selected tags table into the editor. If there is no current tags table, it prompts for the name of one, which you can specify as a file (F), all editor buffers (B), or a system (S).

Visit Tag Table (m-X)

Creates a tags table by reading in a tags file. First, it reads in the specified tags file. It prompts for a file name from the minibuffer. Next, it goes through the tags file and marks the name of each tag as being a possible section of its file. The Edit Definition command (m-.) uses these marks to figure out which file to use.

It uses a support buffer (see "Support Buffers" below) to hold the elements of the tags table and another support buffer to hold the state of a pending operation involving all the files in the tags table. Each contains the names of the files.

Support Buffers

Zmacs creates *support buffers* to save lists that it creates as part of the execution of some commands:

- Tags table commands.
- Edit Buffers (m-X).
- View File (m-X).
- Lists for Edit Definition (m-.), when more than one definition exists.
- Buffers for Dired (m-X).
- Everything that edits a sequence of definitions, as in List Callers (m-X) or List Methods (m-X).

This means that you can examine the buffers containing the lists even after you have done some editing.

Tags Tables and Search Domains, *cont'd.*

c-X c-B, the List Buffers command, displays these support buffers in the listing of buffers. Their names are, for example, `*Definitions-1*`, `*Tags-Search-1*`, and `*Tags-Query-Replace-1*`.

To avoid proliferation of editor buffers, Zmacs reuses support buffers in most cases, so that it usually saves no more than two of each type of support buffer at a time.

Possibility Buffers

Each time you use a command that generates a set of possibilities (for example, Tags Search (m-X) and Tags Query Replace (m-X)), it creates a possibility buffer for that set and pushes the set of possibilities onto a stack. c-., Next Possibility, extracts the next item from the set at the top of the stack. The set is popped from the stack when no more items remain in it. Several informational messages are associated with this facility. When the whole possibilities stack is empty and you have nothing more pending it displays:

```
No more sets of possibilities.
```

Displaying the Next Possibility

c-. Next Possibility

Selects the next possibility for the current set of possibilities. With a negative argument, pops off a set of possibilities. An argument of c-U or any positive number displays the remaining possibilities in the current set. With an argument of zero, selects the current buffer of possibilities.

See the chapter "Editing Lisp Programs", page 153, for a description of the Edit Definition and Edit Callers commands.

Example

Suppose you had been using c-. to move through the set provided by Tags Search and you then used Tags Query Replace to push a new set of possibilities onto the stack. When you finished the set provided by Tags Query Replace, you would see a message like the following to notify you that the empty set had been popped off the stack and the set of possibilities for Tags Search had been reinstated.:

```
c-. is now Search for next occurrence of "string"
```

The position of point in the support buffer indicates the next item for Next Possibility (c-.). You can select the support buffer and move point manually in order to skip or redo possibilities.

Tags Tables and Search Domains, *cont'd.*

Typing c-. while in a support buffer that is not at the top of the possibilities stack moves it to the top, prints an appropriate message, then takes the next possibility from that support buffer.

Sorting

Overview

The following commands alphabetically sort a region by line, paragraph, or whatever *sort key* you specify.

Sort Lines (m-X)

Sorts the region alphabetically by lines.

Sort Paragraphs (m-X)

Sorts the region alphabetically by paragraphs.

Sort Via Keyboard Macros (m-X)

Sorts the region, prompting for actions to define the *records* (the units of the region to be rearranged) and the sort keys (the fields in the records that are compared alphabetically to determine the new order of records). It prompts you to define the records and sort keys by performing positioning commands. It prompts for three actions:

1. Move to the beginning of the sort key (that is, move the cursor to the beginning of the field upon which to sort).
2. Move to the end of the sort key (that is, move to the end of the sort field).
3. Move to the end of the sort record (that is, move to the end of the record containing that field).

For each, it records the keystrokes that you use (as keyboard macros) and plays those back to find and sort the records in the region.

Manipulating Buffers and Files

Working With Buffers and Files

Overview

Files are semipermanent collections of information stored safely outside the Zmacs environment. *Buffers*, on the other hand, are more dynamic, temporary collections of information, used by Zmacs for manipulating text. Buffers live in the active Zmacs environment. Each buffer has its own point and mark as well as other associated information.

We say we use Zmacs to "edit files", but what we really do is copy a file into a buffer created for the purpose, edit the buffer, and then write out a new version of the file from the edited buffer. The old version of the file is retained, to be deleted explicitly when appropriate. Successive versions of files are distinguished by *version number*, a component of the file name that is incremented with each new revised copy (except on file server hosts like UNIX that do not have version numbers).

Zmacs allows multiple buffers, so that you can edit many files simultaneously. Usually only one buffer is visible on the screen at a time. You can, however, divide the screen into multiple windows so that you can view the contents of several buffers at once.

Zmacs keeps track of the association between files and buffers. If you are editing a file's contents in a buffer, Zmacs gives that buffer the same name as that of the file being edited.

Buffer and File Names

Both buffers and files have long names that indicate the host directory as well as the file name (and version, where supported). Hence completion is a necessary aid and is always provided for entering buffer and file names.

Working With Buffers and Files, *cont'd.*

Buffer Flags for Existing Files

Each buffer has a *modification flag* that tells whether the buffer has been changed to be different from the associated file. You can see the modification flag by clicking on either the List Buffers command or the Kill or Save Buffers command in the editor menu (editor menu is click right once), or by pressing c-X c-B for List Buffers. The modification flag is cleared when:

- The file is read into the buffer from the file system.
- The buffer is *saved*, that is, whenever its contents are written out to the associated file. As soon as its contents are modified thereafter, the modification flag is set and Zmacs displays an asterisk (*): (1) in the mode line to the right of the buffer name, and (2) whenever it displays output from the List Buffers command.

Buffer Flags for New Files

The List Buffers (c-X c-B) command uses the plus sign (+) to mark new files that have not been saved. In addition, it uses + to mark new buffers, not associated with files, that have text in them. This helps when you put text into a new buffer and later want to be reminded to write that buffer to a file.

Selecting, Listing, and Examining Buffers

Current Buffer

At all times when using Zmacs, you have one *selected* buffer, which is the buffer that you are actively editing. This is the buffer whose cursor moves when you type c-F and in which all other current activity takes place until you switch buffers.

Buffer History

With a single Zmacs window on the screen, the editor keeps one buffer history, the *global history list*, which remembers the previous-buffer history (stack history) of that window. The top buffer in the stack is the currently selected one. Usually, when a buffer is selected, it is dredged out of the stack and put on top. The buffers near the top are usually the most recently used. Each time you change buffers Zmacs offers the name of the most recently used buffer as the default buffer name.

When we refer to the *n*th buffer, we mean the *n*th buffer in Zmacs's stack of buffers.

Every additional window maintains its own buffer history, but the global history list continues to display an entry for every buffer in every window.

When you create a new window, Zmacs initially takes the history list for the new window from the global history list. From then on, as you switch from buffer to buffer within that window, the list for that window reflects the history of those changes in chronological order. This affects particularly c-m-L (Select Previous Buffer) and the default for c-X B (Select Buffer).

The global history list still exists and is used for name completion and c-X c-B (List Buffers).

Buffer Commands

Changing Buffers

`c-X B` Select Buffer

Prompts for the name of a buffer and selects that buffer, displaying its contents on the screen. If you press END or RETURN instead of a name, it reselects the second most recently selected buffer.

Using completion, it takes the string you enter and tries to complete it to an existing buffer name:

- When completion is successful, it selects that buffer.
- When completion is unsuccessful, (there is no buffer with the name given), it either waits for you to type more characters (if there are multiple possible completions) or it beeps to give you a chance to correct a typing error (if there is no possible completion). A subsequent response of `c-RETURN` creates a new buffer with the specified name and selects it.

If you precede the `c-X B` command with a numeric argument, Zmacs prompts for the name of the buffer and then creates and selects it.

`c-m-L` Select Previous Buffer

Selects a previously selected buffer. With a numeric argument *n*, it selects the *nth* previous buffer. The default argument is 2. When the argument is 1, it rotates the entire buffer history. A negative argument means to rotate the other way. An argument of zero displays the buffer history, which is mouse-sensitive.

`c-X c-m-L` Select Default Previous Buffer

With a numeric argument *n*, this is exactly the same as `c-m-L`. Without a numeric argument, this command *remembers the last numeric argument it received* and uses that as its argument this time.

This is useful if you happen to be working with the top few buffers on the buffer stack and want to cycle among them without having to remember how many there are.

Buffer Commands, *cont'd.*

Listing Buffers

c-X c-B List Buffers

Lists all the currently existing buffers in the typeout window, along with the editor mode of the buffer and the name of the associated file, if any. For buffers with associated files, it displays the version number of the file, if any. If there is no associated file, c-X c-B gives the size of the buffer in lines instead. For Dired buffers, it displays the pathname used for creating the buffer. It lists modified buffers with an asterisk. It lists the buffers sorted in stack order. You can inhibit this sorting by setting the global variable **zwei:*sort-zmacs-buffer-list*** to **nil** (default is **t**).

With an argument of c-U, it prompts for a substring and then lists all buffers whose names contain that substring.

The buffer names are mouse sensitive. Click right on the name of the buffer for a menu of operations (Kill, Not Modified, Save, Select) for that buffer. You can select one of the buffers by clicking left on its name.

Example

```
Buffers in Zmacs:
  Buffer name:                 File Version:          Major mode:

+ file1 /dess/zmacs VIXEN:                            (Fundamental)
= *Dired-1*                    VIXEN: /dess/zmacs/*   (Dired)
* doc.mss /dess/zmacs VIXEN:                          (Text)
  *Buffer-1*                   [1 line]               (Fundamental)

+ means new file or non-empty non-file buffer.  * means modified file.
= means read-only.
```

Editing Buffers

Edit Buffers (c-m-X) is not part of the standard comtab. It is similar to List Buffers (c-X c-B), except that the buffer listing that Edit Buffers produces is a buffer in its own right. (See "Setting Editor Variables in Init Files", page 196, for an example showing how to make c-X c-B call Edit Buffers instead of List Buffers.) It contains one line for each of the buffers in the editor.

Buffer Commands, *cont'd.*

Edit Buffers (c-m-X)

Displays a list of all buffers, allowing you to save or delete buffers and to select a new buffer. A set of single character subcommands lets you specify various operations for the buffers. For example, you can mark buffers to be deleted, saved, or not modified. The buffer is read-only; like the Directory editor (Dired) buffer, you can move around in it by searching and with commands like c-N and c-P.

The lines in the list are not mouse-sensitive. With the cursor on the line for a buffer, the following single character commands apply to that buffer:

RUBOUT	Undeletes buffer above the cursor.
SPACE	Selects the specified buffer immediately.
D	Marks the buffer for deletion (K, c-D, c-K are synonyms).
U	Undeletes either the buffer on the current line or the buffer on the line above.
S	Marks the buffer for saving.
~	Marks the buffer for setting not modified.
X	Executes an extended command (same as m-X).

Viewing a Buffer

View Buffer is for when you want to just look at a buffer, not edit it.

c-X V View Buffer
View Buffer (m-X)

Prompts for the name of a buffer and prints out the buffer contents for viewing only in the typeout window. If there is more than a screenful, it pauses between screenfuls, displaying a --MORE-- message at the bottom.

SPACE	Displays the next screenful.
BACKSPACE	Displays the previous screenful.
RUBOUT	Exits.

Anything else exits and is executed as a command.

Buffer Commands, *cont'd.*

Hardcopying the Buffer

Hardcopy Buffer (m-X)

Prompts for the name of a buffer and then prints the specified buffer on a hardcopy printer.

Renaming the Buffer

Rename Buffer (m-X)

Prompts for a new name for the current buffer and changes the name accordingly. This operation removes any file association that the buffer had.

Writing Out All Buffers

Save All Files (m-X)

Offers to write out each buffer that is associated with a file. It prompts in the typeout window with the name of each buffer: `Save file old.lisp /dass/pubs/pgs VIXEN:? (Y or N).`

Encrypt Buffer (m-X)

Encrypts the contents of the buffer. It prompts for a key and does not echo it as you type it. It prompts for the same key again, just in case you mistyped it because of the lack of echoing, and makes sure you typed it the same both times. The encryption algorithm is the same one used by the Hermes mail-reading system.

Decrypt Buffer (m-X)

Decrypts the contents of an encrypted buffer. It prompts for a key and does not echo it as you type it. The encryption key given for decrypting must match the one used for encrypting. The encryption algorithm is the same one used by the Hermes mail-reading system.

Reading a File Into a New Buffer

c-X c-F Find File

Prompts for the name of a file and looks for a buffer currently associated with that file. If one is found, c-X c-F selects it. Otherwise, it creates a new buffer and reads that file into it.

Buffer Commands, *cont'd.*

Reading a File Into an Existing Buffer

The `c-X c-V` command, Visit File, is primarily useful when you type in a mistaken file name after `c-X c-F` and Zmacs responds `(New File)`. You can simultaneously read in the correct file and get rid of the unwanted buffer with Visit File.

`c-X c-V` Visit File

Prompts for the name of a file and reads that file into *the current buffer*. This action associates the current buffer with the specified file. This command can only be used if the current buffer is not already associated with an existing file.

Writing the Buffer Contents to a File

`c-X c-W` Write File

Prompts for the name of a file and writes out the contents of the current buffer to the specified file. This changes the current buffer's name and associates it with the specified file. Subsequent saves using `c-X c-S` save to the newly specified file. This operation clears the modification flag.

Saving the Buffer Contents to the File

`c-X c-S` Save File

Writes the contents of the current buffer out to the associated file and clears the modification flag. It does not write the file if the buffer is unchanged from when the file was last visited or saved. It reads a file name from the minibuffer if the current buffer does not have an associated file.

Re-reading a File Into the Buffer

Revert Buffer (`m-X`)

Reads a file into the buffer that it is associated with. It prompts for a buffer name, defaulting to the current buffer. The prompt serves as a confirmation, since Revert Buffer (`m-X`) throws away any modifications made to the buffer since you last saved or read the file. This command is useful if you have damaged the buffer and want to start over or if the associated file is more current than the buffer. This operation clears the modification flag.

Buffer Commands, *cont'd.*

Creating a Fundamental Mode Buffer

Find File In Fundamental Mode (m-X)

Creates a fundamental mode buffer containing the file. This is useful because Zmacs does not parse the file while reading it in, thus the names of the functions in the file do not conflict with those already known to completion in m-. and similar commands. This command is necessary if the normal parsing of a Lisp Mode file signals an error, preventing it from being read into the editor to correct the cause of the error.

Associating a File With a Buffer

Set Visited File Name (m-X)

Prompts for the name of a file and associates the current buffer with that file. This command does *not* read the specified file into the buffer. Effectively, the current contents of the buffer are declared to be the new intended contents of the specified file. This command should be used with caution to avoid unintentionally destroying the old contents of the specified file.

Destroying Buffers

c-X K Kill Buffer

Prompts for the name of a buffer and destroys that buffer. If you press END or RETURN instead of a name, c-K destroys the current buffer and prompts for the name of a buffer to select instead.

Kill Some Buffers (m-X)

For each existing buffer, tells you something about the status of the buffer and asks whether or not to delete it. If you elect to delete a buffer that has been modified since it was last saved, the command offers to save it first.

Buffer Commands, *cont'd.*

Kill Or Save Buffers (m-X)

Puts up a multiple-choice menu listing all existing buffers. You can then choose which buffers to destroy and which to write out to files. This command appears on the editor menu.

Appending, Prepending, and Inserting Text

Appending a Region to a Buffer

c-X A Append To Buffer

Prompts for the name of a buffer and appends the contents of the region onto the end of the specified buffer.

Appending a Region to a File

Append To File (m-X)

Prompts for the name of a file (Append region to end of file:) and appends the contents of the region onto the end of the specified file, writing a new version of that file.

Prepending a Region to a File

Prepend To File (m-X)

Prompts for the name of a file and prepends the contents of the region onto the beginning of the specified file.

Inserting a Buffer Into Another Buffer

Insert Buffer (m-X)

Prompts for the name of a buffer and inserts the entire contents of that buffer into the current buffer at the cursor.

Inserting a File Into a Buffer

Insert File (m-X)

Prompts for the name of a file and inserts the contents of that file into the current buffer at the cursor.

Comparing Files and Buffers

Source Compare

Source Compare (m-X)

Compares two files or buffers, prompting for type (F or B) and name of each, and displays the results of the comparison in the typeout window. It saves the output in a support buffer named *Source-Compare-*N**. You can read the comparison while checking the file, for example, by going into two window mode with the comparison in one window and the file in the other.

Example

This example shows a comparison between the file new, as it was read into the buffer, and the buffer new, which contains the contents of the file new *plus* changes that have been made:

```
Source compare made by ESG on 12/21/83 12:30:40 -*-Fundamental-*-
of Buffer new /dass/pubs/pgs VIXEN: with File
VIXEN: /dass/pubs/pgs/new

****Buffer new /dass/pubs/pgs VIXEN:, Line #179
Source Compare Merge compares two files or buffers,
prompting for type and name, and merges the differences

****File VIXEN: /dass/pubs/pgs/new, Line #179
Compares two files or buffers, prompting for type and
name, and merges the differences

***************

Done.
```

Source Compare Merge

Source Compare Merge (m-X)

Compares two files or buffers, prompting for type and name, and produces a new version that reconciles the differences between the two. You choose which version (if any) to accept. You can also manually edit one or both versions.

Comparing Files and Buffers, *cont'd.*

At each place where the sources differ, the command prompts you twice. The first time you specify what to do to resolve the difference (prompts: `Specify which version to keep:`). (For example, you can keep one or the other version, both of them, or neither.) Respond to the prompt using these subcommands:

Option	*Action*
1	Leaves the first alternative in the text, redisplays the contents, and asks for confirmation of change.
2	Leaves the second alternative in the text, redisplays the contents, and asks for confirmation of change.
*	Leaves both alternatives in the text, redisplays the contents, and asks for confirmation of change.
I	Leaves both alternatives in the text, along with the message lines from the source compare (`*** MERGE LOSSAGE ***`), but does not ask for confirmation.
SPACE	Leaves both alternatives in the text, but does not redisplay the contents or ask for confirmation.
!	Disposes of this and all remaining differences the same way, without confirmation. It asks: `What to do with remaining differences (1, 2, *, I, or RUBOUT?`
c-R	Edits. Press END to return to this question.
RUBOUT	Leaves nothing in the new buffer, does not redisplay the contents or ask for confirmation.

The second time you confirm or reject the change that was made. The screen now shows the change that was made as a result of your choice and prompts: `Please confirm the change that has been made: (SPACE, RUBOUT, or c-R)`. Confirming it keeps that change and moves on to the next difference. Rejecting it returns to the prior appearance so that you can make a different choice:

Option	*Action*
SPACE	Yes, that's right.
RUBOUT	No, take that back.
c-R	Edit. Press END to return to this question.

When you finish confirming your decisions, Zmacs incorporates all changes into the new version in the specified buffer and the minibuffer displays: `Done. Resectionizing the buffer.`

Comparing Files and Buffers, *cont'd.*

Source Compare Merge also has a mouse interface. You can answer the first question by clicking left on the text you want to keep or on the dividing line between them to keep both. You can answer the second question by clicking left for "yes" (changes confirmed) or middle for "no" (changes rejected).

Compare/Merge Commands for Definitions

The following commands operate on definitions by comparing, or comparing and merging, the current version with the newest version, newest version on disk, or installed version.

Comparing/Merging Current/Newest Versions

Source Compare Newest Definition (m-X)

Compares the current definition with the newest version in the normal source file for this definition, regardless of patch files.

Source Compare Merge Newest Definition (m-X)

Compares and merges the current definition with the newest version in the normal source file.

Comparing/Merging Current/Saved Versions

Source Compare Saved Definition (m-X)

Compares the current definition with the source for the newest version on disk.

Source Compare Merge Saved Definition (m-X)

Compares and merges the current definition with the source for the newest version on disk.

Comparing/Merging Current/Installed Versions

Source Compare Installed Definition (m-X)

Compares the current definition with the source for the installed version.

Comparing Files and Buffers, *cont'd.*

Source Compare Merge Installed Definition (m-X)

Compares the current definition with the source for the installed version, merging the results.

Window Commands

Using Two Windows, Select Bottom

`c-X 2` Two Windows

Shows two windows, selecting the bottom one. It splits the frame into two editor windows, selects the bottom one, and displays the next buffer from the global history in it. With a numeric argument, it displays that same buffer in the second window.

Using Two Windows, Select Top

`c-X 3` View Two Windows

Shows two windows, selecting the top one. It splits the frame into two editor windows, selects the top one, and displays the next buffer from the global history in it. With a numeric argument, it displays that same buffer in the second window.

Two Windows, Specify Other Contents

`c-X 4` Modified Two Windows

Selects a buffer, file, or definition in the other window. `c-X 4` combines the functions of splitting the frame and selecting contents for the second window. It prompts for the type of contents you want for the second window (`Select what in other window? (B, F, D, or J)`, for buffer, file, definition, or jump to register). Then it reads the name of the file, buffer, definition, or register that you want to select for that window.

Two Windows, Region in Top

`c-X 8` Two Windows Showing Region

Makes two windows on the same buffer, with the top one displaying the current region.

Change Window Size

`c-X ^` Grow Window

Changes the size of the current window by some number of lines. With a positive numeric argument, it expands the window; with a negative numeric argument, it shrinks the window.

Window Commands, *cont'd.*

Choose Other Window

`c-X O` Other Window

Moves the cursor to the other window.

Return to One Window

`c-X 1` One Window

Returns the editor frame to displaying only one window. It expands the current window to use the whole frame. With a numeric argument, it expands the other window to use the whole frame.

Scroll Other Window

`c-m-V` Scroll Other Window

Scrolls the other window up several lines. By default, it scrolls the same way as `c-V`. With no argument, it scrolls a full screen. With just a minus sign as an argument (`c-m- -V`), it scrolls a full screen backward. A numeric argument tells it how many lines to scroll — a positive number scrolls forward, a negative number scrolls backward.

Split Screen

Split Screen (`m-X`)

Pops up a menu that offers to create a new buffer or find a file; makes several windows split among the buffers as specified.

File Manipulation Commands

Overview

The commands described in this section are unlike most other Zmacs commands. Their main business is not manipulating buffers and their contents, but rather files out in a file system. First we discuss some commands for dealing with files, then we describe buffer and file attributes, and finally we explain *Dired Mode*, a special Zmacs mode for directory editing.

Listing Files in a Directory

List Files (`m-X`)

Prompts for the name of a directory and displays the names of all the files in that directory.

The file names are mouse-sensitive. Pointing at a file name and clicking left is just like doing a `c-X c-F` (Find File) on that file. Clicking right pops up a menu with three items:

Load — Loads the file into the Lisp world. The file must be either a Lisp source file or a compiled Lisp (*"bin"* or *"qbin"*) file.

Find — Reads the file into an editor buffer.

Compare — Compares the file with its most recent version and prints the differences.

Displaying the Contents of a Directory

`c-X c-D` Display Directory

Displays the directory of the file in the current Zmacs buffer. `c-X c-D` does not ask for a directory but lists files with the same host, device, directory, and name as the file in the current buffer. It lists files with any type and version. With a numeric argument, it prompts for a directory to list and lists that directory.

The heading of the directory listing is mouse-sensitive; clicking left on it selects a Dired buffer containing that directory listing.

`c-U c-X c-D` does the same thing as List Files, except that it gives more details about each file.

File Manipulation Commands, *cont'd.*

Viewing a File

View File is for when you just want to look at a file, not edit it.

View File (m-X)

Prompts for the name of a file and prints out the file contents for viewing only in the typeout window. If there is more than a screenful, it pauses between screenfuls displaying a --MORE-- message at the bottom.

SPACE	Displays the next screenful.
BACKSPACE	Displays the previous screenful.
RUBOUT	Exits.

Anything else exits and is executed as a command.

Viewing the Properties of a File

View File Properties (m-X)

Prompts for the name of a file and displays all the properties of the file that are maintained by the file system on which it resides. These are the properties like creation date and time, author, time of last access, and length. For files on a Lisp Machine file system, it displays user-defined properties as well.

It prompts for a file specification, which it merges with the current default to form the pathname. Wildcards are not accepted; this must correspond to a unique file or directory name.

Hardcopying a File

Hardcopy File (m-X)

Prompts for the name of a file and then prints the specified file on a hardcopy printer.

Renaming a File

Rename File (m-X)

Renames one or more files. It prompts for the name of a file and then asks for a new name for that file. It renames the specified file with that new name.

If the source file specification is wild, the target file specification must also be wild.

File Manipulation Commands, *cont'd.*

Copying a File Into Another

Copy File (m-X)

Copies any type of file to another specified file.

Prompts from the minibuffer for the names of two files and copies the contents of the first into the second. In file systems supporting multiple versions, this creates a new version of the second file whose contents are identical to those of the first.

Copy File determines whether the source file is a character file or a binary file and copies the file appropriately. Different file systems sometimes use different character sets, and if the file is a character file, character translations have to be done (for example, on some hosts Return characters have to be converted into a carriage return and a line feed).

The numeric argument controls copying of attributes and properties. With no numeric argument, it copies creation date and author and determines the mode (binary or character) of copy by the file being copied. To force mode, or suppress author or creation date copying, supply a numeric argument created by adding the values corresponding to the descriptions below:

1	Force copy in 16-bit binary mode.
2	Force copy in character (text) mode.
4	Suppress copy of author.
8	Suppress copy of creation date.

Examples

For example, to suppress author and creation date for copying:

```
c-12 Copy File (m-X)
```

Use wildcard pathnames to specify groups of files for copying. For example, to copy all files in the subdirectory `mine`:

```
F:>program>mine>*.*
```

If the source file specification is wild, the target file specification must also be wild.

File Manipulation Commands, *cont'd.*

```
you type:  m-X Copy File
   Zmacs:  Copy File from:
you type:  scrc:<lmfs>*.l*sp;0
           (Copies all the newest .LISP and .LSPs)
   Zmacs:  to:
you type:  ff:>sys-hold>scrc-sources>old-*.*.*
   Zmacs:  SCRC:<LMFS>TEST.LSP.3 is copied into
           ff:>sys-hold>scrc-sources>old-test.lisp.3

           SCRC:<LMFS>FILES.LISP.147 is copied into
           ff:>sys-hold>scrc-sources>old-files.lisp.147
```

Note that .LSP gets mapped into .lisp because Copy File uses canonical types when the type of the target pattern is **:wild**. This command can copy file authors and creation dates, when the target operating system supports setting these attributes. This action is not the default.

Creating Links to Files

Create Link (m-X)

Creates a link to a file. It prompts in the minibuffer for the names of two files as arguments; first the name of the link, then the name of the target pointed to by the link.

Deleting Files

Delete File (m-X)

Deletes a file. It prompts in the minibuffer for a file name, which can be wild. With a wild name as an argument, deletes multiple files. It lists the files that would be deleted and requires that you confirm the list. It deletes the files, showing any errors that occur but continuing rather than halting. Displays a message in the minibuffer if the specified file does not exist.

Deleting Multiple Versions

Reap File (m-X)

This command works in file systems supporting multiple versions. It prompts for the name of a file (not including version number) and deletes excess or temporary versions of the specified file, keeping the most recent *n* files. With no numeric argument, the default keeps two versions and deletes any excess. Any numeric argument specifies the number of versions to keep. It prompts for confirmation of files being deleted.

File Manipulation Commands, *cont'd.*

Clean Directory (m-X)

Deletes excess versions or temporary file types in the specified directory. The default for excess versions is more than two. It prompts for confirmation of files being deleted. With a numeric argument *n*, it deletes excess versions greater than *n*.

Excess is defined by the value of the Zmacs variable File Versions Kept or by the numeric argument. The temporary file types are defined by the Zmacs variable Temp File Type List. It accepts wildcards in the file name specification. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

Changing the Properties of a File

Change File Properties (m-X)

Edits the properties of a file. Properties are the qualities of the file that are maintained by the file system on which it resides, such as creation date and time, author, time of last access, and length. For files on a Lisp Machine file system, this means user-defined properties as well. It prompts for the name of a file and pops up a choose-variable-values window, allowing you to alter various properties of the file. The exact properties that can be varied depend on the file system, but they might include:

- Generation (version) retention count
- Author
- Creation, modification, and reference dates
- Protection flags
- Other file-associated information

Creating a Directory

Create Directory (m-X)

Creates a new directory. It prompts for a directory name, using the standard conventions for defaults. For consistency between hierarchical and nonhierarchical file systems, you specify the directory to be created as the directory component of a pathname. That is, you must end the directory name with whatever delimiter or separator is appropriate for the host.

File Manipulation Commands, *cont'd.*

Example

Host	*Directory string*	*Result*
TOPS-20	<A.B.C>	Creates directory C
Multics	>udd>Sun>Luna>z>	Creates directory z
Lisp Machine	>sun>luna>b>	Creates directory b
UNIX	/usr/jek/new/	Creates directory new

Currently, the file servers for VAX/VMS and TOPS-20 can fail to create directories, due to missing options.

Buffer and File Attributes

Attributes

Each buffer and generic pathname has *attributes*, such as Package and Base, which can also be displayed in the text of the buffer or file as an attribute list. An attribute list must be the first nonblank line of a file, and it must set off the listing of attributes on each side with the characters -*-. If this line appears in a file, the attributes it specifies are bound to the values in the attribute list when you read or load the file.

How They Work

Suppose you want your new program to be part of a package named **graphics** that contains graphics programs. In this case, you want to set the Package attribute to **graphics** in three places: the generic pathname's property list; the buffer data structure; and the buffer text. Here are two ways to make the change:

- If the package already exists in your Lisp environment, use Set Package (m-X) to set the package for the buffer. The command asks you whether or not to set the package for the file and attribute list as well. You can use this command to create a new package.
- Use Update Attribute List (m-X) to transfer the current buffer attributes to the file and create a text attribute list. Edit the attribute list, changing the package. Use Reparse Attribute List (m-X) to transfer the attributes in the attribute list to the file and the buffer data structure. If the package you specify by editing the attribute list does not exist in your Lisp environment, Reparse Attribute List asks you whether or not to create it with default characteristics.

Attribute-Manipulating Commands

Update Attribute List (m-X)

Updates the attribute list (-*- line) of the buffer. It creates or updates the attribute list of the file, using the current set of parameters. A new attribute list inherits the Package, Mode, Backspace, and Fonts attributes of the current buffer. It includes the Backspace and Fonts attributes in the line only if they have values other than the defaults. It does not change other attributes in an existing mode line.

Reparse Attribute List (m-X)

Reparses the attribute list (-*- line) of the buffer. It finds the attribute list for the buffer and processes it to set up the

Buffer and File Attributes, *cont'd.*

environment that the line specifies. It changes the major mode, package, base, and so on, as necessary. When you edit the attribute list, you should then use this command to make the changes take effect in Zmacs. The changes take effect both for the editor buffer and for the file that the buffer is editing.

Example

Suppose the package for the current buffer is **user** and the base is 8. You want to create a package called **graphics** for the buffer and associated file. You also want to set the base to 10. If no attribute list exists, use Update Attribute List (m-X) to create one using the attributes of the current buffer. An attribute list appears as the first line of the buffer:

```
;;; -*- Mode: LISP; Package: USER; Base: 8 -*-
```

Now edit the buffer attribute list to change the package name from USER to GRAPHICS and to change the base from 8 to 10. Use Reparse Attribute List (m-X). The command queries:

```
The file belongs in package GRAPHICS, which does not exist.
Create it with default characteristics,
 Try again, or Use another package? (C, T, or U)
```

Answer C to create the new package. The package becomes **graphics** and the base 10 for the buffer and the file.

File Attribute Checking

Zmacs notes errors in file attribute lists and warns you when it finds an unknown attribute. It goes ahead and ignores the unknown attribute in the list. The purpose of the warning is simply to help you detect misspellings.

Setting the Package

Set Package (m-X)

Changes the package associated with the buffer. It prompts for a new package, offering to create the package if necessary. Forms that are read from the buffer are read in that package. (The default value for this attribute is **user**.)

You can have any package as the default package by specifying it as the value of the Zmacs variable Default Package. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193). You can set the variable in your lispm-init.l file (see "Creating an Init File", page 196) by using the internal form of its name.

Buffer and File Attributes, *cont'd.*

For example, in your init file:

```
(login-forms
        (setq zwei:*default-package* (pkg-find-package "tv")))
```

If you set the variable to **nil**, it sets the default to the package from the previous buffer.

Information about the package attribute exists in four places. Set Package offers to set the package for the generic pathname attribute list and updates the attribute line in the buffer when you answer Yes to:

```
Set it for the file and attribute list too?
```

Your answer affects the various versions of the package attribute as follows:

Location	*"Y"*	*"N"*
Generic pathname	changes	same
Buffer property	changes	changes
Buffer text	changes	same
Current package	changes	changes

The system is informed that the file belongs to the specified package. If you are not sure what to answer, say Yes. The global variable **zwei:*set-attribute-updates-list*** controls this query. Its default value is **:ask**. Setting the variable to **t** means Yes; **nil** means No.

Other Set commands for File and Buffer Attributes

Each of the file attributes has a Set command associated with it. You have two choices when you want to change an attribute for a file:

- Edit the text of the buffer and then use Reparse Attribute List.

- Use the relevant Set command and answer `Y` to its query. The meanings for `Y` and `N` are the same as for the Set Package command (except that only the Set Package command affects the current package).

Buffer and File Attributes, *cont'd.*

Update Attribute List Query

The Set commands use the value of the global variable **zwei:*set-attribute-updates-list*** to determine whether to query you about updating the file attribute list. The default value for the variable is **:ask**; set to **nil** to suppress the query.

Value	*Meaning*
:ask	Always asks whether to update the attribute list.
nil	Never updates the attribute list.
t	Always updates the attribute list.

Set *attribute* (m-X)

where *attribute* is one of the following: Backspace, Base, Fonts, Lowercase, Nofill, Package, Patch File, Tab Width, or Vsp. It sets *attribute* for the current buffer. It queries whether or not to set *attribute* for the file and in the text attribute list.

Attribute Descriptions

The following table describes some of the attributes, their associated Set commands, and the default value for the attribute.

Backspace — The Set Backspace command (default value **nil**) controls whether a backspace character in a file displays as the word "back-space" ("overstrike" on an LM-2) with a lozenge around it or performs the backspace. The default is the lozenge form.

Base — The Set Base command (default value 8) specifies the value of **ibase** that the Lisp reader uses when reading forms from the file. Thus, Base controls the **ibase** used when you evaluate or compile parts of the buffer, *and* controls the value of **base** for printing during evaluating all or part of the buffer. This value does not affect the values of either **base** or **ibase** in the Lisp Listener you get by using SUSPEND (BREAK on an LM-2).

Fonts — The Set Fonts command (default value **nil**) changes the set of fonts to use. It reads a sequence of fonts names separated by spaces from the minibuffer.

Buffer and File Attributes, *cont'd.*

Lowercase

The Set Lowercase command (default value **nil**) means that the file being edited is intended to contain lowercase code or text. When the Lowercase attribute is **nil** (that is, not present), whatever you want in the way of case handling prevails. People who want automatic uppercase code would use the following in their lispm-init file (see also "Creating An Init File", page 196):

```
(login-forms
  (setq zwei:lisp-mode-hook
   'zwei:electric-shift-lock-if-appropriate))
```

When the Lowercase attribute is anything but **nil** (you answer `Y` to its query), the Electric Shift Lock Mode is never turned on automatically.

Nofill

The Set Nofill command has a default value of **nil**, which means that whatever you want in the way of autofilling behavior prevails. When Nofill is anything else (you answer `Y` to its query), it means that autofilling is not appropriate for people who specify the mode of "autofilling if appropriate".

Use Nofill sparingly. Setting it means that everyone who edits the file has to be satisfied with Auto Fill Mode being off by default. In most cases, it is more reasonable to let an individual user's preferences prevail. It is useful for files that are not plain text, such as mailing lists, where you need to avoid spurious line breaks.

People who want to have autofilling turned on by default should use the following in their lispm-init file (see also "Creating An Init File", page 196):

```
(login-forms
  (setq zwei:text-mode-hook
   'zwei:auto-fill-if-appropriate))
```

People who do not want it never get it by default.

Buffer and File Attributes, *cont'd.*

Patch-File

The Set Patch File command has a default value of **nil,** which means that the file does not contain patches. When a file is classified as containing patches (you answer Y to its query), **fdefine** does not warn about functions being redefined during loading. Classifying something as a patch file also affects Edit Definition (which prefers files that are not patches) and **defvar** (which becomes **setq**).

Tab-Width

The Set Tab Width command (default 8 characters) specifies how many spaces the editor uses between "tab stops".

Vsp

The Set Vsp command (default 2 pixels) specifies the vertical spacing (in pixels) between the text lines of an editor window. It specifies the distance between the descenders of one line and the ascenders of the next.

Dired Mode

Overview

There is a special Zmacs mode, called *Dired*, just for doing housekeeping in a directory. In this mode, you see the names of all the files in a directory at once, and can manipulate these files in various ways.

Entering Dired

The following commands specify a directory to manipulate and enter Dired mode.

Dired (m-X)

Prompts for a wildcard file specification for files contained in the specified directory. The default edits all files in the current directory by specifying wild name, type, and version. You must type the pathname in the form acceptable to your host system.

c-X D Dired

Edits the files in the directory that contains the current file.

With a numeric argument of 1, shows files with the same host, device, directory, and name as the file in the current buffer. It lists files with any type and version.

With a c-U argument, it prompts for a wildcard file specification showing the name of a directory to edit.

The Dired Display

When you go into Dired mode, Zmacs creates a special buffer that contains the names of the files that are under consideration, as well as some auxiliary information pertaining to those files. In a typical Dired buffer, each line describes a single file and lists the following information, from left to right:

- An indicator (D) that shows if the file has been marked for deletion or is already deleted
- The physical volume of the file (on some hosts)
- The name of the file
- The length of the file in blocks (where the length of a block is system-dependent)
- The length of the file in bytes, followed by the byte length in bits, enclosed in parentheses
- ! if the file has not been backed up to tape
- $ if the file has been marked against reaping
- @ if the file has been marked against deletion
- The file's creation date

Dired Mode, *cont'd.*

- The file's creation time
- The date the file was last referenced, enclosed in parentheses
- The author of the file
- Optionally, the name of the last user to read the file

If there are too many files to be displayed in one screenful, the Zmacs window looks only at one section of the directory at a time (although the buffer does contain the names of all the files).

The files are arranged in alphabetical order by name.

Updating the Display

Use the Revert Buffer (M-X) command (described on page 109) to update a Dired display. After using Dired commands (or native host commands) to perform operations on files in your directory, invoke Revert Buffer, which reexecutes Dired with the default directory name and rereads the updated directory into the buffer.

Dired Commands

Dired mode has its own command table (comtab) for manipulating the files whose names are displayed. These commands are described in this section. All invocations given in this section are with respect to the Dired comtab and do not apply to regular Zmacs.

You use Dired by moving the cursor around to various lines and then specifying operations to be performed on the file listed on that line (the *current file*, while in Dired Mode).

Most Dired commands schedule some action for the future rather than performing it instantly. For example, when you want to delete a file using Dired, you move the cursor to the line describing that file and type D. Rather than deleting the file immediately, Dired *marks the file for deletion*. The deletion actually happens when you leave Dired mode and confirm your request (see "Getting Out of Dired", page 134).

Some of the commands in Dired mode take numeric arguments. You type numeric arguments in exactly the same way as you do in Zmacs proper, except that you do not have to hold the CONTROL key down while typing the argument — just typing the number suffices.

Dired Mode, *cont'd.*

Command Summary

The following table summarizes the Dired commands:

Character	*Action*
RUBOUT	Undeletes file above the cursor.
SPACE	Moves to the next file.
!	Moves to the next file that is not backed up.
$	Complements the Don't Reap ($) flag.
,	Describes the attribute list of this file. In text files, this is the -*- line of the file. In compiled Lisp files, it includes information about the compilation as well.
.	Changes properties of current file.
@	Complements the Don't Delete (@) flag.
=	Compares this file with the newest version (Source Compare).
A	Queues this file for function application.
C	Copies this file to someplace else.
D	Marks the file for deletion (K, c-D, c-K are synonyms).
E	Edits the file in a buffer, or runs Dired if the line is a subdirectory name.
G	Sets and enforces the generation retention count.
*n*H	Marks excess versions of the file for deletion (argument means whole directory).
L	Loads the file into Lisp.
*n*N	Moves to the next file with more than *n* versions (see the Zmacs variable File Versions Kept). (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

Dired Mode, *cont'd.*

P	Prints the file on the standard hardcopy device.
Q	Exits. It shows the files marked for deletion and prompts for confirmation. The exit display marks files that have special status, using the following marks: : a link > most recent version $ file marked for not reaping ! file not backed up
R	Renames this file to something else.
U	Undeletes either the file on the current line or the file on the line above.
V	Views the file without creating a buffer (using View File conventions).
X	Executes an extended command (same as m-X).

Default Pathnames in Dired

When the current buffer is a Dired buffer, and you execute an editor command that accepts a file name as an argument, the default file name is the file name that appears on the line of the Dired buffer that point is on.

It makes it easier to do things to the file that you are currently operating on in Dired. For example, you can move point to some line, and then do Compile File (m-X), and it will default to that file name.

Getting Out of Dired

Q Dired Exit
END

Leaves Dired mode. It prints the names of files marked for various actions and gets your final confirmation that these actions are really to be performed.

At this point the available options are:

Y	Delete but do not expunge, also doing any other marked actions.
N	Go back to Dired.
Q	Abort out of Dired (X also works).

Dired Mode, *cont'd.*

`E` Delete files and expunge directory. This is meaningful for file systems in which there is undeletion, such as TOPS-20, TENEX, and the Lisp Machine file system. This command is useful if you use Dired to free up disk space, since the disk space is not deallocated until the directory is expunged.

Dired Exit performs those actions and returns to the previous buffer.

`ABORT` Dired Abort

Leaves Dired mode at once, without performing any actions on marked files. You can also just switch to another buffer.

Online Documentation for Dired

If you do not have a manual and cannot remember what the commands do, just press HELP.

`?` Dired Help
`HELP`

Displays a short table explaining the Dired commands.

Dired Menu

Click right in Dired to display the Dired menu, which offers to perform the following actions on the listing:

```
Sort by reference date (up)
Sort by reference date (down)
Sort by creation date (up)
Sort by creation date (down)
Sort by file name (up)
Sort by file name (down)
Sort by file size (up)
Sort by file size (down)
Dired Automatic
Dired Automatic All
Dired Change File Properties
Dired Describe Attribute List
```

Dired Automatic (which includes Dired Automatic All), Dired Change File Properties, and Dired Describe Attribute List are described later in this section.

Dired Mode, *cont'd.*

Moving Around in Dired

SPACE Down Real Line
c-N

Moves point to the next line (same as in regular Zmacs). With a numeric argument of *n*, it moves point forward *n* lines.

c-P Up Real Line

Moves point to the previous line (same as in regular Zmacs). With a numeric argument of *n*, it moves point backward *n* lines.

Viewing File Attributes in Dired

, Dired Describe Attribute List

This command is also available on the pop-up menu that you get when you click right in Dired. It prints out the contents of the attribute list of the current file (the one where point is). It works for character files and compiled files. It does not work for LM-2 compiled files when running on a 3600 or 3600 compiled files when running on an LM-2.

Changing File Properties in Dired

. Dired Change File Properties

This command is also available on the pop-up menu that you get when you click right in Dired. It edits the properties of the current file. These properties are the qualities of the file that are maintained by the file system on which it resides, such as creation date and time, author, time of last access, and length. For files on a Lisp Machine file system, this means user-defined properties as well. It pops up a choose-variable-values window, allowing you to alter various properties of the file. The exact properties that can be varied depend on the file system, but they might include:

- Generation (version) retention count
- Author
- Creation, modification, and reference dates
- Protection flags
- Other file-associated information

Dired Mode, *cont'd.*

Viewing and Editing File Contents in Dired

You might want to look at the contents of a file before deciding what to do with it. You might also want to read the file into a buffer and edit it. The following commands provide that capability:

V — Dired View File

Displays the contents of the current file on the typeout window.

Use this command when you just want to skim the contents of the file, not edit it. You can move forward while viewing with SPACE and move backward with BACKSPACE.

E — Dired Edit File

Reads the current file into a Zmacs buffer and selects that buffer. You are then back in normal Zmacs and can edit the file normally. When you want to return to Dired mode, just use the c-m-L command to reselect the Dired buffer.

Comparing Recent Versions of Files

Often before deciding whether or not to delete a file, you want to find out exactly how extensive the differences are between the file and its most current version. Use the following command:

= — Dired Srccom

Compares the current file with its most recent version and displays the differences on the typeout window. With an argument of c-U, it asks what version to compare it to.

Copying and Renaming Files

C — Dired Copy File

Copies the current file. It prompts for the new pathname, displaying the default pathname.

R — Dired Rename File

Renames the current file. It prompts for the new pathname, displaying the default pathname.

Dired Mode, *cont'd.*

Marking Files for Deletion

D Dired Delete
K
c-D
c-K

Marks the current file for deletion. Dired puts a D in the first column to show that the file has been so marked.

With a numeric argument of *n*, it marks the next *n* files for deletion.

Sometimes you mark a file for deletion by mistake. Here is how you recover from this error:

U Dired Undelete

U takes one of two actions:

1. If the current file is marked for deletion, printing, or a function application (with a D, P, or A), reprieves it.
2. In file systems with soft deletion, U marks a deleted file for undeletion.

In either case, U removes the D, P, or A next to the file. If the current file is not marked with D, P, or A, U reprieves the file on the immediately preceding line, positioning point on that line.

With a numeric argument of *n*, it reprieves the files on the next *n* lines including the current line.

RUBOUT Dired Reverse Undelete

Reprieves the file on the preceding line.

With a numeric argument of *n*, it reprieves the files on the previous *n* lines including the current line.

Deleting Multiple Versions

If you are using Dired for housekeeping purposes, the following commands are useful:

N Dired Next Hog

Moves point to the next file with superfluous versions. Superfluous is defined by the value of the Zmacs variable File Versions Kept (whose default is 2) or by a numeric argument. (Zmacs variables are described in "How to Specify Zmacs Variable Settings", page 193).

Dired Mode, *cont'd.*

H Dired Automatic

This command is also available on the pop-up menu that you get when you click right in Dired. It marks all the superfluous versions of the current file for deletion. With an argument of c-U, it marks superfluous versions of all files in the Dired buffer.

Setting Generation Retention Count

G Dired Set Generation Retention Count

Sets and enforces the generation retention count on this group of files, which specifies how many versions to save (that is, deletes multiple versions).

With a numeric argument *n*, sets it to *n* versions. With no numeric argument, prompts for a number in the minibuffer. An argument of zero means save all versions. *Enforce* means mark for deletion or undeletion.

Protecting Files From Being Reaped

In addition to keeping other users aware of protected files, protection features can also inform the system itself. Some file systems have automatic reaping facilities that go into action when storage becomes scarce. Most such systems have a *don't reap* bit associated with each file; use it to protect only your most vital files.

$ Dired Complement No Reap Flag

Complements the Don't Reap flag associated with the current file; Dired displays the flag as $ between the length and date on that line. With a numeric argument of *n*, it complements the flag on the next *n* files, including the current one.

Dired Mode, *cont'd.*

Protecting Files From Being Deleted

@ Dired Complement Dont Delete Flag

Complements the Don't Delete flag associated with the current file; Dired displays the flag as @ between the length and date on that line.

With a numeric argument of *n*, it complements the flag on the next *n* files, including the current one.

Finding Files That Have Not Been Backed Up

Many file systems have tape backup facilities so that files can be copied onto tape against the possibility of a file system disaster. These systems almost always associate a bit with each file that is set when the file is created or modified and cleared when it is backed up to tape.

! Dired Next Undumped

Moves point forward to the next file that has not yet been backed up; Dired displays the flag as ! between the length and date on that line.

Marking Files to be Hardcopied

You may want to obtain a hardcopy of a group of related files. Dired allows you to mark files to be hardcopied as well as to be deleted.

P Dired Hardcopy File

Marks the current file for printing. Dired puts a P in the first column to show that the file has been so marked.

With a numeric argument *n*, marks the next *n* files for printing.

Dired Mode, *cont'd.*

Applying Arbitrary Functions to Files

Very occasionally, you want to perform some operation on selected files in your directory for which there is no Dired command provided. When this occurs, you can write up the operation that you want to perform as a Lisp function, whose single argument is the pathname of the file. The following command is relevant:

A Dired Apply Function

Marks the current file for having an arbitrary function applied to it. Dired puts a A in the first column to show that the file has been so marked. With a numeric argument of *n*, it marks the next *n* files, including the current one.

Setting the Major Mode

Major Editing Modes

Overview

Whenever you are editing some text, some set of modes is in effect. The buffer is always associated with one major mode that tells the editor what kind of document is being edited. A major mode has the following characteristics:

- It has its own distinct set of key bindings.
- It affects groups of related language-specific items, such as delimiter characters and indentation rules.

The major modes are listed below. You can establish the mode:

- By turning it on using the prefix `m-X` followed by the name of the mode. For example, to invoke Lisp Mode, type: `m-X Lisp Mode`.
- By setting it in the attribute list (see the section "Buffer and File Attributes", page 125)
- By having Zmacs do it for you when you read a file with `c-X c-F`. It recognizes the type component of the pathname of the file (for example, folon.lisp) and puts the buffer in the corresponding mode.

Fundamental Mode

Fundamental Mode enters Zwei's fundamental mode (the default mode).

Lisp Mode

Lisp Mode sets things up for editing Lisp code. It puts Indent-For-Lisp on `TAB`.

Text Mode

Sets things up for editing English text. It puts Tab-To-Tab-Stop on `TAB`.

Note

Zmacs supports Fortran Mode as a part of FORTRAN '77, the separately priced software product. For more information, see the *User's Guide to the FORTRAN '77 Tool Kit.*

Macsyma Mode

Macsyma Mode enters a mode for editing Macsyma code. It modifies the delimiter dispatch tables appropriately for Macsyma syntax, makes comment delimiters /* and */. It puts Indent-Relative on `TAB`.

Major Editing Modes

Midas Mode

Midas Mode sets things up for editing PDP-10 assembly language code.

Bolio Mode

Bolio Mode sets things up for editing Bolio source files. It is like Text Mode, but also makes c-m-*N*, c-m-:, and c-m-* insert font characters, and makes word-abbrevs for znil and zt.

Teco Mode

Teco Mode sets things up for editing TECO. It makes comment delimiters be !* and *!. It puts Indent-Nested on TAB, Forward-Teco-Conditional on m-', and Backward-Teco-Conditional on m-".

Pll Mode

Pll Mode sets things up for editing PL/1 programs. It makes comment delimiters /* and */, and puts Indent-For-Pll on TAB, Roll-Back-Pll-Indentation on c-m-H, and Plldcl on c-≡. Underscore is made alphabetic for word commands.

Electric Pll Mode

Electric Pll Mode sets things up for editing PL/1 programs. It does everything Pll Mode does: it makes comment delimiters /* and */, puts Indent-for-Pll on TAB, Roll-Back-Pll-Indentation on c-m-H, , and Plldcl on c-≡. Underscore is made alphabetic for word commands. In addition, ; is Pll-Electric-Semicolon, : is Pll-Electric-Colon, # is Rubout, @ is Clear, \ is Quoted Insert.

Changing Case and Indentation

Changing Case

Overview

Zmacs offers extended commands that convert the case of the code for words, regions, and buffers.

Changing Case of Words

m-C Uppercase Initial

Puts next word in lowercase, but capitalizes initial character. With an argument, it capitalizes that many words.

m-L Lowercase Word

Puts next word in lowercase. With an argument, it puts that many words in lowercase.

m-U Uppercase Word

Puts next word in uppercase. With an argument, it puts that many words in uppercase.

Changing Case of Regions

c-X c-U Uppercase Region

Uppercases the region.

c-X c-L Lowercase Region

Lowercases the region.

Uppercase Code in Region (m-X)

Converts all code (not comments, strings, or quoted characters) to uppercase. This gives the same effect as retyping that text while in Electric Shift Lock Mode. It operates on the region if there is one, otherwise it operates on the current definition.

Lowercase Code in Region (m-X)

Converts all code (not comments, strings, or quoted characters) to lowercase. It operates on the region if there is one, otherwise it operates on the current definition.

Changing Case, *cont'd.*

Changing Case of Buffers

Uppercase Code in Buffer (m-X)

Converts all code (not comments, strings, or quoted characters) to uppercase. This gives the same effect as retyping that text while in Electric Shift Lock Mode. It queries for a buffer name (the default is the current buffer) and operates on that buffer.

Lowercase Code in Buffer (m-X)

Converts all code (not comments, strings, or quoted characters) to lowercase. It queries for a buffer name (the default is the current buffer) and operates on that buffer.

Indentation

Overview

Proper indentation helps make complicated Lisp programs readable. Indentation should reflect the structure of a program. An expression should be indented so that its subforms are easily identifiable, and so that a function can be related to its arguments by eye, without counting parentheses.

The indentation commands work in any Zmacs major mode; the TAB key indents differently depending on the mode. When you give an indent command an argument of *n*, *n* equals the number of Space characters in the default font.

Indenting Current Line

TAB

In Lisp mode, the TAB key indents the current line of Lisp code correctly with respect to the line above it. (In most other modes, TAB inserts a Tab character.) Point remains fixed with respect to the code.

With a numeric argument *n*, it indents the next *n* lines including the current one, and leaves point at the *n*+1st line.

c-TAB Indent Differently

Tries to indent this line differently. If called repeatedly, it makes multiple attempts.

m-TAB Insert Tab

Inserts a Tab character, even in Lisp Mode, in the buffer at point.

c-m-TAB Indent For Lisp

Indents this line to make ground (indented) LISP code, even in a mode other than Lisp mode. Numeric argument specifies number of lines to indent.

Centering the Current Line

m-S Center Line

Centers the text of the current line within the line. With an argument *n*, it centers *n* lines and moves past them.

Indentation, *cont'd.*

Indenting New Line

The keystroke combination RETURN TAB gets you into the right position to start typing the next line of code. LINE is the abbreviation for that combination.

LINE Indent New Line

If the next two lines are blank, goes to the next line; otherwise, it creates a new blank line following the current one. In any case, it does a TAB on that blank line.

Reindenting Expression

c-m-Q Indent Sexp

Corrects the indentation of the expression following point by adjusting the amount of space before each line in the expression. c-m-Q positions point in front of the incorrectly indented expression. This does not affect the indentation of the current line, but only fixes the indentation of following lines with respect to the current line. Use after modifying an expression.

With a numeric argument of *n*, it fixes the indentation of the next *n* expressions.

Indenting Region

c-m-\ Indent Region

Indents each line in the region. With no argument, it calls the current Tab command to indent. With an argument of *n*, it indents each line *n* spaces in the current font.

Going Back to First Indented Character

m-M Back To Indentation
c-m-M
m-RETURN
c-m-RETURN

Positions point before the first nonblank character on the current line.

Indentation, *cont'd.*

Indenting Region Uniformly

`c-X TAB` Indent Rigidly
`c-X c-I`

Shifts text in the region sideways as a unit. All lines in the region have their indentation increased by the numeric argument of the command (the argument can be negative).

Aligning Indentation

Indent Under (`c-m-X`)

Indents to align under *string*, which is read from the minibuffer. It searches back, line by line, forward in each line, for a string that matches the one read and that is farther to the right than the cursor already is. It indents to align with the string found, removing any previous indentation first.

Deleting Indentation

`m-^` Delete Indentation
`c-m-^`

Deletes the newline character and any indentation at the beginning of the current line. It tacks the current line onto the end of the previous line, leaving one space between them when appropriate, for example, at the beginning of a sentence.

With any numeric argument, it moves down a line first, thus killing the end of the current line.

New Line with This Indentation

`m-O` This Indentation

Makes a new line after the current one, deducing the new line's indentation from point's position on the current line. If point is to the left of the first nonblank character on the current line, it indents the new line exactly like the current one. But if point is to the right of the first nonblank character, it indents the new line to the current position of point. Regardless, it leaves point at the end of the newly created line.

With a numeric argument, the new line is always indented like the current one, no matter where point is. With an argument of zero, it indents current line to point.

Indentation, *cont'd.*

Moving Rest of Line Down

`c-m-O` Split Line

Moves rest of current line down one line. It inserts a carriage return and indents new line directly beneath point. With a numeric argument *n*, it moves down *n* lines.

Inserting Blank Line

`c-O` Make Room

Inserts a blank line after point. With a numeric argument *n*, it inserts *n* blank lines.

Deleting Blank Line

`c-X c-O` Delete Blank Lines

Deletes any blank lines around the end of the current line.

Editing Lisp Programs

Introduction

Lisp Machine programmers develop programs in repeated cycles, each a sequence of editing, compiling, testing, and debugging. These cycles are often nested. Zmacs allows you to edit and test large programs dynamically, without frequent file system operations. This manual does not describe any style of interacting with the environment in developing Lisp programs. However, the *Programming Development Tools and Techniques* manual shows just that: It focuses on the interaction between programmers and the Lisp Machine, presenting ways of using helpful Lisp Machine features and tools during each stage of program development.

As a programmer on a Lisp Machine you typically read a file containing Lisp code into an editor buffer, make modifications, test the results, make more changes, and so on, until satisfied with the behavior of the program. Only then do you need to write the buffer back out to the file system. The debugging loop is much tighter and more responsive than in traditional programming environments. You can even evaluate Lisp forms directly from inside the editor, without returning to a Lisp Listener. Alternatively, you can divide the screen into a Lisp Listener window and a Zmacs window, so that you can direct your attention to either without changing the display.

Zmacs provides extensive features for locating source code of specified functions. If an error occurs, the Debugger can cause Zmacs to read in the source of the function that got the error. You can then debug and recompile the function. Similar features complement the message-passing capabilities of the Zetalisp language.

When you edit a file whose file type is "lisp", Zmacs puts that buffer into Lisp mode. A command exists for explicitly placing a buffer in Lisp mode:

Lisp Mode (M-X) Lisp Mode

Places the current buffer into Lisp mode.

Commenting Code

Overview

Zmacs differentiates between the different comment indicators for different major modes. Comments in Lisp begin with a semicolon. The Lisp reader ignores everything between a (significant) semicolon and the next newline. By convention, there are three kinds of comments, beginning with one, two, and three semicolons:

- Comments beginning with a single semicolon are placed to the right of a line of code, start in a preset column (the *comment column*), and describe what is going on in that line.
- A comment with two semicolons is a long comment about code within a Lisp expression and has the same indentation as the code to which it refers. It describes the function of a group of lines.
- A comment headed by three semicolons is normally placed against the left margin, and describes a large piece of code like a function or group of functions.

This section outlines Lisp commenting conventions and explains Zmacs commands for manipulating comments.

Indenting for Comment

`c-;` Indent For Comment
`m-;`

If the current line has no comment, moves point out to the comment column (inserting spaces to get there, if necessary) and starts a comment by inserting a semicolon there. If the current line already has a comment, it indents it correctly and leaves point at the beginning of it. Zmacs positions the various kinds of comments appropriately. If a comment begins at the left margin, it leaves it there.

With a numeric argument *n*, it realigns any comments on the next *n* lines, including the current line, but does not create any new comments.

In case a comment cannot be positioned at the comment column because the associated line of code is too long, comments are moved to the right until they are clearly separated from the code.

Killing a Comment

`c-m-;` Kill Comment

If the current line has a comment, deletes it.

Commenting Code, *cont'd.*

Moving Down to Comment on Next Line

`m-N` Down Comment Line

Moves point to the beginning of the comment on the next line. If there is no comment on the next line, it creates one. If the comment on the current line is empty, it deletes it before going to the next line.

With a numeric argument *n*, it moves point to the beginning of the comment on the *n*th line after the current one.

Moving Up to Comment on Previous Line

`m-P` Up Comment Line

Moves point to the beginning of the comment on the previous line. If there is no comment on the previous line, it creates one. If the comment on the current line is empty, deletes it before going on to the previous line.

With a numeric argument *n*, it moves point to the beginning of the comment on the *n*th line before the current one.

Setting the Comment Column

`c-X ;` Set Comment Column

Sets the comment column to be the current horizontal position of the cursor.

With a numeric argument, it finds the nearest comment above the current line, sets the comment column to line up with that comment, and actually puts a comment on the current line at that column.

Creating a New Indented Comment Line

`m-LINE` Indent New Comment Line

Makes a new blank line after the current line and starts a new comment there, indented properly. If there was already a comment on the current line, the comment on the new line is of the same kind. That is, it has the same number of semicolons and is

Commenting Code, *cont'd.*

indented the same. If there was no comment on the starting line, m-LINE starts a new line, indenting the new line as appropriate for the major mode.

Commenting Regions

c-X c-; Comment Out Region

Comments out each of the lines in the region. When the region ends at the beginning of a line, it does not comment out that line. If any part of the line is part of the region, then it does comment out that line.

A numeric argument activates lines in the region that have been commented out. When any part of the line is part of the region, it removes commenting from around that line. This assumes that any comment starting in column 1 is fair game. It stops when it encounters a line that does not begin the way a comment would, even if more lines that have been commented out remain in the region. It does keep the remainder of the region in this case, so that you can resume.

Uncomment Region (m-X)

Removes all comments from lines whose beginnings are contained in the region.

Evaluation and Compilation

Overview

The commands in this section form a link between the Zmacs editor and the Lisp language. They allow the evaluation and compilation of code from Zmacs buffers. These commands are an important part of the debugging loop.

When a Lisp form is being compiled or evaluated, the editor displays a message that classifies what is being compiled.

It classifies macros as functions (because these go in the function cell of a symbol). For example:

```
Compiling Function SUN
Evaluating Variable MARS
Compiling Flavor STAR
```

Evaluation

m-ESCAPE Evaluate Minibuffer

Evaluates expressions from the minibuffer. You enter Lisp expressions in the minibuffer, which are evaluated when you press END. The value of the expression itself appears in the echo area. If the expression displays any output, that appears as a typeout window.

Evaluate Into Buffer (m-X)

Evaluates an expression read from the minibuffer and inserts the result into the buffer. You enter a Lisp expression in the minibuffer, which is evaluated when you press END. The result of evaluating the expression appears in the buffer before point. With a numeric argument, it also inserts any typeout that occurs during the evaluation into the buffer.

Evaluate Buffer (m-X)

Evaluates the entire buffer. The result of evaluating the buffer appears in the minibuffer. With a numeric argument, it evaluates from point to the end of the buffer.

Evaluate Region (m-X)
c-sh-E

Evaluates the region. When no region has been defined, it evaluates the current definition. It shows the results in the echo area.

Evaluation and Compilation, *cont'd.*

c-m-sh-E Evaluate Region Verbose

Evaluates the region. When no region has been defined, it evaluates the current definition. It shows the results in a typeout window.

Evaluate Region Hack (m-X)

Evaluates the region, ensuring that any Lisp variables appearing in a **defvar** have their values set. When no region has been defined, it evaluates the current definition. It shows the results in the echo area.

Evaluate Changed Definitions (m-X)

Evaluates any definitions that have changed in any of the current buffers. With a numeric argument, it prompts individually about whether to evaluate particular changed definitions (the default evaluates all changed definitions).

Evaluate Changed Definitions of Buffer (m-X)
m-sh-E

Evaluates any definitions that have changed in the current buffer. With a numeric argument, it prompts individually about whether to evaluate particular changed definitions (the default evaluates all changed definitions).

Evaluate And Replace Into Buffer (m-X)

Evaluates the Lisp object following point in the buffer and replaces it with its result.

c-m-Z Evaluate And Exit

Evaluates the buffer and exits Zmacs. It selects the window from which the last **ed** function or the last debugger c-E command was executed.

Evaluation and Compilation, *cont'd.*

Compilation

Compile Buffer (m-X)

Compiles the entire buffer. With a numeric argument, it compiles from point to the end of the buffer. (This is useful for resuming compilation after a prior Compile Buffer has failed.)

Compile Changed Definitions (m-X)

Compiles any definitions that have changed in any of the current buffers. With a numeric argument, it prompts individually about whether to compile particular changed definitions (the default compiles all changed definitions).

Compile Changed Definitions of Buffer (m-X)
m-sh-C

Compiles any definitions that have changed in the current buffer. With a numeric argument, it prompts individually about whether to compile particular changed definitions (the default compiles all changed definitions).

Compile File (m-X)

Compiles a file, offering to save it first (if it has an associated buffer that has been modified). It prompts for a file name in the minibuffer, using the file associated with the current buffer as the default.

Load File (m-X)

Loads a file, possibly saving and compiling it first. It prompts for a file name, taking the default from the current buffer.

m-Z Compile And Exit

Compiles the buffer and exits Zmacs. It selects the window from which the last **(ed)** function or the last debugger c-E command was executed.

Evaluation and Compilation, *cont'd.*

Compiler Warnings

Compiler warnings are kept in an internal database that you can inspect and manipulate in various ways with several editor commands.

Compiler Warnings (m-X)

Creates the compiler warnings buffer (called `*Compiler-Warnings-1*`) if it doesn't exist, puts all outstanding compiler warnings in that buffer, and switches to that buffer. You can peruse the compiler warnings by scrolling around and doing text searches through them (see Edit Compiler Warnings).

Edit Compiler Warnings (m-X)

Prompts you with the name of each file mentioned in the database, allowing you to edit the warnings for that file. It then splits the Zmacs frame into two windows: the upper window displays a warning message and the lower one displays the source code whose compilation caused the warning. After you have finished editing each function, c-. gets you to the next warning: the top window scrolls to show the next warning and the bottom window displays the function associated with this warning. Successive c-.s take you through all of the warning messages for all of the files you specified. When you are done, the last c-. puts the frame back into its previous configuration.

Edit File Warnings (m-X)

Asks you for the name of the file whose warnings you want to edit. You can give either the source file or the compiled file. Only warnings for this file are edited. If the database does not have any entries for the file you specify, the command prompts you for the name of a file that contains the warnings, in case you know that the warnings are stored in another file.

Load Compiler Warnings (m-X)

Loads a file containing compiler warning messages into the warnings database. It prompts for the name of a file that contains the printed representation of compiler warnings. It always replaces any warnings already in the database.

Parenthesizing Expressions

`m-(` **Make ()**

Inserts matching parentheses, leaving point between them. With a numeric argument *n*, it encloses the next *n* Lisp expressions in parentheses. When the number of expressions requested cannot be satisfied, it beeps and does nothing. With point on the open parenthesis of a defun, an argument of 1 encloses the whole defun within a new set of parentheses. Any argument larger than 1 would have no effect. In text mode, a word or a phrase within parentheses is treated as a Lisp form.

See also the description of the command `m-)`, in "Motion Among Top-Level Expressions", page 55.

Expanding Expressions

The following editor commands allow you to expand macros.

`c-sh-M` Macro Expand Expression

Reads the Lisp expression following point and expands the form itself but not any of the subforms within it. It displays the result in the typeout window. With a numeric argument, it pretty-prints the result back into the buffer immediately after the expression.

Macro Expand Expression All (`m-X`)

Reads the Lisp expression following point, and expands all macros within it at all levels. It displays the result in the typeout window. With a numeric argument, it pretty-prints the result back into the buffer immediately after the expression. It assumes that every list in the expression is a form; so if car of a list is a symbol with a macro definition, the purported macro invocation is expanded. (Some sublists are not intended to be Lisp forms, and attempts to macro-expand them are incorrect and may not work.)

Locating Source Code to Edit

Introduction

The functions that make up a program or system can depend on each other in complicated ways. When you are editing one function, you sometimes have to go off and look at another function, and possibly modify that one too.

This section describes the Edit Definition command and other commands that list and/or edit various sets of definitions. In addition, two pairs of List and Edit commands help identify changed code by finding or editing *changed* definitions in buffers. By default, the *changed* commands find changes made since the file was read; use numeric arguments to find definitions that have changed since they were last compiled or saved.

The Edit Definition Commands

Edit Definition (`m-.`) is a powerful command to find and edit function definitions, macro definitions, global variable definitions, and flavor definitions. In general, Zmacs treats as a definition any top-level expression having in functional position a symbol whose name begins **def**.

It is particularly valuable for finding source code, including system code, that is stored in a file other than that associated with the current buffer. It finds multiple definitions when, for example, a symbol is defined as a function, a variable, and another type of object. It maintains a list of these definitions in a support buffer.

`m-.` Edit Definition

Prompts for the name of any named Lisp object. Selects a buffer containing that definition, reading in the source file if necessary, and positions the cursor in front of the definition. With a numeric argument, it edits another definition of the object now being edited. This can be repeated until there are no more definitions of that object.

The prompt has three helpful features: selection by mouse, context default, and completion (for definitions already in the buffer). You can specify a definition by typing the name into the minibuffer or clicking left on a name already in the buffer. If you just press END instead of typing a function name, Zmacs assumes that the function you want is the one at the front of the innermost expression containing point. This default is displayed with the prompt.

Locating Source Code to Edit, *cont'd.*

Zmacs finds definitions this way:

- If the definition is in the current buffer, it moves point there.
- If the definition is in a different buffer, it changes buffers to get to the definition and moves point there.
- If the definition is in a file that has not been read into a Zmacs buffer, Zmacs goes out to the file system to get it, creating a new buffer and reading in the file, and then moves point to the definition.

When a symbol has more than one definition (for example, **list** might be defined both as a function and as a global variable), Zmacs finds all the definitions, but only presents the first one for editing. Zmacs remembers the other definitions, and tells you about them with a message in the echo area. When you have finished with the first definition, you can look at the next by invoking `m-.` with a numeric argument. Each time you do this, you bring up a new definition to be edited, until you run out of definitions. `m-.` displays `No more definitions` if you try to continue.

Example

Suppose you are modifying a function called **sun**, which was written originally by someone else. **sun** calls the unfamiliar **luna**, and you need to find out what **luna** does before proceeding. Use `m-.` to peek at the definition of **luna**.

When you type `m-.`, Zmacs prompts you for the name of a definition. If point is right in the expression where **luna** is called, the default name is **luna**, and you only need to press `END`. If, on the other hand, point is somewhere else and the default is wrong, you can point at the word **luna** with the mouse or you can type it in. To let you know that you can define a name with the mouse, the mouse cursor changes to an arrow pointing straight up. All the symbols that are names of definitions you could specify become mouse-sensitive.

Edit Changed Definitions (`m-X`)

Determines which definitions in any Lisp mode buffer have changed and selects the first one. It makes an internal list of all the definitions that have changed since the buffer was read in and selects the first one on the list. Use `c-.` (Next Possibility) to move to subsequent definitions.

Locating Source Code to Edit, *cont'd.*

Edit Changed Definitions accepts a numeric argument to control the time point for determining what has changed:

Value	*Meaning*
1	For each buffer, since the file was last read (the default).
2	For each buffer, since the buffer was last saved.
3	For each definition in each buffer, since the definition was last compiled.

Edit Changed Definitions of Buffer (m-X)

Determines which definitions in the current buffer have changed and selects the first one. It makes an internal list of all the definitions that have changed since the buffer was read in and selects the first one on the list. Use c-. (Next Possibility) to move to subsequent definitions.

Edit Changed Definitions of Buffer accepts a numeric argument to control the time point for determining what has changed:

Value	*Meaning*
1	Since the file was last read (the default).
2	Since the buffer was last saved.
3	Since the definition was last compiled.

The List Definition Commands

List Definitions (m-X)

Displays the definitions in a specified buffer. It reads the buffer name from the minibuffer, using the current buffer as the default. It displays the list as a typeout window. The individual definition names are mouse-sensitive.

List Changed Definitions (m-X)

Displays a list of any definitions that have been edited in any buffer. Use c-. (Next Possibility) to start editing the definitions in the list.

Locating Source Code to Edit, *cont'd.*

List Changed Definitions accepts a numeric argument to control the time point for determining what has changed:

Value	*Meaning*
1	For each buffer, since the file was last read (the default).
2	For each buffer, since the buffer was last saved.
3	For each definition in each buffer, since the definition was last compiled.

List Changed Definitions of Buffer (m-X)

Displays the names of definitions in the buffer that have changed. It makes an internal list of the definitions changed since the buffer was read in and offers to let you edit them. Use c-. (Next Possibility) to move to subsequent definitions.

List Changed Definitions of Buffer accepts a numeric argument to control the time point for determining what has changed:

Value	*Meaning*
1	Since the file was last read (the default).
2	Since the buffer was last saved.
3	Since the definition was last compiled.

The Edit Callers Commands

When you are modifying a large system, you often have to make sure that changing a function does not render unusable other functions that call the modified one. Zmacs provides facilities for editing the sources of all the functions defined in the current world that call a given one. This removes some of the unpleasantness of making incompatible changes to large programs and is a good example of how Zmacs interacts with the Lisp environment to make programming easier.

Edit Callers (m-X)

Prepares for editing all functions that call the specified one. The prompt is the same kind that Edit Definition gives you. It reads a function name via the mouse or from the minibuffer with completion. By default, it searches the current package. You can control the package being searched by giving the function an

Locating Source Code to Edit, *cont'd.*

argument. With an argument of c-U, it searches all packages; with c-U c-U, it prompts for the name of a package to search. It selects the first caller; use c-. (Next Possibility) to move to a subsequent definition.

Multiple Edit Callers (m-X)

Prompts for the names of a group of functions and edits those functions in the current package that call *any* of the specified ones. It reads a function name from the minibuffer, with completion, initially offering a default function name. It continues prompting for more function names until you end the list with RETURN.

By default, it searches the current package. You can control the package being searched by giving the function an argument. With an argument of c-U, it searches all packages. With two c-Us, it prompts for the name of a package.

List Callers (m-X)

Prompts for the name of a function exactly the way Edit Callers does, but instead of editing the callers in the current package of the specified function, it simply displays their names. The names are mouse-sensitive. If you point at one and click left, you can edit the source of that caller. If you click right, a menu pops up that offers to give the argument list of the selected caller, to disassemble it, to edit it, or to see its documentation string. In addition, c-. (Next Possibility) works in this context, offering the first caller to be edited, and queuing up the other callers to be edited in sequence.

With an argument of c-U, it lists all the callers in every package. With two c-Us, it prompts for the name of a package to search.

Locating Source Code to Edit, *cont'd.*

Multiple List Callers (m-X)

Lists all the functions that call the specified functions. It reads a function name from the minibuffer, with completion. It continues prompting for more function names until you end the list with RETURN.

The list of function names is mouse-sensitive: see List Callers (m-X). c-. (Next Possibility) edits the callers.

By default, it searches the current package. You can control the package being searched by giving the function an argument. With an argument of c-U, it searches all packages. With two c-Us, it prompts for the name of a package.

Patching

Introduction

During a typical maintenance session you might make several edits to a system's source files. The patch facility allows you to copy these edits into a patch file so that they can be automatically incorporated into the system to create a new minor version. Edits in a patch file can be of varying levels of complexity — modified function definitions, new functions, modified **defvars** and **defconsts**, or arbitrary forms to be evaluated, even including **loads** of new files. (For complete information about patching, see the section "Patching" in the document *Maintaining Large Systems*.)

The Patch Commands

Start Patch (m-X) and Start Private Patch (m-X) are two commands for initiating a patch.

Start Patch (m-X)

Starts a new patch but does not move any Lisp forms into the patch file. Prompts you for the system you want to patch; it must be a system currently loaded. It allocates a new minor version number for that particular system and starts constructing the patch file in an editor buffer.

While you are making your patch file, the minor version number that has been allocated for you is reserved so that nobody else can use it. Thus, if two people are patching a system at the same time, they cannot both get the same minor version number. Also note that you can put together patches for only one system at a time.

If you do a subsequent patch after finishing the current patch (see Finish Patch (m-X)), Start Patch (m-X) asks you which system you wish to patch and starts a new minor version.

Start Private Patch (m-X)

Similar to Start Patch (m-X), but it does not have any relationship to systems, major and minor version numbers, and official patch directories. Instead of prompting for a system, it prompts for a file name. You can use other patching commands, like Add Patch (m-X), Finish Patch (m-X), and Abort Patch (m-X). When you finish the patch it is written out to the specified file.

This command allows you to make a private patch file that you can load, test, and share with other users before you install it as a numbered patch that all users automatically get.

Patching, *cont'd.*

If you change a function, you should recompile it and test it; then, once it works, use Add Patch (m-X), Add Patch Changed Definitions (m-X), or Add Patch Changed Definitions of Buffer (m-X) to put the code in the patch file.

Add Patch (m-X)

Adds the region (if there is one) or else the current definition to the patch file currently being constructed. If you mistakenly use the command on code that does not work, select the buffer containing the patch file and delete it. Then later you can use Add Patch (m-X) on the corrected version.

Add Patch Changed Definitions of Buffer (m-X)

Selects each definition that was changed in the buffer and asks you whether or not you want the definition patched.

For each definition, you can respond as follows:

Response	*Action*
Y	Patches the definition.
N	Skips the definition.
P	Patches the definition and any additional definitions in the same buffer without asking any more questions.

A definition needs to be patched if it has been changed since it was last patched or if it has not been patched since the file was read into the buffer.

Note that patching any region of text lying entirely within a definition (with Add Patch (m-X)) counts as patching that definition.

Add Patch Changed Definitions (m-X)

Selects a buffer in which definitions were changed and asks whether or not you want to patch the changed definitions. Answering N skips the buffer and proceeds to the next buffer, if any. Answering Y selects each definition that has changed in that buffer and asks you whether or not you want the definition patched.

Patching, *cont'd.*

For each definition, you can respond as follows:

Response	*Action*
Y	Patches the definition.
N	Skips the definition.
P	Patches the definition and any additional definitions in the same buffer without asking any more questions; when done, it proceeds to the next buffer.

If there are more buffers containing definitions to be patched, it asks questions again when it gets to the next buffer.

A definition needs to be patched if it has been changed since it was last patched or if it has not been patched since the file was read into the buffer.

Note that patching any region of text lying entirely within a definition (with Add Patch (m-X)) counts as patching that definition.

After making and testing all of your patches, use Finish Patch (m-X).

Finish Patch (m-X)

Installs the patch file so that other users can load it. This compiles the patch file if you have not done so yourself (patches are always compiled). It prompts you for a comment describing the reason for the patch; **load-patches** and **print-system-modifications** print these comments.

Sometimes you start making a patch file and for a variety of reasons do not install it — for example, you decide to abort the patch, you need to end your work session at this machine, or your machine crashes.

Abort Patch (m-X)

Deallocates the minor version number that was assigned by Start Patch (m-X). It tells Zmacs that you are no longer currently making a patch; the next time you do Start Patch (m-X), Zmacs starts a new patch instead of appending to the one in progress.

Patching, *cont'd.*

Resume Patch (m-X)

Allows you to go back to a patch that you were not able to finish in the same session in which you started it. This command works only if you have previously saved all modified buffers.

If the system crashes, use Resume Patch (m-X) and then Abort Patch (m-X). Begin the patch again.

Customizing the Zmacs Environment

Overview

Introduction

Now that you are familiar with the basic Zmacs concepts and techniques, you can set up a large set of minor modes, Zmacs and Lisp variables, and parameters to change the way the editor works. Zmacs's flexibility allows you to change which keys are connected to which commands, write your own commands, and install them in lieu of the standard system commands. A few users make extremely radical changes to the point where almost every key has a new meaning.

This section describes:

- Zmacs minor and major modes, and how they provide a degree of customization
- Creating new commands with keyboard macros
- Setting key bindings
- Specifying Zmacs variable settings
- Sample init file forms for automatically reloading your customized environment

Built-in Customization — Zmacs Minor Modes

Definition — Minor Modes

A *minor mode*:

- Is an option.
- Is independent of other minor modes and of the selected major mode.

How It Works

Zmacs has an extended command for each minor mode (m-X) that turns the mode on or off. With no argument, the command turns the mode on if it was off and off if it was on. This is known as *toggling*. A positive argument always turns the mode on, and a zero argument or a negative argument always turns it off. All the minor mode commands are suitable for connecting to single- or double-character commands if you want to enter and exit a minor mode frequently. (See the section "Key Bindings", page 191.)

Example — Filling Text

Auto Fill Mode (m-X)

Turns on *Auto Fill Mode*, a minor mode that inserts Return characters automatically to break lines as you type. You can turn Auto Fill Mode on regardless of your major mode. If the mode line displays `Fill`, Auto Fill Mode is on. If Auto Fill Mode is already turned on, this command turns it off.

This mode is useful when you are typing large amounts of text. It makes it unnecessary to look at the screen or to worry about line length: you just type in the text without newlines and Zmacs inserts them whenever they are needed.

Auto Fill Mode works by establishing a hook that runs after you press one of the activation characters (SPACE, RETURN, ., ?, !, or ") that activate filling in this mode. When you press one of these characters in Auto Fill Mode, Zmacs does more than simply insert it. First it checks to see whether the line exceeds the maximum allowable line length or *fill column* (see Set Fill Column below). If the line is too long, Zmacs finds the last word on the current line that fits inside the fill column. Zmacs then inserts a newline right after that word. Extra spaces (if any) are deleted from the beginning of the newly formed line.

Because of the way Auto Fill Mode works, you will often find yourself typing a word out beyond the fill column. The word will be moved to the next line as soon as you press one of the activation characters.

Built-in Customization — Zmacs Minor Modes, *cont'd.*

The fill column is used by Auto Fill Mode (and by the paragraph adjusting commands) to decide where to break lines. It is measured in pixels, not in characters, so that Auto Fill Mode works even if characters of different widths appear in a buffer. (A *pixel* is a tiny rectangular area on the screen that is either all white or all black. Pixels are the smallest addressable region of the display. If you look closely, you can see the separate rectangular pixels that make up everything on the display.)

You can change the fill column with the following command:

`c-X F` Set Fill Column

Changes the fill column to match up with the current position of the cursor. That means that if point is at the end of a line, filled lines will not be longer than the current one from now on.

With a positive numeric argument *n* less than 200, the fill column is set to be *n* character-widths, and if *n* is 200 or greater, the fill column is set to be *n* pixels.

Summary of Minor Modes

Atom Word Mode (`m-X`)

Makes word-moving commands, in Lisp mode, move over Lisp atoms instead of words. This command does not display anything in the mode line.

Auto Fill Lisp Comments Mode (`c-m-X`)

Turns on auto filling of comments, but not code. This command displays `Fill-Comments` in the mode line.

Auto Fill Mode (`m-X`)

Turns on auto filling. Auto Fill mode allows you to type text endlessly without worrying about the width of your screen. Return characters are inserted where needed to prevent lines from becoming too long. This command displays `Fill` in the mode line.

Electric Font Lock Mode (`m-X`)

Puts comments in font B. This command displays `Electric Font-lock` in the mode line.

Built-in Customization — Zmacs Minor Modes, *cont'd.*

Electric Shift Lock Mode (m-X)

Facilitates typing in programs that are in uppercase. Whenever you type a character that is part of a Lisp symbol, such as the name of a function, variable, or special form, Zmacs inserts it in uppercase, but when you type a character that is part of a character string or a comment or after a slash, Zmacs inserts it normally. This command displays `Electric Shift-lock` in the mode line.

EMACS Mode (m-X)

Provides commands for EMACS users. It puts bit-prefix commands on ESCAPE (ALTMODE on an LM-2), c-^, and c-C, and Universal argument on c-U. It also makes c-I a synonym for TAB, c-H a synonym for BACKSPACE, and c-] a synonym for ABORT. This command displays `EMACS` in the mode line.

Overwrite Mode (m-X)

Turns on overwrite mode. In overwrite mode, ordinary printing characters replace existing text, instead of inserting themselves next to it. It is good for editing pictures. This command displays `Overwrite` in the mode line.

Word Abbrev Mode (m-X)

Allows you to define word abbreviations that expand as you type them. This command displays `Abbrev` in the mode line.

See...

See "Setting Mode Hooks", page 197, for information about setting minor modes permanently.

Major Modes

User-Defined Major Modes

In Zmacs, you can define your own major modes (see **zwei:defmajor** in the code).

File Types and Major Modes

You can control the default major mode associated with a particular file type. For example, Zmacs sets the major mode to Lisp for files with type lisp. The repository for this information is a list called **fs:*file-type-mode-alist***. For example, suppose you wanted to associate the file type tex with text mode:

```
(push '("tex" . :text) fs:*file-type-mode-alist*)
```

The **car** of an element should be either a canonical type symbol or a string when the type is not one of the known canonical types.

In addition, suppose you have files that would require Scribe mode, if Zmacs had such a thing. You can define a correspondence between two major modes, using a global variable called **zwei:*major-mode-translations***. It is an alist of major mode names, expressed as keyword symbols. Example:

```
(push '(:scribe . :text) zwei:*major-mode-translations*)
```

Creating New Commands: Keyboard Macros

Definition

A *keyboard macro* is a command that you define to abbreviate a sequence of other commands. If you discover that you are about to type `c-N c-D` 40 times, you can define a keyboard macro to do `c-N c-D` and call it with a repeat count of 40.

How It Works

You define a keyboard macro by telling Zmacs that you are about to write a macro and then typing the commands that are the definition. That is, as you are defining a keyboard macro, the definition is being executed for the first time. When you are finished, the keyboard macro is defined and also has been, in effect, executed once. You can then do the whole thing over again by invoking the macro.

Procedure

1. To start defining a keyboard macro, type `c-X (` (Start Kbd Macro). From then on, your commands continue to be executed, but also become part of the definition of the macro. `Macro-level: 1` appears in the mode line.

2. If you want to perform an operation on each line, do one of the following:
   - Start by positioning point on the line above the first one to be processed and then begin the macro definition with a `c-N`
   - Start on the proper line and end with a `c-N`.

   Either way, repeating the macro operates on successive lines.

3. After defining the body of the macro, you can terminate it in several ways.
   - `c-X )` (End Kbd Macro) terminates the definition.
   - An argument of zero to `c-X )` automatically repeats the macro (upon termination of the definition) until it gets an error or reaches the end of the buffer.
   - `c-X )` can be given a repeat count as a numeric argument, in which case it repeats the macro that many times right after defining it, but defining the macro counts as the first repetition (since it is executed as you define it). (Subsequent invocations ignore the numeric argument contained in the macro.)

Example

Inserting an argument of 5 before ending the macro (`...c-5 c-X )`) executes the macro immediately four additional times.

Creating New Commands: Keyboard Macros, *cont'd.*

Start Keyboard Macro

c-X (Start Kbd Macro

Begins defining a keyboard macro. A numeric argument means append to the previous keyboard macro.

End Keyboard Macro

c-X) End Kbd Macro

Terminates the definition of a keyboard macro.

View Keyboard Macro

To see the keyboard macro, use View Kbd Macro (m-X), which prints the macro at the top of your screen.

View Kbd Macro (m-X)

Displays the specified keyboard macro. The name of the macro is read from the minibuffer; just RETURN means the last one defined, which can also be temporary.

Call Last Keyboard Macro

The macro thus defined can be invoked again with c-X E (Call Last Kbd Macro), which can be given a repeat count as a numeric argument to execute the macro many times.

c-X E Call Last Kbd Macro

Repeats the last keyboard macro.

Example

The example below defines a keyboard macro that goes to the beginning of a line, inserts a semicolon, and goes to the next line. It also executes the macro four times, including once as it is being defined.

```
c-X (
c-A
;
c-N
c-4 c-X )
```

Creating New Commands: Keyboard Macros, *cont'd.*

Defining an Interactive Keyboard Macro

Within the keyboard macro definition, you can specify steps at which you want the macro to query. To define an interactive keyboard macro, use the Kbd Macro Query command after beginning the macro definition (with Start Kbd Macro). Invoke Kbd Macro Query at each spot in the macro where you want the macro to query. Then close the definition with End Kbd Macro.

`c-X Q` Kbd Macro Query

Allows user interaction on each iteration of macro, similar to Query Replace (`m-X`). While defining a keyboard macro, press `c-X Q` at each step where you want a pause to occur. Upon execution of the macro, it stops and waits at each of those steps for one of the following characters:

SPACE	Continues execution of the macro.
RUBOUT	Skips rest of keyboard macro (use nested `c-X (` and `c-X )` for grouping to control range of skip).
? or HELP	Displays HELP information.
.	Continues but does not iterate anymore.
!	Continues, iterates, but does not ask anymore.
c-R	Enters editing mode; `c-m-FUNCTION R` (`MACRO R` on an LM-2) resumes the keyboard macro.

Naming a Keyboard Macro

Having defined a keyboard macro, you can name it with Name Last Kbd Macro (`m-X`). A prompt (`Name for macro:`) appears in the minibuffer.

Name Last Kbd Macro (`m-X`)

Assigns a name to the most recent temporary keyboard macro, making it permanent. The new name for the macro is read from the minibuffer.

Creating New Commands: Keyboard Macros, *cont'd.*

Using Keyboard Macros to Sort

You can use a keyboard macro to set up a sorting mechanism and run it on any region of text. See the description of Sort Via Keyboard Macros, page 100.

Installing a Macro on a Key

To bind the macro to the key of your choice, use Install Macro (m-X). You are asked to identify the macro and specify the key(s) to which you want it bound.

Install Macro (m-X)

Installs a specified user macro on a specified key. The name of the macro is read from the minibuffer, and the keystroke on which to install it is read in the echo area. If the key is currently holding a command prefix (like c-X), it asks you for another character, so that you can redefine c-X commands. However, with a numeric argument, it assumes you want to redefine c-X itself, and does not ask for another character.

Installing a Mouse Macro

You can bind the macro to a mouse click instead of a key using Install Mouse Macro (m-X). This command works similarly to Install Macro.

Install Mouse Macro (m-X)

Installs a specified user macro on a specified mouse click. The name of the macro is read from the minibuffer, and the mouse click on which to install it is read in the echo area. When the mouse is clicked to invoke this macro, the macro is invoked from the current location of the mouse cursor.

Deinstalling a Macro

To remove the macro from that key, use Deinstall Macro (m-X). The key is rebound to the standard system usage, if any.

Deinstall Macro (m-X)

Deinstalls a keyboard macro.

Creating New Commands: Keyboard Macros, *cont'd.*

Example

This example shows how to install a macro and deinstall the same macro:

```
you type:       m-X Install Macro
minibuffer:     Name of macro to install (CR for last macro defined):
you type:       macro-name or CR
minibuffer:     Key to get it:
you type:       h-T

A menu appears and asks you in which comtab to install the macro:
• Just this editor
• Zmacs
• Zwei

Click on your choice.

minibuffer:     Command #<DTP-CLOSURE 34465726> installed on Hyper-T.

you type:       m-X Deinstall Macro
minibuffer:     Key to deinstall:
you type:       h-T

The menu appears and asks you to specify in which of the three
comtabs to deinstall the macro.  Click on your choice.

minibuffer:     Command NIL installed on Hyper-T.
```

See...

See "Key Bindings", page 198, for information about saving keyboard macros permanently.

More Features of the Keyboard Macro Facility

The keyboard macro facility implemented with the c-m-FUNCTION key provides more features, such as an easy way to make tables.

c-m-FUNCTION

Reads a keyboard macro command, consisting of an optional numeric argument made up of any number of digits (0-9) followed by a non-numeric character, usually a letter. Each keyboard macro command must be preceded by the c-m-FUNCTION prefix. After typing the prefix, you may type HELP for a list of available keyboard macro commands.

Creating New Commands: Keyboard Macros, *cont'd.*

Keyboard Macro Commands for c-m-FUNCTION

0-9 Optional numeric argument.

C Calls a macro by name. Prompts in the minibuffer for the name of the macro.

P Begins a macro definition (same as c-X (— see "Start Keyboard Macro").

R Ends a macro definition (same as c-X) — see "End Keyboard Macro").

M Defines a named macro. Prompts for the name of the macro to define and then enters macro definition mode.

S Stops (aborts) macro definition (also c-G.

D Defines a named macro but does not execute it while reading its characters.

SPACE Inserts pauses for user interaction in the macro (same as c-X Q — see "Defining an Interactive Keyboard Macro").

A Steps though characters on successive iterations (for example, letters and numbers). Asks for starting character, amount to increase (or decrease if negative) on each iteration.

U Allows typein terminated by c-m-FUNCTION R (MACRO R on LM-2). This allows you to stop while in the middle of defining the macro, do other things in the editor, and then go back and finish defining the macro.

T Allows typein every iteration.

The difference between c-m-FUNCTION U and c-m-FUNCTION T is that c-m-FUNCTION U allows typein while defining a macro that does not get stored in the macro, hence does not executed on subsequent iteration nor when the macro is called again. c-m-FUNCTION T allows typein on every iteration. As with c-m-FUNCTION U, the typein while defining the macro does not get stored in the macro. But on each subsequent iteration, new typein will be requested.

Creating New Commands: Keyboard Macros, *cont'd.*

Example

The following example shows how to create a macro that constructs a table using c-m-FUNCTION A.

```
  you type:  c-X (
Minibuffer:  Macro-level: 1 *
  you type:  c-m-FUNCTION A
Minibuffer:  Initial character (type a one-character string):
  you type:  a RETURN
Minibuffer:  Amount by which to increase it (type a decimal number):
  you type:  1 RETURN
                         (Zmacs inserts the a into the buffer.)
  you type:  c-2 c-6 c-X )
```

As you close the macro, Zmacs inserts into the buffer:

```
a b c d e f g h i j k l m n o p   r s t u v w x y z
```

by executing the macro 26 times, increasing the letter once each time.

Example

The following example shows how to create a macro that constructs a table using c-m-FUNCTION A, and this time, c-m-FUNCTION T, which allows typein during every iteration of the macro:

```
  you type:  c-X (
Minibuffer:  Macro-level: 1 *
  you type:  Item SPACE
  you type:  c-m-FUNCTION A
Minibuffer:  Initial character (type a one-character string):
  you type:  1
Minibuffer:  Amount by which to increase it (type a decimal number):
  you type:  1
  you type:  TAB
  you type:  c-m-FUNCTION T
Minibuffer:  Macro-level: 2 *
  you type:  Rosemary
  you type:  c-m-FUNCTION R
Minibuffer:  Macro-level: 1 *
  you type:  RETURN
  you type:  c-5 c-X )
  you type:  Sage
  you type:  c-m-FUNCTION R
  you type:  Thyme
  you type:  c-m-FUNCTION R
  you type:  Parsley
  you type:  c-m-FUNCTION R
  you type:  Pepper
  you type:  c-m-FUNCTION R
```

Creating New Commands: Keyboard Macros, *cont'd.*

The table looks like this:

```
Item 1  Rosemary
Item 2  Sage
Item 3  Thyme
Item 4  Parsley
Item 5  Pepper
```

Key Bindings

Definition

A *key binding* is the set of specific keystrokes that invoke a specific command.

How It Works: The Comtab

A *command table*, or *comtab*, assigns a command to each possible keystroke. While Zmacs is running, there is always a unique *selected comtab*, in which Zmacs finds the command that corresponds to each user keystroke. When you type a keystroke, Zmacs looks up the keystroke in the currently selected comtab, finds the appropriate command, and runs it. Usually the command's side-effects all occur within the buffer: Point might be moved and text might be deleted, inserted, or rearranged. Sometimes a command has more extensive side-effects. A command can alter or replace the selected comtab itself, in which case Zmacs looks up the next keystroke in the new command table.

Zmacs' *basic state* consists of the standard editor key bindings, which reside in one special command table, the *standard comtab* (*Zwei comtab*). The standard comtab interacts with the Zmacs comtab and the various mode-dependent comtabs. The typical selected comtab when in Zmacs is "unnamed" for mode-specific key bindings, which indirects to "Zmacs", which indirects to "Zwei". Although the standard comtab can be temporarily replaced, it is always reselected eventually, often after only one "nonstandard" keystroke.

A keystroke that functions as a prefix actually runs a command that replaces the standard comtab for one keystroke. This is the mechanism by which multikeystroke commands are implemented. For example, there are many two-stroke commands whose first keystroke is c-X. This keystroke runs a command that brings in its own comtab before interpreting the next stroke.

Set Key

If you want to put a command on the keystroke of your choice, use Set Key. This command works for any of the already defined commands.

Set Key (m-X)

Installs a specified command on a specified key. If the key is currently holding a command prefix (like c-X), it asks you for another character so that you can redefine c-X commands. However, with a numeric argument, it assumes you want to redefine c-X itself and does not ask for another character.

Key Bindings, *cont'd.*

It assigns key bindings in the editor that are active in all buffers, and takes two arguments: the name of a command, and a keystroke to invoke it. It reads the name of the command in the minibuffer, completing any command name in any comtab.

Install Command

If you want to put a function on the keystroke of your choice, use Install Command. It takes a function, regards it as a command, and puts it on a key.

Install Command (m-X)

Installs a specified function as a command in the comtab, on a specified key. It takes two arguments: the name of the function (the current definition, that is, top level expression), and a keystroke to invoke it. (Zmacs treats as a definition any top-level expression having in functional position a symbol whose name begins "**def**".) If the key is currently holding a command prefix (like c-X), it asks you for another character so that you can redefine c-X commands. However, with a numeric argument, it assumes you want to redefine c-X itself and does not ask for another character.

See...

See "Key Bindings", page 198, for information about setting key bindings permanently.

How to Specify Zmacs Variable Settings

Definition

A *variable* is a name that is associated with a value, for example, a number or a string. Zmacs has editor variables that you can set for customization. (Variables can also be set automatically by major modes.)

You can distinguish the names of Zmacs variables from other Lisp variables by their names — the first letters are capitalized and the names contain spaces rather than hyphens. For example, Region Marking Mode is **zwei:*region-marking-mode*** internally.

Finding Out About Zmacs Variables

To examine the value of a single Zmacs variable, use Describe Variable (m-X). To print a complete list of all variables, use List Variables (m-X).

Describe Zmacs Variable

Describe Variable (m-X)

Displays the documentation and current value for a single Zmacs variable. It reads the variable name from the minibuffer, using completion.

List Zmacs Variables

List Variables (m-X)

Lists *all* Zmacs variables and their values. With a numeric argument, this command also displays the documentation line for the variable.

Variable Apropos

HELP V Variable Apropos
c-HELP V
c-m-? V

Displays the names of all possible Zmacs variables containing a specific substring. With a numeric argument, this command also displays the documentation lines for the variables.

How to Specify Zmacs Variable Settings, *cont'd.*

Example

One example of such a Zmacs variable is the Fill Column variable, which specifies the width, in pixels, used in filling text.

For example, `c-1 HELP V` prompts in the minibuffer `Variable Apropos (substring):` and you type `fill col`. It does pattern matching on the variable name and thus matches Fill column, which displays: `Fill column: 576. Width in pixels used in filling text.`

Set Variable

Set Variable (`m-X`)

Sets any existing Zmacs variable. This command reads the name of a variable (with completion), displays its current value and documentation, and prompts in the minibuffer for a new value. It does some checking to see that the new value has the right type.

Although either uppercase or lowercase works, you are encouraged to capitalize each word of the name for aesthetic reasons, since Zmacs stores the name as you give it.

Settable Zmacs Variables

You can view all settable Zmacs variables with the List Variables command.

The following are some examples of variables that can be set with Set Variable. In addition, they can be set in init files by using the internal form of their names. For example, Region Marking Mode is **zwei:*region-marking-mode*** internally.

Region Marking Mode

Value: **:reverse-video** for setting the region to reverse video. The default is **:underline**.

Region Right Margin Mode

Value: **t**. Causes whatever marks the region (reverse video or underlining) to extend across unfilled space to the right margin. The default is **nil**.

How to Specify Zmacs Variable Settings, *cont'd.*

One Window Default

Controls which window remains selected after a One Window (c-X 1) command when you were using more than one window. Possible values:
:current
:other
:top
:bottom

This feature operates best when the current layout has no more than two windows. The value **:current** is the only one that is always well defined with more than two windows on the screen.

Check Unbalanced Parentheses When Saving

Controls whether Zmacs checks a file for unbalanced parentheses when you are saving the file. The check is on (**t**) by default. When it checks a file that you are saving and finds unbalanced parentheses, it queries you about whether to go ahead and save anyway. This applies to all major modes based on Lisp; it is ignored for text modes.

See...

See "Customizing the Editor in Init Files", page 196, for information about setting variables permanently.

Customizing the Editor in Init Files

Introduction

As you gain sophistication with the more advanced features, you will find the settings of parameters that most please you and put these into a command file (*init file*) that the system executes every time you log in.

Creating An Init File

Create a file named *lispm-init.l* in your home directory on your host system and put your Zmacs customizations there.

This section contains examples of forms that you can place inside of a **login-forms** in your init file to customize the editor.

login-forms is a special form for wrapping around a set of forms in your init file. It evaluates the forms and arranges for them to be undone when you log out.

Setting Editor Variables

The forms described show how to set Zmacs variables (the kind that Set Variable (m-X) sets).

Ordering Buffer Lists

```
(SETQ ZWEI:*SORT-ZMACS-BUFFER-LIST* NIL)
```

displays the list of buffers in the order the buffers were created rather than in the order they were most recently visited.

Putting Buffers Into Current Package

```
(SETQ ZWEI:*DEFAULT-PACKAGE* NIL)
```

puts buffers created with c-X B (Select Buffer) into whatever package is current; the default is to put them in the USER package.

Setting Default Major Mode

```
(SETQ ZWEI:*DEFAULT-MAJOR-MODE* ':TEXT)
```

sets the default major mode to Text mode for buffers with no Mode attribute and no major mode deducible from the file type; the default is Fundamental mode.

Customizing the Editor in Init Files, *cont'd.*

Setting Find File Not To Create New Files

```
(SETQ ZWEI:*FIND-FILE-NOT-FOUND-IS-AN-ERROR* T)
```

beeps and prints an error message when you give c-X c-F (Find File) the name of a nonexistent file. The default prints (New File) and creates an empty buffer, which when saved by c-X c-S (Save File) creates the file that was nonexistent.

Setting Goal Column for Real Line Commands

```
(SETQ ZWEI:*PERMANENT-REAL-LINE-GOAL-XPOS* 0)
```

moves subsequent c-N and c-P (Down Real Line and Up Real Line) commands to the left margin, like doing c-0 c-X c-N (Set Goal Column to zero).

Fixing White Space For Kill/Yank Commands

```
(SETQ ZWEI:*KILL-INTERVAL-SMARTS* T)
```

tells the killing and yanking commands optimize white space surrounding the killed or yanked text.

Setting Mode Hooks

Each major mode has a *mode hook*, a variable which, if bound, is a function that is called with no arguments when that major mode is turned on.

Electric Shift Lock in Lisp Mode

```
(SETQ ZWEI:LISP-MODE-HOOK 'ZWEI:ELECTRIC-SHIFT-LOCK-IF-APPROPRIATE)
```

tells Lisp major mode to turn on Electric Shift Lock minor mode unless the buffer has a Lowercase attribute. The effect is that by default Lisp code is written in upper case.

Customizing the Editor in Init Files, *cont'd.*

Auto Fill in Text Mode

```
(SETQ ZWEI:TEXT-MODE-HOOK 'ZWEI:AUTO-FILL-IF-APPROPRIATE)
```

tells Text major mode to turn on Auto Fill minor mode unless the buffer has a Nofill attribute. The effect is that by default lines of text are automatically broken by carriage returns when they get too wide.

Key Bindings

To bind keys, you first define the comtab in which to put the binding. For example, *standard-comtab* and *standard-control-x-comtab* define features of all zwei-based editors; *zmacs-comtab and *zmacs-control-x-comtab define features that are Zmacs-specific.

Balanced Quotation Marks and Asterisks

```
ZWEI:(SET-COMTAB *STANDARD-COMTAB*
                 '(#\m-/" COM-MAKE-/(/)
                   #\c-m-/" COM-MOVE-OVER/)
                   #\m-/* COM-MAKE-/(/)
                   #\c-m-/* COM-MOVE-OVER-/)
                   ))
```

defines commands to insert balanced pairs of quotation marks or asterisks into the buffer. For example, one can type an asterisked special variable name as `m-* FOO`, which inserts `*FOO*` into the buffer, ensuring that one does not forget to type the trailing asterisk.

White Space In Lisp Code

```
ZWEI:(SET-COMTAB *STANDARD-CONTROL-X-COMTAB*
                 '(#\SP COM-CANONICALIZE-WHITESPACE))
```

defines c-X SPACE as a command that makes the horizontal and vertical white space around point (or around mark if given a numeric argument or immediately after a yank command) conform to standard style for Lisp code.

Customizing the Editor in Init Files, *cont'd.*

c-m-L *on the* SQUARE *Key*

```
ZWEI:(SET-COMTAB *ZMACS-COMTAB*
                 '(#\SQUARE COM-SELECT-PREVIOUS-BUFFER))
```

defines the Square key to do the same thing as c-m-L. This key binding is placed in *zmacs-comtab* rather than *standard-comtab* since buffers are a feature of Zmacs, not of all Zwei-based editors.

Edit Buffers on c-X c-B

```
ZWEI:(SET-COMTAB *ZMACS-CONTROL-X-COMTAB*
                 '(#\c-B COM-EDIT-BUFFERS))
```

This makes c-X c-B invoke Edit Buffers rather than List Buffers. This key binding is placed in *zmacs-control-x-comtab* rather than *standard-control-x-comtab* since buffers are a feature of Zmacs, not of all Zwei-based editors.

Edit Buffers on m-X

```
ZWEI:(SET-COMTAB *ZMACS-COMTAB*
                 ()
                 (MAKE-COMMAND-ALIST '(COM-EDIT-BUFFERS)))
```

This makes Edit Buffers available on m-X in Zmacs (by default it is only available on c-m-X).

m-. *on* m-*[(L)]*

```
ZWEI:(SET-COMTAB *ZMACS-COMTAB*
                 '(#\m-MOUSE-L COM-EDIT-DEFINITION))
```

This makes clicking the Left mouse button while holding down the Meta key do what m-. does. Invoking this command from the mouse is convenient when you specify the name of the definition to be edited by pointing at it rather than typing it.

Appendix A
Help Command Summary

This section lists the names of the available help commands grouped according to the context in which they are available. The purpose of this section is to summarize the capabilities and to help you determine both the overall contexts for which you can find help and a particular function that might be what you are looking for.

Zmacs commands for finding out about the state of buffers

Edit Buffers (m-X)
Edit Changed Definitions (m-X)
Edit Changed Definitions Of Buffer (m-X)
List Buffers (c-X c-B)
List Changed Definitions (m-X)
List Changed Definitions Of Buffer (m-X)
List Definitions (m-X)
List Matching Lines (m-X)
Print Modifications (m-X)
Select System as Tag Table (m-X)
Tags Search (m-X)

Zmacs commands for finding out about the state of Zmacs

Apropos (HELP A, m-X)
Describe Variable (m-X)
Edit Zmacs Command (m-X)
List Commands (m-X)
List Registers (m-X)
List Some Word Abbrevs (m-X)
List Tag Tables (m-X)
List Variables (m-X)
List Word Abbrevs (m-X)

Zmacs commands for finding out about Lisp

Brief Documentation (c-sh-D)
Describe Variable At Point (c-sh-V)
Edit Callers (m-X)
Edit Definition (m-.)

Edit File Warnings (m-X)
Function Apropos (m-X)
List Callers (m-X)
List Matching Symbols (m-X)
Long Documentation (m-sh-D)
Multiple Edit Callers (m-X)
Multiple List Callers (m-X)
Quick Arglist (c-sh-A)
Where Is Symbol (m-X)

Zmacs commands for finding out about flavors
Describe Flavor (m-X)
Edit Combined Methods (m-X)
Edit Methods (m-X)
List Combined Methods (m-X)
List Methods (m-X)

Zmacs commands for interacting with Lisp
Break (SUSPEND — BREAK on an LM-2)
Compile And Exit (m-Z)
Compile Buffer (m-X)
Compile Changed Definitions (m-X)
Compile Changed Definitions Of Buffer (m-sh-C, m-X)
Compile File (m-X)
Compile Region (c-sh-C, m-X)
Compiler Warnings (m-X)
Edit Compiler Warnings (m-X)
Evaluate And Exit (c-m-Z)
Evaluate And Replace Into Buffer (m-X)
Evaluate Buffer (m-X)
Evaluate Changed Definitions (m-X)
Evaluate Changed Definitions Of Buffer (m-sh-E, m-X)
Evaluate Into Buffer (m-X)
Evaluate Minibuffer ((ESCAPE — m-ALTMODE on an LM-2))
Evaluate Region (c-sh-E, m-X)
Evaluate Region Hack (m-X)
Evaluate Region Verbose (c-m-sh-E)
Load Compiler Warnings (m-X)
Macro Expand Expression (c-sh-M, m-X)
Trace (m-X)
Quit (c-Z)

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DEBUG Debugger

Cambridge, Massachusetts

Debugger
# 990015

February 1984

This document corresponds to Release 5.0.

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Printing year and number: 87 86 85 84 9 8 7 6 5 4 3 2 1

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1. Entering the Debugger

When an error condition is signalled and no handlers decide to handle the error, an interactive Debugger is entered to allow you to look around and see what went wrong and to help you continue the program or abort it. This section describes how to use the Debugger and the various debugging facilities.

The Debugger is invoked automatically when errors arise during program execution or when you explicitly cause an error, for example, by typing a nonsense symbol name, such as **ahsdgf**, at the Lisp read-eval-print loop.

You can also enter the Debugger explicitly by pressing m-SUSPEND. Adding the CONTROL modifier to this combination has the effect of saying "enter the Debugger immediately". Thus, you can:

- Press m-SUSPEND while the currently running program or read-eval-print loop is reading from the console.
- Press c-m-SUSPEND so that the currently running program enters the Debugger whether or not it is reading from the console.

Note: Pressing the SUSPEND key without the META modifier or just pressing c-SUSPEND enters a read-eval-print loop rather than the Debugger.

You can use the **dbg** function in your source code to help detect errors in your programs.

- Insert a call to **dbg** (with no arguments) into your code and then recompile.
- Call **dbg** with an argument of *process* to force a process into the Debugger.

dbg &optional *process* *Function*

Forces *process* into the Debugger so that you can look at its current state. **dbg** sets up a restart handler for c-Z, ABORT, and RESUME that exits from the **dbg** function back to the original process. The message for this restart handler is "Allow process to continue". You can use c-T, c-R, c-m-R, and other similar Debugger commands when you enter the Debugger via **dbg**.

- With no argument, it enters the Debugger as if an error had occurred for the current process. It is not an error; in particular, **errset** and **catch-error** do not handle it. You can include this form in program source code as a means of entering the Debugger. This is useful for breakpoints and causes a special compiler warning.
- With an argument of **t** (rather than a process, window, or stack group), it finds a process that has sent an error notification.

Suppose you are running in process *X* and you use **dbg** on some process *Y*. Process *Y* is forced into the Debugger, no matter what it is doing.

> Technically, it is "interrupted", similar to how c-SUSPEND, c-ABORT and c-m-SUSPEND work. Process *Y* starts running the Debugger, using the stream **debug-io**. **debug-io** gets the same stream as was bound to **terminal-io** in Process *X*. At this time, Process *X* waits in a state called DBG until Process *Y* leaves the Debugger, and so Process *X* does not contend for the stream.

For more information: See the special form **break**. See the section "Breakpoints".

1.1 Error Display

Errors are signalled by the Lisp Machine's microcode and by Lisp programs (by using **ferror** or related functions). Here is an example of an error:

```
foo

>>Trap: The variable FOO is unbound.

SI:*EVAL:
   Arg 0 (FORM): FOO
s-A, <RESUME>:    Supply a value to use this time as the value of FOO
s-B, m-C:         Supply a value to store permanently as the value of FOO
s-C:              Retry the SYMEVAL instruction
s-D, <ABORT>:     Return to Lisp Top Level in Lisp Listener 1
→
```

>> indicates entry to the Debugger. The word immediately following >> shows what caused you to enter the Debugger; most commonly you see Trap, Error, or Break.

Trap indicates a microcode error.
Error indicates a software error.
Break indicates entry by keystroke or the **dbg** function.

The message that follows describes the error in English, in this example, an unbound variable. The next two lines in the example show the stack frame in which the error occurred — the function that was being called and the current value(s) of its argument(s).

The right-facing arrow (→) indicates that the Debugger is waiting for a command. Multiple arrow prompts signal recursive invocations of the Debugger.

The Debugger provides options for proceeding from the error or restarting from some prior point. When the Debugger is entered, all *proceed types*, *special commands*, or *restart handlers* available in the error context are assigned to keystrokes with the SUPER modifier, starting with s-A, s-B, and so on, from the most recently established (innermost) to the oldest (outermost). Also, the RESUME key is assigned to the innermost proceed type (or restart handler if there are no proceed types), and the ABORT key is assigned to the innermost restart handler. All these keystroke assignments are displayed when you enter the Debugger or when you type the c-L Debugger command. (See the document *Signalling and Handling Conditions.*)

You can use one of these options or any of the Debugger commands. See the section "Debugger Commands". See the section "How to Use the Debugger". For details on the Debugger command keys: See the section "Special Keys".

Optionally, you can request that backtrace information appear when you enter the Debugger by setting the variable **dbg:*show-backtrace*** in your init file. See the section "Debugger Commands".

c-m-A c-m-1 c-m-A or (DBG:arg 1) access 2nd arg

c-m-L c-m-0 c-m-L or (DBG:loc 0) access 1st local (including local values of symbols in lambda list)

when message is "... ending with <end>" use <return>

2. How to Use the Debugger

Once inside the Debugger, you can give a wide variety of commands. With these commands, you can see the arguments for the current stack frame, disassemble its code, return a value for the stack frame, move up and down the stack, and enter the editor to edit function definitions. Press the HELP key or the ? key to display a brief help message or c-HELP for documentation on all of the Debugger commands.

This section describes how to give the commands, and then explains them in approximate order of usefulness.

When the Debugger prompts you with →, you can do one of the following:

- Type a Lisp expression
- Type a Debugger command
- Use the input editor to recall a previous Lisp expression

The Debugger considers most keys used with a modifier (such as CONTROL or SUPER) to be commands. Most unmodified keys begin a Lisp expression; however, a few keys are commands even without a modifier. (See the section "Debugger Commands".)

The Debugger and the input editor use some of the same keys for commands. You can enter the input editor at any time by pressing a key that is not a Debugger command, for example, SPACE. Once there, you can type an input editor command that is also a Debugger command.

When you press a key that is not a command, the Debugger prompts with Eval:, which means that it will evaluate any Lisp expression that you type. The Debugger interprets the Lisp expression as a Lisp form and evaluates it in the context of the function that got the error. That is, all bindings that were in effect at the time of the error will be in effect when your form is evaluated, with certain exceptions explained later in this section. The result of the evaluation is printed, and the Debugger prompts again with an arrow.

If, during the typing of the form, you change your mind and want to get back to the Debugger's command level, press ABORT or c-G; the Debugger responds with an arrow prompt. In fact, you can press ABORT or c-G whenever the Debugger expects typein in order to flush what you are typing and get back to command level.

If a nontrivial error occurs in the evaluation of the Lisp expression, you are thrown into a second Debugger looking at the new error. The Debugger prompts with two arrows (→→) to show that you are inside two Debuggers. You can abort the computation and get back to the first Debugger by pressing the ABORT key. However, if the error is trivial the abort is done automatically and the original error message is reprinted.

Various Debugger commands ask for Lisp objects, such as an object to return or the name of a catch-tag. Whenever it requests a Lisp object, it expects you to type in a *form*; it will evaluate what you type in. This provides greater generality, since there are objects to which you might want to refer that cannot be typed, such as arrays. If the form you type is nontrivial (not just a constant form), the Debugger shows you the result of the evaluation and asks you if it is what you intended. It expects a Y or N answer. (See the function **y-or-n-p**.) If you answer negatively it asks you for another form. To exit the command, just press ABORT or c-G.

When the Debugger evaluates a form, the variable bindings at the point of error are in effect with the following exceptions:

- **terminal-io** is rebound to the stream the Debugger is using. **dbg:old-terminal-io** is bound to the value that **terminal-io** had at the point of error.

- **standard-input** and **standard-output** are rebound to be synonymous with **terminal-io**; their old bindings are saved in **dbg:old-standard-input** and **dbg:old-standard-output**.

- **query-io**, **debug-io**, and **error-output** are rebound to be synonymous with **terminal-io**; their old bindings are not directly accessible.

- + and * are rebound to the Debugger's previous form and previous value. When the Debugger is first entered, + is the last form typed, which is typically the one that caused error, and * is the value of the *previous* form. ++, +++, **, ***, -, and // are treated in an analogous fashion. See the section "The Lisp Top Level". When the Debugger is exited, all of these variables are restored to their original values; the interactions with the Debugger's read-eval-print loop do not affect the interactions with the top-level Lisp read-eval-print loop.

- **rubout-handler** and **read-preserve-delimiters** are rebound to **nil**, in case the error occurred while in the input editor or the reader.

- **evalhook** is rebound to **nil**, turning off the **step** facility if it had been in use when the error occurred. See the section "**evalhook**".

- **dbg:*bound-handlers*** and **dbg:*default-handlers*** are rebound to **nil**, preventing conditions signalled by the form the Debugger is evaluating from reaching condition handlers in the program being debugged. This prevents you from accidentally being thrown out of the Debugger.

Note that the variable bindings are those in effect at the point of error, *not* those of the current frame being examined.

The m-S command can be used to evaluate a special variable in the context of the current frame. This works even for the special variables listed as exceptions (earlier in this section).

3. Debugger Commands

All Debugger commands are single characters, usually with the CONTROL or META modifiers. The single most useful command is ABORT (or c-Z), which exits from the Debugger and throws out of the computation that got the error. Often you are not interested in using the Debugger at all and just want to get back to the command level in the program you are running; ABORT lets you do this in one character.

The ABORT command returns control to the most recently established restart handler, usually a command or read-eval-print loop. Pressing ABORT multiple times throws you back to successively older read-eval-print or command loops until top level is reached. Pressing c-m-ABORT, on the other hand, always throws you to top level. (Note: c-m-ABORT is not a Debugger command but a system command, which is available from every program.)

Pressing ABORT in the middle of typing a form to be evaluated by the Debugger aborts that form and returns to the Debugger's command level, whereas pressing ABORT as a Debugger command returns out of the Debugger and the erring program to the *previous* command level.

Documentation is provided by the HELP or ? command, which types out a very brief explanation of the Debugger. The c-HELP command gives documentation for all of the Debugger commands. If you type c-L or press REFRESH, the Debugger clears the screen, redisplays the error message and the current stack frame, displays a brief backtrace, and lists the special commands that apply to the particular error currently being handled and gives a one-line explanation of each of them.

Often you want to try to proceed from the error. To do this, use the RESUME (or c-C) command. The exact way RESUME works depends on the kind of error that happened. For some errors, there is no standard way to proceed, and RESUME just tells you so and returns to the Debugger's command level. For the very common "unbound variable" error, it requests that you supply the Lisp object that should be used in place of the (nonexistent) value of the symbol. For unbound-variable or undefined-function errors, you can also just type Lisp forms to set the variable or define the function, and then press RESUME; execution proceeds after the Debugger asks you to confirm that the new value is acceptable.

The Debugger knows about a *current stack frame* and has several commands that use it. The initially current stack frame is the one that signalled the error: either the one that got the microcode-detected error, or the one that called **ferror**, **error**, or a related function. When the Debugger starts up it shows you this frame in the following format:

```
FOO
   Arg 0 (X): 13
   Arg 1 (Y): 1
```

This means that **foo** was called with two arguments, whose names (in the Lisp source code) are **x** and **y**. The current values of **x** and **y** are **13** and **1** respectively. On the LM-2 these might not be the original arguments if the function happens to **setq** its argument variables. On the 3600, the Debugger shows the original arguments.

The Debugger provides several commands to allow you to examine the Lisp control stack and to make other frames current than the one that got the error. The control stack (or *regular pdl*) keeps a record of all functions that are currently active. If you call **foo** at Lisp's top level, and it calls **bar**, which in turn calls **baz**, and **baz** gets an error, then a *backtrace* (a backwards trace of the stack) would show all of this information.

The Debugger has three backtrace commands:

```
c-B
m-B
c-m-B
```

c-B simply displays the names of the functions on the stack, starting from the current frame; in the above example it would display

```
BAZ ← BAR ← FOO ← SI:*EVAL ← SI:LISP-TOP-LEVEL1 ← SI:LISP-TOP-LEVEL
```

The arrows indicate the direction of calling. A numeric argument specifies how many frames to display.

The m-B command displays a more extensive backtrace, indicating the names of the arguments to the functions and their current values; for the example above it might look like:

```
BAZ:
   Arg 0 (X): 13
   Arg 1 (Y): 1

BAR:
   Arg 0 (ADDEND): 13

FOO:
   Arg 0 (FROB): (A B C . D)
```

c-m-B is comparable to m-B but also includes internal frames of the Lisp interpreter, which normally are skipped.

The c-N command moves down to the next frame (that is, it changes the current frame to be the frame that called it) and displays the frame in this same format. c-P or RETURN moves up to the previous frame (that is, the one that this one called) and displays the frame in the same format.

m-< moves to the stack frame where the error occurred (the top or most recent frame), whereas m-> goes to the bottom (the oldest frame); both display the new current frame. Use c-P after m-< to go up through **signal**, handlers, and so forth, in turn, until you get to the highest possible frame — the call to the Debugger itself.

c-S asks you for a string, and searches the stack for a frame whose executing function's name contains that string. That frame becomes current and is displayed.

m-L displays the current frame in full-screen format, which shows the arguments and their values, the local variables and their values, and the machine code with an arrow pointing to the next instruction to be executed. On the 3600, if a function **setq**s one of its arguments, m-L shows both the original argument supplied by the caller and the current value of the variable.

m-N moves to the next frame and displays it in full-screen format, and m-P moves to the previous frame and displays it in full-screen format.

Commands such as c-N and m-N, which are meaningful to repeat, take a prefix numeric argument and repeat that many times. The numeric argument is typed by using c- or m- and the number keys, as in the editor.

c-E puts you into the editor, looking at the source code for the function in the current frame. This is useful when you have found a function that caused the error and needs to be fixed. The editor command c-Z will return to the Debugger, if it is still there.

m-C is only available for such errors as an unbound variable or undefined function. It is similar to c-C, but actually **setq**s the variable or defines the function, so that the error does not happen again. c-C (or RESUME) provides a replacement value but does not actually change the variable.

c-sh-P is only available for such errors as an unbound variable or undefined function when there is a variable or function in another package that has the same name. It permits easy recovery when you forget to supply a package prefix.

c-R is used to return a value or values from the current frame; the frame that called that frame continues running as if the function of the current frame had returned. This command asks for as many values as the caller expects, which might be no values, one value, more than one, or an indefinite number of values. For each value it prompts you for a form, which it evaluates; it returns the resulting value, possibly after confirming it with you. If no values are expected, it requests confirmation before returning.

The c-T command does a ***throw** to a given tag with a given value; you are prompted for the tag and the value.

c-m-R is a variation of c-R; it starts the current frame over with the same function and arguments. If the function has been redefined in the meantime (perhaps you edited it and fixed its bug) the new definition is used. c-m-R asks for confirmation before doing it.

The c-m-N, c-m-P, and c-m-B commands are like the corresponding c- commands but do not censor the stack. When running interpreted code, the Debugger tries to skip over frames that belong to functions of the interpreter, such as ***eval**, **prog**, and **cond**, and only show "interesting" functions. The c-m-U command goes down the stack to the next interesting function and makes that the current frame.

c-m-A takes a numeric argument *n*, and displays the value of the *n*th argument of the current frame. The default value for the argument is 0, meaning the first frame. It leaves * set to the value of the argument, so that you can use the Lisp read-eval-print loop to examine it. It also leaves + set to a locative pointing to the argument on the stack, so that you can change that argument (by calling **rplacd** on the locative).

c-m-L is similar to c-m-A, but refers to the *n*th local variable of the frame.

c-m-V is similar to c-m-A, but refers to the *n*th value being returned by the frame. If the frame is not in the process of returning values, the command displays an error message. c-m-V is meaningful only when you are using trap-on-exit (see c-X) and looking at a frame that is about to return.

c-m-F is similar to c-m-A, but refers to the function executing in the frame; it ignores its numeric argument and does not allow you to change the function.

c-m-H describes any condition handlers established by the current frame (or its subframes if it is an interpreted function).

c-m-S describes any special-variable bindings in the current frame (or its subframes if it is an interpreted function).

m-S asks for the name of a special variable and displays its value in the binding context of the current frame. It leaves * set to the value that was displayed.

m-I (for "Instance") helps you examine the values of instance variables in the stack group being debugged. The command prompts you for the name of an instance variable and displays the value of that instance variable, inside the instance that is the value of **self** in the environment of the current frame.

c-m-W calls the Display Debugger, a window-oriented Debugger, which is not documented in this manual. It should, however, be usable without further documentation.

c-M sends a bug report. It creates a new process and runs the **bug** function in that process. It starts up a mail-sending window that contains a copy of the error message and an extensive backtrace of the stack. You are expected to supply context information explaining what you were doing when the problem occurred, preferably including a way for the person reading the bug report to make it happen again. The stack trace by itself is not adequate information for debugging. When you type the END key the bug report is transmitted as mail and the window containing the Debugger is reselected. You can also use normal window-switching commands such as FUNCTION S to switch back and forth between the Debugger and the mail-sending window while composing the bug report. A numeric argument to c-M controls the number of stack frames in the backtrace that have complete information. The current stack frame at the time c-M is typed begins the backtrace, so you might want to type m-< before c-M if you have been examining other frames than the one that got the error.

c-X toggles the trap-on-exit flag of the current frame and displays its new state. m-X sets the trap-on-exit flag in the current frame and all its callers. c-m-X clears the trap-on-exit flag in the current frame and all its callers. If a frame with the trap-on-exit flag set returns or is thrown through, the Debugger is entered. Press RESUME to continue returning or throwing. The ABORT key, however, bypasses the trap-on-exit mechanism.

The Debugger's command loop lets you type in Lisp forms, which it reads, evaluates, and prints. When you are typing these forms, you can use the following functions to examine or modify the arguments, locals, function object, and values being returned in the current frame.

dbg:arg *name-or-number* *Function*

Returns the value of argument *name-or-number* in the current stack frame. **(setf (dbg:arg** *n*) **x)** sets the value of the argument *n* in the current frame to the value of **x**. *name-or-number* can be the number of the argument (for example, 0 to specify the first argument) or the name of the argument. This function can be called only from the read-eval-print loop of the Debugger.

dbg:loc *name-or-number* *Function*

Returns the value of the local variable *name-or-number* in the current stack frame. **(setf (dbg:loc** *n*) **x)** sets the value of the local variable *n* in the current frame to the value of **x**. *name-or-number* can be the number of the local variable (for example, 0 to specify the first local variable) or the name of the local variable. This function can be called only from the read-eval-print loop of the Debugger.

(dbg:loc 'epsilon)

dbg:fun *Function*

Returns the function object of the current stack frame. **(setf (dbg:fun) x)** sets the function object of the current frame to the value of **x**. This function can be called only from the read-eval-print loop of the Debugger.

dbg:val &optional *val-no 0* *Function*

Returns the value of the *val-no*th value to be returned from the current stack frame. **(setf (dbg:val** *val-no*) **x)** sets the value of the *val-no*th value to be returned from the current frame to the value of **x**. *val-no* must be a fixnum (since values do not have names) and defaults to 0. **(dbg:val)** without a value number gives the first value. This function can be called only from the read-eval-print loop of the Debugger.

~~(dbg:~~

The Debugger uses the following variables:

dbg:*frame* *Variable*

Inside the read-eval-print loop of the Debugger, the value of **dbg:*frame*** is the location of the current frame.

dbg:*defer-package-dwim* *Variable*

When this is **nil** (the default), the Debugger searches over all packages to find any look-alike symbols, when errors concerning unbound variables occur.

When the option is not **nil**, the search does not occur until you type c-sh-P. In this case the Debugger offers c-sh-P in the list of commands even if the search would find no look-alike symbols.

dbg:*debug-io-override* *Variable*

If the value of this variable is **nil** (the default), the Debugger uses the stream that is the value of **debug-io**. But if the value of **dbg:*debug-io-override*** is not **nil**, the Debugger uses the stream that is the value of this variable instead. This variable should always be set (using **setq**), not bound, so all processes and stack groups can see it.

dbg:*show-backtrace* *Variable*

Backtrace information appears when you enter the Debugger. The default is **nil**. @symindexm(pkg={dbg:},sym={*show-backtrace*},key={show-backtrace*})

Value	*Meaning*
nil	The Debugger startup message does not include any backtrace information.
t	The Debugger startup message includes a three-element backtrace.

4. Summary of Debugger Commands

c-A Displays argument list of function in current frame. It displays only the names of the arguments, not their values.

c-m-A Examines or changes the *n*th argument of the current frame.

c-B Displays a brief backtrace, including only the names of the functions.

m-B Displays a more extensive backtrace than c-B, including the names of the arguments to the functions and their current values.

c-m-B Displays a longer backtrace than c-B and m-B, providing the names of the arguments to the functions and their current values as well as the internal frames of the Lisp interpreter.

c-C, RESUME Attempts to continue execution, if possible.

m-C Attempts to continue, **setq**ing the unbound variable or otherwise permanently fixing the error.

c-E Puts you in the editor with the cursor positioned at the source code for the function in the current frame. c-Z to return

c-m-F Sets * to the function in the current frame.

c-G or ABORT Quits various Debugger commands; use to escape from typing in a form.

c-m-H Describes any condition handlers established by the current frame.

m-I Evaluates an instance variable of the instance that is **self** in the current frame.

c-L, REFRESH Redisplays error message and current frame.

* m-L Displays full-screen typeout of current frame.

c-m-L Gets local variable *n*.

c-M Sends mail to report a bug.

c-N, LINE Moves to next frame. With argument of *n*, moves down *n* frames.

m-N Moves to next frame with full-screen typeout. With argument of *n*, moves down *n* frames.

c-m-N Moves to next frame even if it is "uninteresting". With argument of *n*, moves down *n* frames.

c-P, RETURN Moves to previous frame. With argument of *n*, moves up *n* frames.

m-P Moves to previous frame with full-screen typeout. With argument of *n*, moves up *n* frames.

c-m-P Moves to previous frame even if it is "uninteresting". With argument of *n*, moves up *n* frames.

c-R Returns from the current frame.

c-m-R Reinvokes the function in the current frame (throws back to it and starts it over at its beginning).

c-S Searches for a frame containing a user-specified function.

m-S Evaluates a special variable in the binding context of the current frame.

c-m-S Describes any special-variable bindings established by the current frame.

c-T Throws a value to a tag.

c-m-U Moves down the stack to the next "interesting" frame.

c-m-V Gets the *n*th value being returned by the current frame.

c-m-W Invokes the Display Debugger.

c-X Toggles the trap-on-exit flag of the current frame.

m-X Sets the trap-on-exit flag in the current frame and all its callers.

c-m-X Clears the trap-on-exit flag in the current frame and all its callers.

c-Z, ABORT Aborts the computation and throws back to the most recent **break** or Debugger, to the program's "command level", or to Lisp top level.

? or HELP Displays a brief help message.

c-HELP Displays a detailed help message.

m-< Goes to top or most recent frame of stack, the stack where the error occurred.

m-> Goes to bottom or oldest frame of stack.

c-0—c-m-9 Numeric arguments to the following command are specified by typing a decimal number with the CONTROL and/or META keys held down.

5. Summary of Debugging Aids

Anyone who writes programs for the Lisp Machine should become familiar with these debugging facilities.

- The *trace* facility provides the ability to perform certain actions at the time a function is called or at the time it returns. The actions may be simple typeout, or more sophisticated debugging functions. See the section "Tracing Function Execution".
- The *advise* facility is a somewhat similar facility for modifying the behavior of a function. See the section "Advising a Function".
- The *step* facility allows the evaluation of a form to be intercepted at every step so that the user may examine just what is happening throughout the execution of the form. See the section "Stepping Through an Evaluation".
- The *evalhook* facility allows you to get at a particular Lisp form whenever the evaluator is called. The step facility uses **evalhook**. See the section "**evalhook**".
- The *MAR* facility (available only on the LM-2) provides the ability to cause a trap on any memory reference to a word (or a set of words) in memory. If something is getting clobbered by agents unknown, the MAR facility can help track down the source of the problem.

See the section "Tracing and Stepping".

6. Tracing Function Execution

The trace facility allows you to *trace* some functions. Tracing is useful when you need to find out why a program behaves in an unexpected manner, particularly when you suspect that arguments are being passed incorrectly or functions are being called in the wrong sequence. The trace facility is closely compatible with Maclisp.

Certain special actions are taken when a traced function is called and when it returns. The default tracing action prints a message when the function is called, showing its name and arguments, and another message when the function returns, showing its name and value(s). See the section "Tracing".

You invoke the trace facility in several ways:

- Use the **trace** and **untrace** special forms.
- Click on [Trace] in the System menu. Enter or point to the function to be traced; a menu of options pops up.
- Invoke the Trace (m-X) command in the editor. Enter the function to be traced; a menu of options pops up.

The menu options are also available with **trace**; however, the syntax is complex. For a table explaining the correspondence between menu options and **trace** options: See the section "Tracing".

trace *Special Form*

A **trace** form looks like:

```
(trace spec-1 spec-2 ...)
```

Each *spec* can take any of the following forms:

a symbol

This is a function name, with no options. The function is traced in the default way, printing a message each time it is called and each time it returns.

a list (*function-name option-1 option-2* ...)

function-name is a symbol and the *options* control how it is to be traced. For a list of the various options: See the section "Options to **trace**". Some options take arguments, which should be given immediately following the option name.

a list (**:function** *function-spec option-1 option-2* ...)

This option is like the previous form except that *function-spec* need not be a symbol. (See the section "Function Specs".) It exists because if *function-name* were a list in the previous form, it would instead be interpreted as the following form:

a list **(***(function-1 function-2...)* *option-1 option-2* **...)**
All of the functions are traced with the same options. Each *function* can be either a symbol or a general function-spec.

trace returns as its value a list of names of all functions it traced. If called with no arguments, as just **(trace)**, it returns a list of all the functions currently being traced.

If you attempt to trace a function already being traced, **trace** calls **untrace** before setting up the new trace.

Tracing is implemented with encapsulation, so if the function is redefined (for example, with **defun** or by loading it from a compiled code file) the tracing is transferred from the old definition to the new definition.

See the section "Encapsulations".

6.1 Options to trace

The following **trace** options exist:

:break *pred*
Enters a breakpoint after printing the entry trace information but before applying the traced function to its arguments, if and only if *pred* evaluates to non-**nil**. During the breakpoint, the symbol **arglist** is bound to a list of the arguments of the function.

:exitbreak *pred*
This is just like **:break** except that the breakpoint is entered after the function has been executed and the exit trace information has been printed, but before control returns. During the breakpoint, the symbol **arglist** is bound to a list of the arguments of the function, and the symbol **values** is bound to a list of the values that the function is returning.

:error Calls the Debugger when the function is entered. Use RESUME (or c-C) to continue execution of the function. If this option is specified, no printed trace output appears other than the error message displayed by the Debugger. (Note: If you also want to call the Debugger when the function returns, use the Debugger's c-X command.)

:step Steps through the function whenever it is called. See the section "Stepping Through an Evaluation".

:entrycond *pred*
Prints trace information on function entry only if *pred* evaluates to non-**nil**.

:exitcond *pred*
Prints trace information on function exit only if *pred* evaluates to non-**nil**.

:cond *pred*

Prints trace information on function entry and exit only if *pred* evaluates to non-**nil**.

:wherein *function*

Traces the function only when it is called, directly or indirectly, from the specified function *function*. You can give several trace specs to **trace**, all specifying the same function but with different **:wherein** options, so that the function is traced in different ways when called from different functions.

This is different from **advise-within**, which only affects the function being advised when it is called directly from the other function. The **trace :wherein** option means that when the traced function is called, the special tracing actions occur if the other function is the caller of this function, or its caller's caller, or its caller's caller's caller, and so on.

:argpdl *pdl*

Specifies a symbol *pdl*, whose value is initially set to **nil** by **trace**. When the function is traced, a list of the current recursion level for the function, the function's name, and a list of arguments is pushed onto the *pdl* when the function is entered, and then popped when the function is exited. The *pdl* can be inspected from within a breakpoint, for example, and used to determine the very recent history of the function. This option can be used with or without printed trace output. Each function can be given its own pdl, or one pdl can serve several functions.

:entryprint *form*

form is evaluated and the value is included in the trace message for calls to the function. You can give this option more than once, and all the values will appear, preceded by \\.

:exitprint *form*

form is evaluated and the value is included in the trace message for returns from the function. You can give this option more than once, and all the values will appear, preceded by \\.

:print *form*

form is evaluated and the value is included in the trace messages for both calls to and returns from the function. You can give this option more than once, and all the values will appear, preceded by \\.

:entry *list*

Specifies a list of arbitrary forms whose values are printed along with the usual entry-trace. The list of resultant values, when printed, is preceded by \\ to separate it from the other information.

:exit *list*

Similar to **:entry**, but specifies expressions whose values are printed with the exit-trace. The list of values printed is preceded by \\.

:arg :value :both nil

Specifies which of the usual trace printouts should be enabled.

If you specify	*Then*
:arg	On function entry prints the name of the function and the values of its arguments.
:value	On function exit prints the returned value(s) of the function.
:both	Same as if both **:value** and **:arg** were specified.
nil	Same as if neither **:value** or **:arg** was specified.
None	The default is to **:both**.

If any further *options* appear after one of these, they are not treated as options. Rather, they are considered to be arbitrary forms whose values are to be printed on entry and/or exit to the function, along with the normal trace information. The values printed are preceded by a //, and follow any values specified by **:entry** or **:exit**. Note that since these options "swallow" all following options, if one is given it should be the last option specified.

(trace whatever :both (cdr arglist))

If the variable **arglist** is used in any of the expressions given for the **:cond**, **:break**, **:entry**, or **:exit** options, or after the **:arg**, **:value**, **:both**, or **nil** option, when those expressions are evaluated the value of **arglist** will be bound to a list of the arguments given to the traced function. Thus the following form would cause a break in **foo** if and only if the first argument to **foo** is **nil**.

```
(trace (foo :break (null (car arglist))))
```

If the **:break** or **:error** option is used, the variable **arglist** will be valid inside the break-loop. If you **setq arglist**, the arguments seen by the function will change.

Similarly, the variable **values** will be a list of the resulting values of the traced function. For obvious reasons, this should only be used with the **:exit** option. If the **:exitbreak** option is used, the variables **values** and **arglist** are valid inside the break-loop. If you **setq values**, the values returned by the function will change.

You can "factor" the trace specifications, as explained earlier. For example,

```
(trace ((foo bar) :break (bad-p arglist) :value))
```

is equivalent to

```
(trace (foo :break (bad-p arglist) :value)
       (bar :break (bad-p arglist) :value))
```

Since a list as a function name is interpreted as a list of functions, nonatomic function names are specified as follows:

```
(trace (:function (:method flavor :message) :break t))
```

(See the section "Function Specs".)

trace-compile-flag *Variable*

If the value of **trace-compile-flag** is non-**nil**, the functions created by **trace** will get compiled, allowing you to trace special forms such as **cond** without interfering with the execution of the tracing functions. The default value of this flag is **nil**.

6.2 Controlling the Format of trace Output

Tracing output is printed on the stream that is the value of **trace-output**. This is synonymous with **terminal-io** unless you change it. Following is an example of the default form of **trace** output:

```
1 Enter FACT 4.
| 2 Enter FACT 3.
|   3 Enter FACT 2.
|   | 4 Enter FACT 1.
|   |   5 Enter FACT 0.
|   |   5 Exit FACT 1.
|   | 4 Exit FACT 1.
|   3 Exit FACT 2.
| 2 Exit FACT 6.
1 Exit FACT 24.
```

You can use the variables **si:*trace-columns-per-level***, **si:*trace-bar-p***, **si:*trace-bar-rate***, and **si:*trace-old-style*** to control the format of **trace** output.

si:*trace-columns-per-level* *Variable*

For **trace** output, controls the number of columns of indentation that are added for each level of function call. The value must be an integer. The default is 2.

si:*trace-bar-p* *Variable*

For **trace** output, controls whether columns of vertical bars are printed. If the value is not **nil**, they are printed; otherwise, spaces are printed instead of the vertical bars. The default is **t** (print the bars).

si:*trace-bar-rate* *Variable*

When **si:*trace-bar-p*** is not **nil**, columns of vertical bars are printed in **trace** output for every *n* levels of function call, where *n* is the value. The value must be an integer. The default is 2.

si:*trace-old-style* *Variable*

If not **nil**, the old, Maclisp-compatible form of printing **trace** output is used. The default is **nil** (use the new style).

6.3 Untracing Function Execution

untrace &quote &rest *fns* *Special Form*

Use **untrace** to undo the effects of **trace** and restore functions *fns* to their normal, untraced state. **untrace** takes multiple specifications, for example, **(untrace foo bar baz)**. Calling **untrace** with no arguments untraces all functions currently being traced.

7. Advising a Function

To *advise* a function is to tell a function to do something extra in addition to its actual definition. Advising is achieved by means of the function **advise**. The something extra is called a piece of advice, and it can be done before, after, or around the definition itself. The advice and the definition are independent, in that changing either one does not interfere with the other. Each function can be given any number of pieces of advice.

Advising is fairly similar to tracing, but its purpose is different. Tracing is intended for temporary changes to a function to give the user information about when and how the function is called and when and with what value it returns. Advising is intended for semipermanent changes to what a function actually does. The differences between tracing and advising are motivated by this difference in goals.

Advice can be used for testing out a change to a function in a way that is easy to retract. In this case, you would call **advise** from the terminal. It can also be used for customizing a function that is part of a program written by someone else. In this case you would be likely to put a call to **advise** in one of your source files or your login init file rather than modifying the other person's source code. See the section "Logging in".

Advising is implemented with encapsulation, so if the function is redefined (for example, with **defun** or by loading it from a compiled code file), the advice will be transferred from the old definition to the new definition. See the section "Encapsulations".

advise *function class name position* &body *forms* *Special Form*

A function is advised by the special form

```
(advise function class name position
  form1 form2...)
```

None of this is evaluated.

function Specifies the function to put the advice on. It is usually a symbol, but any function spec is allowed. (See the section "Function Specs".)

class Specifies either **:before**, **:after**, or **:around**, and says when to execute the advice (before, after, or around the execution of the definition of the function). The meaning of **:around** advice is explained a couple of sections below.

name Specifies an arbitrary symbol that is remembered as the name of this particular piece of advice. It is used to keep track of multiple pieces of advice on the same function. If you have no name in mind, use **nil**; then we say the piece of advice is anonymous.

A given function and class can have any number of pieces of anonymous advice, but it can have only one piece of named advice for any one name. If you try to define a second one, it replaces the first.

Advice for testing purposes is usually anonymous. Advice used for customizing someone else's program should usually be named so that multiple customizations to one function have separate names. Then, if you reload a customization that is already loaded, it does not get put on twice.

position Specifies where to put this piece of advice in relation to others of the same class already present on the same function.

Position can have these values:

- *position* can be **nil**. The new advice goes in the default position: it usually goes at the beginning (where it is executed before the other advice), but if it is replacing another piece of advice with the same name, it goes in the same place that the old piece of advice was in.
- *position* can be a number, which is the number of pieces of advice of the same class to precede this one. For example, 0 means at the beginning; a very large number means at the end.
- *position* can have the name of an existing piece of advice of the same class on the same function; the new advice is inserted before that one.

forms Specifies the advice; they get evaluated when the function is called.

Example: The following form modifies the factorial function so that if it is called with a negative argument it signals an error instead of running forever.

```
(advise factorial :before negative-arg-check nil
  (if (minusp (first arglist))
      (ferror "factorial of negative argument")))
```

unadvise &optional *function class position* *Special Form*

Removes pieces of advice. None of its subforms are evaluated. *function* and *class* have the same meaning as they do in the function **advise**. *position* specifies which piece of advice to remove. It can be the numeric index (0 means the first one) or it can be the name of the piece of advice.

unadvise can remove more than one piece of advice if some of its arguments are missing or **nil**. The arguments *function*, *class*, and *position* all act independently. A missing value or **nil** means all possibilities for that aspect of advice. For example, the following form removes all **:before**, **:after**, and **:around** advice named **negative-arg-check** on the **factorial** function.

```
(unadvise factorial nil negative-arg-check)
```

In this example **unadvise** removes all **:around** advice on all functions in all positions with all names.

```
(unadvise nil :around)
```

In this example **unadvise** removes all classes of advice named **my-personal-advice** on all functions.

```
(unadvise nil nil my-personal-advice)
```

(unadvise) removes all advice on all functions, since *function*, *class*, and *position* take on all possible values.

The following are the primitive functions for adding and removing advice. Unlike the special forms **advise** and **unadvise**, the following are functions and can be conveniently used by programs. **advise** and **unadvise** are actually macros that expand into calls to these two.

si:advise-1 *function class name position forms* *Function*
Adds advice. The arguments have the same meaning as in **advise**. Note that the *forms* argument is *not* a **&rest** argument.

si:unadvise-1 *function* &optional *class position* *Function*
Removes advice. *function*, *class*, and *position* are independent. If *function*, *class*, or *position* is **nil**, or if *class* or *position* is unspecified, all classes of advice or advice for all functions, at all positions, or with all names is removed.

You can find out manually what advice a function has with **grindef**, which grinds the advice on the function as forms that are calls to **advise**. These are in addition to the definition of the function.

To poke around in the advice structure with a program, you must work with the encapsulation mechanism's primitives. See the section "Encapsulations".

si:advised-functions *Variable*
A list of all functions that have been advised.

7.1 Designing the Advice

For advice to interact usefully with the definition and intended purpose of the function, it must be able to interface to the data flow and control flow through the function. The system provides conventions for doing this.

The list of the arguments to the function can be found in the variable **arglist**. **:before** advice can replace this list, or an element of it, to change the arguments passed to the definition itself. If you replace an element, it is wise to copy the whole list first with:

```
    (setq arglist (copylist arglist))
```

After the function's definition has been executed, the list of the values it returned can be found in the variable **values**. **:after** advice can set this variable or replace its elements to cause different values to be returned.

All the advice is executed within a **prog**, so any piece of advice can exit the entire function and return some values with **return**. No further advice will be executed. If a piece of **:before** advice does this, then the function's definition will not even be called.

7.2 :around Advice

A piece of **:before** or **:after** advice is executed entirely before or entirely after the definition of the function. **:around** advice is wrapped around the definition; that is, the call to the original definition of the function is done at a specified place inside the piece of **:around** advice. You specify where by putting the symbol **:do-it** in that place.

For example, **(+ 5 :do-it)** as a piece of **:around** advice would add **5** to the value returned by the function. This could also be done by the following:

```
    (setq values (list (+ 5 (car values))))
```

as **:after** advice.

When there is more than one piece of **:around** advice, they are stored in a sequence just like **:before** and **:after** advice. Then, the first piece of advice in the sequence is the one started first. The second piece is substituted for **:do-it** in the first one. The third one is substituted for **:do-it** in the second one. The original definition is substituted for **:do-it** in the last piece of advice.

:around advice can access **arglist**, but **values** is not set up until the outermost **:around** advice returns. At that time, it is set to the value returned by the **:around** advice. It is reasonable for the advice to receive the values of the **:do-it** (for example, with **multiple-value-list**) and play with them before returning them (for example, with **values-list**).

:around advice can **return** from the **prog** at any time, whether the original definition has been executed yet or not. It can also override the original definition by failing to contain **:do-it**. Containing two instances of **:do-it** can be useful under peculiar circumstances. If you are careless, however, the original definition might be called twice, but something like the following certainly works reasonably.

```
    (if (foo) (+ 5 :do-it) (* 2 :do-it))
```

7.3 Advising One Function Within Another

It is possible to advise the function **foo** only when it is called directly from a specific other function **bar**. You do this by advising the function specifier **(:within bar foo)**. That works by finding all occurrences of **foo** in the definition of **bar** and replacing them with **altered-foo-within-bar**. This can be done even if **bar**'s definition is compiled code. The symbol **altered-foo-within-bar** starts off with the symbol **foo** as its definition; then the symbol **altered-foo-within-bar**, rather than **foo** itself, is advised. The system remembers that **foo** has been replaced inside **bar**, so that if you change the definition of **bar**, or advise it, then the replacement is propagated to the new definition or to the advice. If you remove all the advice on **(:within bar foo)**, so that its definition becomes the symbol **foo** again, then the replacement is unmade and everything returns to its original state.

(grindef bar) prints **foo** where it originally appeared, rather than **altered-foo-within-bar**, so the replacement will not be seen. Instead, **grindef** prints calls to **advise** to describe all the advice that has been put on **foo** or anything else within **bar**.

An alternate way of putting on this sort of advice is to use **advise-within**.

advise-within *within-function function-to-advise class name position* &body *forms* *Special Form*

An **advise-within** form looks like this:

```
(advise-within within-function function-to-advise
               class name position
            forms...)
```

It advises *function-to-advise* only when called directly from the function *within-function*. The other arguments mean the same thing as with **advise**. None of them is evaluated.

To remove advice from **(:within bar foo)**, you can use **unadvise** on that function specifier. Alternatively, you can use **unadvise-within**.

unadvise-within *within-function* &optional *advised-function class position* *Special Form*

An **unadvise-within** form looks like this:

```
(unadvise-within within-function function-to-advise class position)
```

It removes advice that has been placed on `(:within` *within-function function-to-advise*`)`. The arguments *class* and *position* are interpreted as for **unadvise**.

For example, if those two arguments are omitted, then all advice placed on *function-to-advise* within *within-function* is removed. Additionally, if *function-to-advise* is omitted, all advice on any function within *within-function* is removed. If there are no arguments, than all advice on one function within another is removed. Other pieces of advice, which have been placed on one function and not limited to within another, are not removed.

(unadvise) removes absolutely all advice, including advice for one function within another.

The function versions of **advise-within** and **unadvise-within** are called **si:advise-within-1** and **si:unadvise-within-1** respectively. **advise-within** and **unadvise-within** are macros that expand into calls to the other two.

8. Stepping Through an Evaluation

The step facility gives you the ability to follow every step of the evaluation of a form and examine what is going on. It is analogous to a single-step proceed facility often found in machine-language debuggers. Use the step facility if your program is behaving strangely, and it is not obvious how it is getting into this strange state. See the section "Stepping".

You can enter the stepper in two ways:

- Use the **step** function.
- Use the **:step** option of **trace**.

step *form* *Function*

step evaluates *form* with single stepping. It returns the value of *form*.

For example, if you have a function named **foo**, and typical arguments to it might be **t** and **3**, you could say

```
(step '(foo t 3))
```

If a function is traced with the **:step** option, then whenever that function is called it will be single stepped. See the section "Options to **trace**". Note that any function to be stepped must be interpreted; that is, it must be a lambda-expression. Compiled code cannot be handled by the stepper.

When evaluation is proceeding with single stepping, before any form is evaluated, it is (partially) printed out, preceded by a right-facing arrow (→) character. When a macro is expanded, the expansion is printed out preceded by a double arrow (↔) character. When a form returns a value, the form and the values are printed out preceded by a left-facing arrow (←) character; if more than one value is being returned, an and-sign (^) character is printed between the values.

Since the forms can be very long, the stepper does not print all of a form; it truncates the printed representation after a certain number of characters. Also, to show the recursion pattern of who calls whom in a graphic fashion, it indents each form proportionally to its level of recursion.

After the stepper prints any of these things, it waits for a command from you. A variety of commands exist to tell the stepper how to proceed, or to look at what is happening.

c-N (Next) Steps to the next thing. The stepper continues until the next thing to print out, and it accepts another command.

SPACE Goes to the next thing at this level. In other words, it continues to evaluate at this level, but does not step anything at lower levels. In this way you can skip over parts of the evaluation that do not interest you.

c-U (Up) Continues evaluating until we go up one level. Similar to the SPACE command; it skips over anything on the current level as well as lower levels.

c-X (eXit) Exits; finishes evaluating without any more stepping.

c-T (Type) Retypes the current form in full (without truncation).

c-G (Grind) Grinds (that is, pretty-prints) the current form.

c-E (Editor) Enters the editor.

c-B (Breakpoint)

This command puts you into a breakpoint (that is, a read-eval-print loop) from which you can examine the values of variables and other aspects of the current environment. From within this loop, the following variables are available:

step-form The current form.

step-values The list of returned values.

step-value The first returned value.

If you change the values of these variables, it will work.

c-L Clears the screen and redisplays the last ten pending forms (forms being evaluated).

m-L Like c-L, but does not clear the screen.

c-m-L Like c-L, but redisplays all pending forms.

? or HELP Prints documentation on these commands.

It is strongly suggested that you write a little function and try the stepper on it. If you get a feel for what the stepper does and how it works, you will be able to tell when it is the right thing to use to find bugs.

9. evalhook

The **evalhook** facility provides a "hook" into the evaluator; it is a way you can get a Lisp form of your choice to be executed whenever the evaluator is called. The stepper uses **evalhook**; however, if you want to write your own stepper or something similar, then use this primitive albeit complex facility to do so.

evalhook *Variable*

If the value of **evalhook** is non-**nil**, then special things happen in the evaluator. When a form (any form, even a number or a symbol) is to be evaluated, **evalhook** is bound to **nil** and the function that was **evalhook**'s value is applied to one argument — the form that was trying to be evaluated. The value it returns is then returned from the evaluator.

evalhook is bound to **nil** by **break** and by the Debugger, and **setq**ed to **nil** when errors are dismissed by throwing to the Lisp top-level loop. This provides the ability to escape from this mode if something bad happens.

In order not to impair the efficiency of the Lisp interpreter, several restrictions are imposed on **evalhook**. It only applies to evaluation — whether in a read-eval-print loop, internally in evaluating arguments in forms, or by explicit use of the function **eval**. It does *not* have any effect on compiled function references, on use of the function **apply**, or on the "mapping" functions. (In Zetalisp, as opposed to Maclisp, it is not necessary to do **(*rset t)** nor **(sstatus evalhook t)**. Also, Maclisp's special-case check for **store** is not implemented.)

evalhook *form evalhook* &optional *applyhook* *Function*

evalhook is a function that helps exploit the **evalhook** feature. The *form* is evaluated with **evalhook** lambda-bound to the function *evalhook*. The checking of **evalhook** is bypassed in the evaluation of *form* itself, but not in any subsidiary evaluations, for instance of arguments in the *form*. This is like a "one-instruction proceed" in a machine-language debugger.

```
Example:
;; This function evaluates a form while printing debugging
;; information.
(defun hook (x)
   (terpri)
   (evalhook x 'hook-function))

;; Notice how this function calls evalhook to evaluate the
;;  form f, so as to hook the subforms.
(defun hook-function (f)
   (let ((v (evalhook f 'hook-function)))
     (format t "form: ~s~%value: ~s~%" f v)
     v))

;; This isn't a very good program, since if f returns multiple
;; values, it will not work.
```

The following output might be seen from **(hook '(cons (car '(a . b)) 'c))**:

```
form: (quote (a . b))
value: (a . b)
form: (car (quote (a . b)))
value: a
form: (quote c)
value: c
(a . c)
```

Normally after **eval** has evaluated the arguments to a function, it calls the function. If *applyhook* exists, however, **eval** calls the hook with two arguments: the function and its list of arguments. The values returned by the hook constitute the values for the form. The hook could use **apply** on its arguments to do what **eval** would have done normally. This hook is active for special forms as well as for real functions.

Whenever either an evalhook or applyhook is called, both hooks are bound off. The evalhook itself can be **nil** if only an applyhook is needed.

applyhook catches only **apply** operations done by **eval**. It does not catch **apply** called in other parts of the interpreter or **apply** or **funcall** operations done by other functions such as **mapcar**. In general, such uses of **apply** can be dealt with by intercepting the call to **mapcar**, using the applyhook, and substituting a different first argument.

The argument list is like an &rest argument: it might be stack-allocated but is not guaranteed to be. Hence you cannot perform side-effects on it and you cannot store it in any place that does not have the same dynamic extent as the call to *applyhook*.

9.1 applyhook

applyhook provides a hook into **apply**, much as **evalhook** provides a hook into **eval**.

applyhook *Variable*

When the value of this variable is not **nil** and **eval** calls **apply**, **applyhook** is bound to **nil** and the function that was its value is applied to two arguments: the function that **eval** gave to **apply** and the list of arguments to that function. The value it returns is returned from the evaluator.

applyhook *function args evalhook applyhook* *Function*

function is applied to *args* with **evalhook** lambda-bound to the function *evalhook* and with **applyhook** lambda-bound to the function *applyhook*. Like the **evalhook** function, this bypasses the first place where the relevant hook would normally be triggered. Either of the last two arguments can be nil.

10. The MAR

The MAR facility exists only on the LM-2. The 3600 has no identical or equivalent facility.

The MAR facility allows any word or contiguous set of words to be monitored constantly, and can cause an error if the words are referenced in a specified manner. The name MAR derives from a similar device on the ITS PDP-10s and is an acronym for Memory Address Register. The MAR checking is done by the Lisp Machine's memory management hardware, and so the speed of general execution when the MAR is enabled is not significantly slowed down. However, the speed of accessing pages of memory containing the locations being checked is slowed down somewhat, since every reference involves a microcode trap.

The MAR is controlled by the following functions:

dbg:set-mar *location cycle-type* &optional *n-words '1* *Function*

The **dbg:set-mar** function clears any previous setting of the MAR, and sets the MAR on *n-words* words, starting at *location*. *location* can be any object. Often it will be a locative pointer to a cell, probably created with the **locf** special form. *n-words* currently defaults to 1. *cycle-type* determines under what conditions to trap and can have the following values:

:read	Only reading the location should cause an error.
:write	Only writing the location should cause an error.
t	Both reading and writing the location should cause an error.

To set the MAR to detect **setq** (and binding) of the variable **foo**, use:

```
(dbg:set-mar (value-cell-location 'foo) ':write)
```

dbg:clear-mar *Function*

Turns off the MAR. Warm booting the machine disables the MAR but does not turn it off; that is, references to the MARed pages are still slowed down. **dbg:clear-mar** does not speed things back up until the next time the pages are swapped out.

dbg:mar-mode *Function*

(dbg:mar-mode) returns a symbol indicating the current state of the MAR. It returns one of the following:

nil	The MAR is not set.
:read	The MAR causes an error if there is a read.

:write The MAR causes an error if there is a write.

t The MAR causes an error if there is any reference.

Note that using the MAR makes the pages on which it is set somewhat slower to access, until the next time they are swapped out and back in again after the MAR is shut off. Also, use of the MAR currently breaks the read-only feature if those pages were read-only.

Proceeding from a MAR break allows the memory reference that got an error to take place, and continues the program with the MAR still effective. When proceeding from a write, the Debugger asks you whether to allow the write to take place or to inhibit it, leaving the location with its old contents.

Most — but not all — write operations first do a read. **setq** and **rplaca** are examples. This means that if the MAR is in **:read** mode it will catch writes as well as reads; however, they will trap during the reading phase, and consequently the data to be written will not be displayed. This also means that setting the MAR to **t** mode causes most writes to trap twice, first for a read and then again for a write. So when the MAR says that it trapped because of a read, this means a read at the hardware level, which might not look like a read in your program.

11. Variable Monitoring

Variable monitoring works only on the LM-2.

monitor-variable *sym* &optional *current-value-cell-only-p* *monitor-function* — *Function*

Calls a given function just after *sym* is **setq**ed (by compiled code or otherwise). Does not trigger on binding of *sym*. The function is given both the old and new values as arguments. It does not get *sym*, the name of then variable, as an argument, so it is usually necessary to use a closure as *monitor-function* in order to remember this. The old value is **nil** if *sym* had been unbound.

The default monitoring function prints *sym* and the old and new values. This behavior can be changed by specifying the *monitor-function* argument.

Normally this feature applies to all **setqs**, but if *current-value-cell-only-p* is specified non-**nil**, it applies only to those **setqs** that would alter *sym*'s currently active value cell. This is only relevant when *sym* is subject to a closure.

Do not try to use this feature with variables that are forwarded to A-memory (for example, **inhibit-scheduling-flag**).

unmonitor-variable &optional *sym* — *Function*

If *sym* is being monitored, it is restored to normal. If no *sym* is specified, all variables that have been monitored are unmonitored.

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symbolics™

MAINT Maintaining Large Systems

Cambridge, Massachusetts

Maintaining Large Systems

# 995005

February 1984

This document corresponds to Release 5.0.

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Printing year and number: 87 86 85 84 9 8 7 6 5 4 3 2 1

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1. Introduction to Making a System

When a program gets large, it is often desirable to split it up into several files. One reason is to help keep the parts of the program organized, to make things easier to find. Another is that programs broken into small pieces are more convenient to edit and compile. It is particularly important to avoid the need to recompile all of a large program every time any piece of it changes; if the program is broken up into many files, only the files that have changes in them need to be recompiled.

The apparent drawback to splitting up a program is that more mechanism is needed to manipulate it. To load the program, you now have to load several files separately, instead of just loading one file. To compile it, you have to figure out which files need compilation, by seeing which have been edited since they were last compiled, and then you have to compile those files.

An even more complicated factor is that files can have interdependencies. You might have a file called "defs" that contains some macro definitions (or flavor or structure definitions), and functions in other files might use those macros. This means that in order to compile any of those other files, you must first load the file "defs" into the Lisp environment, so that the macros will be defined and can be expanded at compile time. You would have to remember this whenever you compile any of those files. Furthermore, if "defs" has changed, other files of the program might need to be recompiled because the macros might have changed and need to be reexpanded.

This chapter describes the *system* facility, which takes care of all these conditions for you. The way it works is that you define a set of files to be a *system*, using the **defsystem** special form. See the section "Defining a System". This system definition includes the following:

- Which files make up the system.
- Which files depend on the presence of others.
- What properties the system should have, for example, the package into which the object code should be compiled, or whether the system can be patched.

You put this system definition into its own little file, and then all you have to do is load that file (or have your init file load it) and the Lisp environment will know about your system and what files are in it. See the section "Loading the System Definition". You can then use the **make-system** function to load all the files of the system, recompile all the files that need compiling, and so on. See the section "Making a System".

The system facility is very general and extensible. This chapter explains how to use it and how to extend it. This chapter also explains the *patch* facility, which lets you conveniently update a large program with incremental changes.

2. Defining a System

defsystem *name* &body *options* *Special Form*

Defines a system named *name*. *options* are keywords and fall into three categories: properties of the system, modules, and transformations. (See the section "Transformations".) The simplest system is a set of files and a transformation to be performed on them.

Example 1.

```
(defsystem mysys
  (:compile-load ("q:>george>prog1" "q:>george2>prog2")))
```

Example 2.

```
(defsystem zmail
  (:name "Zmail")
  (:pathname-default "q:>zmail>")
  (:package zwei)
  (:module defs "defs")
  (:module mult "mult" :package tv)
  (:module main ("top" "comnds" "mail" "user" "window"
                 "filter" mult "cometh"))
  (:compile-load defs)
  (:compile-load main (:fasload defs)))
```

Example 3.

```
(defsystem bar
  (:module reader-macros "rdmac")
  (:module other-macros "macros")
  (:module main-program "main")
  (:compile-load reader-macros)
  (:compile-load other-macros (:fasload reader-macros))
  (:compile-load main-program (:fasload reader-macros
                                        other-macros)))
```

Example 1 defines a new system called **mysys**, which consists of two files, both of which are to be compiled and loaded.

Example 2 is somewhat more complicated. The primary difference is that there is a module **defs** that must be loaded before **main** can be compiled.

Example 3 has two levels of dependency. **reader-macros** must be compiled and loaded before **other-macros** can be compiled. Both **reader-macros** and **other-macros** must then be loaded before **main-program** can be compiled.

All the **defsystem** options, except transformations, are listed here.

:name Specifies a "pretty" version of the name for the system, for use in printing.

:short-name Specifies an abbreviated name used in constructing disk label comments and in patch file names for some file systems.

:component-systems
Specifies the names of other systems used to make up this system. Performing an operation on a system with component systems is equivalent to performing the same operation on all the individual systems. The format is

```
(:component-systems names...)
```

:package Specifies the package in which transformations are performed. A package specified here overrides the one specified in the attribute list of the file in question.

:pathname-default
Gives a local default within the definition of the system for strings to be parsed into pathnames. Typically this specifies the directory, when all the files of a system are on the same directory.

:patchable Allows the system to be patched. (See the section "Patch Facility".) An optional argument specifies the directory to put patch files in. The default is the **:pathname-default** of the system.

:initial-status Specifies what the status of the system should be when **make-system** is used to create a new major version. The default is **:experimental**. (See the section "Patchable System Status".)

:bug-reports Specifies the name of the system (a string) to which bug mail can be sent. Supply a documentation string describing the purpose of the bug mail. The name of the system appears in the Bug Mail menu (evoked by clicking middle on [Mail] in Zmail) and the documentation string appears in the mouse documentation line. Example: `:bug-reports "Daedalus" "Report problems with the Daedalus system."` sends mail to Bug-Daedalus.

:not-in-disk-label
Makes a patchable system not appear in the disk label comment. This should probably never be specified for a user system. It is used by patchable systems internal to the main Lisp system, to avoid cluttering up the label.

:maintaining-sites
Specifies the list of sites that maintain the system; declares which sites can patch a system and helps to monitor versions in order to ensure that no changes are lost. This option is meaningful only for patchable systems. For example:

```
(defsystem dla-file-system
  ...
  (:maintaining-sites :mit)
  ...)
```

The default for **:maintaining-sites** when it is undeclared is usually the local site. When you attempt to distribute a system with an undeclared maintaining site, you are warned and urged to supply a maintaining site.

When you attempt to patch a system that is not maintained at your site, you see a warning like the following:

```
System DLA-FILE-SYSTEM is not normally maintained at
this site.  Patching it here may result in version skews
and make it difficult for your site to receive
subsequent software updates.
Are you sure you really sure you want to patch it? (Yes
or No)
```

:module Allows assigning a name to a set of files within the system. You can use this name instead of repeating the filenames. The format is:

`(:module` *name module-specification options...*`)`

module-specification can be any of the following:

A string A file name.

A symbol A module name. It stands for all of the files that are in that module of this system.

An *external module component*
A list of the form `(`*system-name module-names...*`)`, to specify modules in another system. It stands for all of the files that are in all of those modules.

A list of *module components*
A module component is any *module-specification.*

A list of file names
Used in the case where the names of the input and output files of a transformation are not related according to the standard naming conventions, for example, when a compiled code file has a different name or resides in a different directory than the source file. The file names in the list are used from left to right, thus, the first name is the source file. Each file name after the first in the list is defaulted from the previous one in the list.

To avoid syntactic ambiguity, this is allowed as a module component but not as a module specification.

The **:module** clause takes the **:package** option, which overrides any package specified for the whole system for transformations performed on just this module. Sometimes you have a module that needs to use the packages specified by the files' attribute lists rather than the package declared for the system. You can make the files' package specs override the general one by putting **:package nil** in the module's plist (at the end of the **:module** declaration).

The second **defsystem** example lists three modules. The first two each have only one file, and the third one (**main**) is made up both of files and another module. To take examples of the other possibilities:

```
(:module prog (("q:>george>prog" "q:>george2>prog")))
(:module foo (defs (zmail defs)))
```

The **prog** module consists of one file, but it lives in two directories, george and george2. If this were a Lisp program, that would mean that the file "q:>george>prog.lisp" would be compiled into "q:>george2>prog.bin". The **foo** module consists of two other modules: the **defs** module in the same system and the **defs** module in the **zmail** system. It is not generally useful to compile files that belong to other systems; thus, this **foo** module would not normally be the subject of a transformation. However, *dependencies* use modules and need to be able to refer to (depend on) modules of other systems. See the section "Transformations".

3. Transformations

A *transformation* is an operation, such as compiling or loading, that takes one or more files and does something to them. Transformations are of two types: simple and complex. A *simple transformation* is a single operation on a file, such as compiling it or loading it. A *complex transformation* takes the output from one transformation and performs another transformation on it, for example, loading the results of compilation.

The general format of a simple transformation is:

(*name input dependencies condition*)

name The name of the transformation to be performed on all the files in the module, or all the output files of the other transformation.

input Usually a module specification or another transformation whose output is used. A module specification can have many different formats, including "anonymous" modules recursively including other modules. Read the description of the **:module** keyword: See the section "Defining a System".

dependencies Optional. *dependencies* is a transformation specification, which is either a list:

(*transformation-name module-names*...)

or a list of such lists. *module-names* is either a symbol that is the name of a module in the current system or a list (*system-name module-names*...).

condition Optional. *condition* is a predicate that specifies when the transformation should take place. Generally it defaults according to the type of the transformation. For a further discussion of conditions: See the section "More Esoteric Transformations".

A dependency declares that all of the indicated transformations must be performed on the indicated modules before the current transformation itself can take place. Thus, in the last line of the following example, the **defs** module must have the **:fasload** transformation performed on it before the **:compile-load** transformation can be performed on **main**.

```
(defsystem zmail
  (:name "Zmail")
  (:pathname-default "q:>zmail>")
  (:package zwei)
  (:module defs "defs")
  (:module mult "mult" :package tv)
  (:module main ("top" "comnds" "mail" "user" "window"
                 "filter" mult "cometh"))
  (:compile-load defs)
  (:compile-load main (:fasload defs)))
```

The dependency has to be a transformation that was explicitly specified as a transformation in the system definition, not just an action that might have been performed by anything. That is, if you have a dependency **(:fasload foo)**, it means that **(:fasload foo)** is a transformation of your system and you depend on that transformation; it does not simply mean that you depend on **foo** being loaded. It is not sufficient if the action is performed as part of a transformation on an anonymous module constructed of other modules, such as in the second example below. It is sufficient if a complex transformation, such as **:compile-load**, expands into the required transformation on the specified module, such as in the third example below.

For example, the following is correct and works properly:

```
(defsystem foo
  (:module foo "foo")
  (:module bar "bar")
  (:compile-load (foo bar)))
```

But the following example does not work because **foo**'s **:fasload** does not occur. The loading of **foo** is performed only implicitly as part of the **:fasload** transformation on the anonymous module **(foo bar)** implicit in the **(:compile-load (foo bar))**.

```
(defsystem foo
  (:module foo "foo")
  (:module bar "bar")
  (:module blort "blort")
  (:compile-load (foo bar))
  (:compile-load blort (:fasload foo)))
```

You must instead write:

```
(defsystem foo
  (:module foo "foo")
  (:module bar "bar")
  (:module blort "blort")
  (:compile-load foo)
  (:compile-load bar)
  (:compile-load blort (:fasload foo)))
```

In the above example, **(:fasload foo)** is part of the expansion of **(:compile-load foo)**; therefore, it can be used as a dependency.

The defined simple transformations are:

:fasload Calls the **si:load-binary-file** function to load the indicated files, which must be compiled code files. The *condition* defaults to **si:file-newer-than-installed-p**, which is **t** if a newer version of the file exists on the file computer than was read into the current environment.

:readfile Calls the **readfile** function to read the indicated files. Use this for files that are not to be compiled. *condition* defaults to **si:file-newer-than-installed-p**.

:compile Calls the **compiler:compile-file** function to compile the indicated files. *condition* defaults to **si:file-newer-than-file-p**, which returns **t** if the source file has been written more recently than the compiled code file.

A special simple transformation is:

:do-components `(:do-components` *dependencies*`)` inside a system with component systems causes the *dependencies* to be done before anything in the component systems. This is useful when you have a module of macro files used by all of the component systems.

The defined complex transformations are:

:compile-load `(:compile-load` *input compile-dependencies load-dependencies compile-condition load-condition*`)` is the same as `(:fasload (:compile` *input compile-dependencies compile-condition*`)` *load-dependencies load-condition*`)`. This is the most commonly used transformation. Everything after *input* is optional.

:compile-load-init See the section "More Esoteric Transformations".

Each file name in an input specification can in fact be a list of strings for the case where the source file of a program differs from the binary file in more than just the file type. In fact, every file name is treated as if it were an infinite list of file names with the last file name, or, in the case of a single string, the *only* file name, repeated forever at the end. Each simple transformation takes some number of input file name arguments, and some number of output file name arguments. As transformations are performed, these arguments are taken from the front of the file name list. The input arguments are actually removed, and the output arguments are left as input arguments to the next higher transformation.

To make this clearer, consider having the **:compile-load** transformation performed on the **prog** module:

```
(:module prog (("q:>george>prog" "q:>george2>prog")))
```

This means that **prog** is given as the input to the **:compile** transformation and the output from this transformation is given as the input to the **:fasload** transformation. The **:compile** transformation takes one input file name argument — the name of a Lisp source file — and one output file name argument — the name of the compiled code file. The **:fasload** transformation takes one input file name argument — the name of a compiled code file — and no output file name arguments. So, for the first and only file in the **prog** module, the file name argument list looks like ("q:>george>prog" "q:>george2>prog" "q:>george2>prog" ...). The **:compile** transformation is given arguments of "q:>george>prog" and "q:>george2>prog" and the file name argument list, which it outputs as the input to the **:fasload** transformation, is ("q:>george2>prog" "q:>george2>prog" ...). The **:fasload** transformation then is given its one argument of "q:>george2>prog".

Note that dependencies are neither transitive nor inherited. For example, if module **a** depends on macros defined in module **b**, and therefore needs **b** to be loaded in order to compile, and if **b** has a similar dependency on **c**, then **c** will not be loaded during compilation of **a**. Transformations with these dependencies would be written as follows:

```
(:compile-load a (:fasload b))
(:compile-load b (:fasload c))
```

To say that compilation of **a** depends on both **b** and **c**, you would instead write:

```
(:compile-load a (:fasload b c))
(:compile-load b (:fasload c))
```

If, in addition, **a** depended on **c**, but not **b**, during loading (perhaps **a** contains **defvars** whose initial values depend on functions or special variables defined in **c**) you would write the transformations as follows:

```
(:compile-load a (:fasload b c) (:fasload c))
(:compile-load b (:fasload c))
```

4. Loading the System Definition

Typically, you place the system definition (the **defsystem** invocation) in a source file. The file must have the canonical file type of **:lisp**.

si:set-system-source-file *system-name source-file* *Function*

si:set-system-source-file allows you to specify *source-file*, the source file that contains the definition of the system called *system-name*, before the system is loaded. *source-file* is loaded the first time that you use **make-system** to load and/or compile your system. *system-name* is the symbol that you supply to **make-system**.

Use **si:set-system-source-file** in your init file.

make-system offers to compile and load a new version of the file containing the system definition if it has changed.

Note for users of ITS: This feature of **make-system** works only if the file containing the **defsystem** form has a file type of **lisp**, that is, an FN2 of > on ITS. Thus, if you have a file FOO PKG and want to benefit from using this feature of **make-system**, you should rename the file FOOPKG >.

make-system has a feature for finding how out to make a system that has not been defined already. When the system it is looking for has not been defined already or been set up with **si:set-system-source-file**, it looks for system definition information in a file with the following name:

sys: site; *system-name* system

That file should contain **si:set-system-source-file**. For more information: See the document *Software Installation Guide*.

5. Making a System

make-system *name* &rest *keywords* *Function*

Compiles and/or loads a system defined by **defsystem**. Consider the following system declaration:

```
(defsystem mysys
  (:compile-load ("q:>george>prog1" "q:>george2>prog2")))
```

If "q:>george>progl" and "q:>george2>prog2" have both been compiled recently, then **make-system** only loads them as necessary:

```
(make-system 'mysys)
```

make-system supports a number of *keyword* options. For example, if any of the constituent files of **mysys** also needs to be compiled, then use:

```
(make-system 'mysys :compile)
```

make-system lists what transformations it is going to perform on what files, asks the user for confirmation, then performs the transformations. Prior to each transformation a message is printed listing the transformation being performed, the file to which it is being done, and the package.

```
Load all twenty-six of them? (Y, N, or S)
```

If you answer S (meaning *selective*), you are asked for confirmation of each individual transformation.

The behavior of **make-system** can be altered by keywords.

If you run **make-system** on a system that is patchable and not already loaded, **make-system** calls **load-patches** after loading the system. **load-patches** is called with the same options as **make-system**; if **make-system** is specified with the **:silent** keyword, **load-patches** is also silent.

5.1 make-system keywords

The **make-system** function recognizes the following keywords:

:batch Allows a large compilation to be done unattended. It acts like **:noconfirm** with regard to questions, turns off more-processing and **fdefine-warnings**, and saves the compiler warnings in an editor buffer and a file (it asks you for the name). See the variable **inhibit-fdefine-warnings**. Func 16

:compile Compiles files also if necessary. The default is to load but not compile. **:compile** always compiles the newest versions of the system's files. unless there is a ~~newer~~ bin file already
(even of an earlier version)

:noconfirm Assumes a yes answer for all questions that you would otherwise be asked.

:noload Does not load any files except those required by dependencies. For use in conjunction with the **:compile** option.

:noop Is ignored. This is mainly useful for programs that call **make-system**, so that such programs can include forms like:

```
(make-system 'mysys (if compile-p ':compile ':noop))
```

:nowarn Suppresses questions requiring operator response. Otherwise you must give permission (yes or no) to have straightforward tasks (like reading files) performed.

:print-only Displays the transformations that would be performed; does not actually do any compiling or loading.

:recompile Compiles all files, regardless of whether or not they need to be compiled. Has the effect of **:compile** and **:reload**. **:recompile** always compiles the newest versions of each constituent file of a system.

:reload Bypasses the specified conditions for performing a transformation. Thus files are compiled even if they have not changed and loaded even if they are not newer than the installed version.

:selective Asks the user whether or not to perform each transformation that appears to be needed for each file.

:silent Avoids printing out each transformation as it is performed.

In addition to the above keywords, you can use the following options for patchable systems.

:increment-patch
Increment a patchable system's major version without doing any compilations. See the section "Patch Facility".

:no-increment-patch
When given along with the **:compile** option, disables the automatic incrementing of the major system version that would otherwise take place. See the section "Patch Facility".

:version Loads specific versions of a patchable system, as designated in the system version-directory file: See the section "Types of Patch Files". A system version can be expressed as the newest, released, or latest version; a version number; or version name.

:version accepts several keyword arguments. Specify the keyword and its arguments as a list. For example, to load version 34 of **mysys**, invoke:

```
(make-system 'mysys '(:version 34.))
```

Argument *Meaning*

:released Loads the system designated in the system version-directory file as the released version. See the section "Types of Patch Files". When you do not supply the **:version, :compile**, or **:recompile** keyword, **make-system** loads the released system. If there is no released version, then **make-system** loads the latest version.

Example: To load the released version of **george**, type:

```
    (make-system 'george '(:version :released))
```

or just:

```
    (make-system 'george)
```

Note: The system developer designates a particular version of the system as the released version by using the **:update-directory** keyword to **make-system**. (See the **:update-directory** keyword.)

:latest Loads the system designated in the system version-directory file as the latest version. See the section "Types of Patch Files". The most recently compiled version of the system is automatically assigned the designation **:latest**.

Example: On Monday the system developer does the following:

```
    (make-system 'alphabet ':recompile)
```

This invocation compiles the most up-to-date source files in the **alphabet** system and then loads each newly compiled file. **make-system** also automatically updates the system version-directory file, marking Monday's version of **alphabet** as the latest version.

On Tuesday the system developer wants to load the version he compiled the day before; hence:

```
    (make-system 'alphabet '(:version :latest))
```

System developers typically use the **:latest** keyword to load systems under development.

:newest Loads the most recently compiled version of each *file* of a system. The newest version differs from the latest version when individual files in the system have been compiled by hand. Note that you cannot define or load patches for the newest system.

Example: On Tuesday the system developer loads the latest version of the system **alphabet**, which contains files A.lisp.10, A.bin.10, B.lisp.10, B.bin.10, and so on, to Z.lisp.10, Z.bin.10. The developer makes changes to several functions in A.lisp.10, compiles the file to A.bin.11, and saves the source file, A.lisp.11. On Wednesday the developer wants to test the incremental changes to the system, but, to be cautious, doesn't want to destroy the latest system that was compiled and loaded on Monday. To do so, the developer uses the **:newest** keyword to load a system consisting of the most recently compiled versions of each of the system's files: A.bin.11 and the remaining files, B.bin.10 through Z.bin.10.

```
(make-system 'alphabet '(:version :newest))
```

The latest version remains intact; and the newest version is the most experimental version of the system.

version-number Loads a particular major version number of the system.

```
(make-system 'george '(:version 23.))
```

Note the decimal point after the version number.

version-name Loads the particular version of the system known as *:version-name* in the system version-directory file. See the section "Types of Patch Files". The system maintainer must have previously assigned *version-name* by using the **:update-directory** keyword to **make-system**.

Example: The system developer plans to demonstrate the **frog** system to a group of prospective customers from Japan. Aside from the regular debugged version, there is a special version that works in Japanese.

After assigning the version name **:japanese** to this particular version of **frog**, the developer can load it, as follows:

```
(make-system 'frog '(:version :japanese))
```

:update-directory

Updates the system version-directory file for the currently loaded version of the system. This keyword works properly *only* for the loaded version of the system. Use **:update-directory** to assign a *version-name* to a particular system version or to designate a particular system version as the released version. **:update-directory** takes a keyword argument; specify **:update-directory** and its argument as a list. When you specify **:update-directory** without an argument, the default entry made to the system version-directory file is **:latest**.

Example 1: The system developer wants to release the latest version of **george**, version #34, for general use. There is currently no released version. The following invocation loads the latest version of **george** and designates it as the released version.

```
(make-system 'george '(:update-directory :released))
```

The developer could also have given this longer but equivalent form:

```
(make-system 'george '(:version 34.) '(:update-directory :released))
```

Example 2: The system developer plans to demonstrate the **frog** system to a group of prospective customers from Japan. Aside from the regular debugged version, there is a special version that works in Japanese. The developer decides to assign this special version a *version-name* of **:japanese**. The system is already loaded, so the developer invokes:

```
(make-system 'frog ':noload '(:update-directory :japanese))
```

To load this version in the future the developer must use the *version-name* argument to the **:version** keyword.

5.2 Using the :version and :update-directory keywords

This section shows how the user and the developer might apply the **:version** and **:update-directory** keywords to (1) update the **rodent** system from Release 4 to Release 5 and (2) be able to maintain multiple versions of **rodent** in parallel. In this example the site has a working version of the **rodent** system that runs in Release 4.4.

1. In order to use the **:version** and **:update-directory** features introduced in Release 4.5, the system developer must compile the system in Release 4.5 by an invocation of **make-system**; for example:

   ```
   (make-system 'rodent ':compile)
   ```

   To make this newly compiled version of **rodent** the released version, the system developer updates the system version-directory file appropriately:

   ```
   (make-system 'rodent ':noload '(:update-directory :released))
   ```

   Note: Assume that version #34 corresponds to Release 4.5 software.

2. The system developer wants to work with Release 5 software. To run **rodent** the developer must bring up a version of the system in Release 5 and recompile it. (Although recompilation is not necessarily required to move from one major software release to another, you *must* recompile the **rodent** system to update to Release 5.) Note: Assume that this recompilation in Release 5 created version #35.

3. A user running Release 4.5 can still load the released version of **rodent** by typing one of the following.

   ```
   (make-system 'rodent)
   ```

   or

   ```
   (make-system 'rodent '(:version 34.))
   ```

   However, the user cannot access the system while running Release 4.4 because the format of the system version-directory file has changed incompatibly.

4. The developer wants to run the experimental version of **rodent,** the one brought up in Release 5. The developer loads the system by issuing one of the following:

   ```
   (make-system 'rodent '(:version :latest))
   ```

   or

   ```
   (make-system 'rodent '(:version 35.))
   ```

   The developer finds problems with **rodent**, fixes them, makes patches, and decides to make the system now running the released version. While running Release 5 in this world, the developer uses **:update-directory** to specify the version:

   ```
   (make-system 'rodent '(:update-directory :released))
   ```

   Because some users still want to use the Release 4.5 version of **rodent**, the developer decides to give this version a version-name of **:old-system**. The developer boots Release 4.5, loads **rodent**, and designates this loaded system as **:old-system**.

   ```
   (make-system 'rodent '(:update-directory :old-system))
   ```

   A user who wants to load the Release 4.5 version of **rodent** must do one of the following:

   ```
   (make-system 'rodent '(:version :old-system))
   ```

   or

   ```
   (make-system 'rodent '(:version 34.))
   ```

   A user who wants to load the released version of **rodent** must do one of the following:

   ```
   (make-system 'rodent)
   ```

   or

   ```
   (make-system 'rodent '(:version 35.))
   ```

5.3 Maintaining Parallel Systems for the LM-2 and the 3600

Normally, when a system is compiled, the system version-directory file is automatically updated. However, maintaining parallel systems for LM-2s and 3600s raises a special problem. Because you must specify **:no-increment-patch** in the compilation for a second machine in order to keep the version number at the same level, you must also specify **:update-directory** to get the correction information for the second machine in the system version-directory file.

Example: Assuming the LM-2 is the second machine and that you have already compiled the system on the 3600, you need to compile the system for the LM-2:

```
(make-system 'george ':compile ':noload ':no-increment-patch)
```

You then need to load the newly compiled files to record the system version information in the database.

```
(make-system 'george '(:version :newest) ':update-directory)
```

5.4 Describing a System

describe-system is a useful function for finding information about a system.

describe-system *system-name* &key *(show-files* **t***)* *Function*
(show-transformations **t***)*

Displays useful information about the system named *system-name*. This includes the name of the system source file, the system package default if any, and component systems. For a patchable system, **describe-system** displays the system version and status, a typical patch file name, the sites maintaining the system, and, if the user wants, a listing of patches. If **:show-files** is **t**, it displays the history of the files in the system. Other possible values are **nil** (do not show file history) and **:ask** (ask the user). If **:show-transformations** is **t**, it displays the transformations required to make the system. Other possible values are **nil** (do not display transformations) and **:ask** (ask the user).

For finding information about patchable systems only: See the section "Finding Out About Patchable Systems".

6. Adding New Keywords to make-system

make-system keywords are defined as functions on the **si:make-system-keyword** property of the keyword. The functions are called with no arguments. Some of the relevant variables they can use are:

si:*system-being-made* *Variable*
The internal data structure that represents the system being made.

si:*make-system-forms-to-be-evaled-before* *Variable*
A list of forms that are evaluated before the transformations are performed.

si:*make-system-forms-to-be-evaled-after* *Variable*
A list of forms that are evaluated after the transformations have been performed.

si:*make-system-forms-to-be-evaled-finally* *Variable*
A list of forms that are evaluated after the body of **make-system** has completed. This differs from **si:*make-system-forms-to-be-evaled-after*** in that these forms are evaluated outside of the "compiler context", which sometimes makes a difference.

si:*query-type* *Variable*
Controls how questions are asked. Its normal value is **:normal**. **:noconfirm** means no questions are asked, and **:selective** asks a question for each individual file transformation.

si:*silent-p* *Variable*
If **t**, no messages are displayed.

si:*batch-mode-p* *Variable*
If **t**, **:batch** was specified.

si:*redo-all* *Variable*
If **t**, all transformations are performed, regardless of the condition functions.

si:*top-level-transformations* *Variable*
A list of the names of transformations that will be performed, such as **(:fasload :readfile)**.

si:*file-transformation-function* *Variable*
The actual function that gets called with the list of transformations that need to be performed. The default is **si:do-file-transformations**.

si:define-make-system-special-variable *name form* &optional (*defvar-p* **t**) *Special Form*

Causes the variable *name* to be bound to *form*, which is evaluated at **make-system** time, during the body of the call to **make-system**. This allows you to define new variables similar to those already existent. If you specify *defvar-p* as (or defaulted to) **t**, *name* is defined with **defvar**. It is not given an initial value. If *defvar-p* is specified as *nil*, *name* belongs to some other program and is not **defvared** here.

The following simple example adds a new keyword to **make-system** called **:just-warn**, which means that **fdefine** warnings regarding functions being overwritten should be displayed, but the user should not be queried. (See the function **fdefine**.)

```
(si:define-make-system-special-variable
  inhibit-fdefine-warnings inhibit-fdefine-warnings nil)

(defun (:just-warn si:make-system-keyword) ()
  (setq inhibit-fdefine-warnings ':just-warn))
```

(See the variable **inhibit-fdefine-warnings**.)

make-system keywords can have effect either directly when called or by pushing a form to be evaluated onto **si:*make-system-forms-to-be-evaled-after*** or one of the other two similar lists. In general, the only useful thing to do is to set some special variable defined by **si:define-make-system-special-variable**.

In addition to the ones mentioned earlier in this section, user-defined transformations can have their behavior controlled by new special variables, which can be set by new keywords. For example, if you want to get at the list of transformations to be performed, the right way would be to set **si:*file-transformation-function*** to a new function, which then might call **si:do-file-transformations** with a possibly modified list. That is how the **:print-only** keyword works.

Remember that when you execute **make-system**, it adds the loaded system to the system version-directory file of patchable systems unless you specify certain keywords that explicitly suppress this action. For example, **:print-only** is among these keywords. Certain user-defined keywords — those that rebind **si:*file-transformation-function*** and then recursively call **make-system** — must also take into account this updating feature of **make-system**. The following code is assumed to be in the **si** package.

```
(defun (:print-only make-system-keyword) ()
  (no-update-directory)                         ;Suppresses updating
  (setq *file-transformation-function* 'print-file-transformations))
```

7. Adding New Options to defsystem

Options to **defsystem** are defined as macros on the **si:defsystem-macro** property of the option keyword. Such a macro can expand into an existing option or transformation, or it can have side effects and return **nil**. They can use several variables, but the only one of general interest is **si:*system-being-defined***.

si:*system-being-defined* *Variable*

The internal data structure representing the system that is currently being constructed.

si:define-defsystem-special-variable *name form* *Special Form*

Causes *form* to be evaluated and *name* to be bound to the result during the expansion of the **defsystem** special form. This allows you to define new variables similar to **si:*system-being-defined***.

si:define-simple-transformation *name function default-condition input-file-types output-file-types* &optional *pretty-names* (*compile-like* **t**) (*load-like* **nil** *ll-p*) *Special Form*

This is the most convenient way to define a new simple transformation. For example,

```
(si:define-simple-transformation :compile si:compile-file-1
        si:file-newer-than-file-p
        (:lisp) (:bin))
```

input-file-types and *output-file-types* are how a transformation specifies how many input file names and output file names it should receive as arguments, in this case one of each. They also, obviously, specify the default canonical file type for these pathnames.

The **si:compile-file-1** function is mostly like **compile-file**, except for its interface to packages. It takes input-file and output-file arguments.

pretty-names, an optional argument, specifies how the transformation will be printed in messages to the user. It can be a list of the imperative ("Compile"), the present participle ("Compiling"), and the past participle ("compiled"). Note that the past participle is not capitalized, because it is not used at the beginning of a sentence. *pretty-names* can be just a string, which is taken to be the imperative, and the system will conjugate the participles itself. If *pretty-names* is omitted or **nil** it defaults to the name of the transformation.

compile-like and *load-like*, both optional arguments, specify when the transformation should be performed. Compile-like transformations are performed when the **:compile** keyword is given to **make-system**. Load-like transformations are performed unless the **:noload** keyword is given to **make-system**. By default *compile-like* is **t** but *load-like* is **nil**.

Complex transformations are just defined as normal macro expansions, for example,

```
(defmacro (:compile-load si:defsystem-macro)
               (input &optional com-dep load-dep
                                com-cond load-cond)
  '(:fasload (:compile ,input ,com-dep ,com-cond)
             ,load-dep ,load-cond))
```

8. More Esoteric Transformations

It is sometimes useful to specify a transformation upon which something else can depend, which is not performed by default, but rather only when requested because of that dependency. The transformation nevertheless occupies a specific place in the hierarchy. The **:skip defsystem** macro allows specifying a transformation of this type. For example, suppose a special compiler for the read table is not ordinarily loaded into the system; the compiled version should still be kept up to date, and it needs to be loaded if the read table ever needs to be recompiled.

```
(defsystem reader
  (:pathname-default "AI: LMIO;")
  (:package system-internals)
  (:module defs "RDDEFS")
  (:module reader "READ")
  (:module read-table-compiler "RTC")
  (:module read-table "RDTBL")
  (:compile-load defs)
  (:compile-load reader (:fasload defs))
  (:skip :fasload (:compile read-table-compiler))
  (:rtc-compile-load read-table (:fasload read-table-compiler)))
```

Assume that there is a complex transformation **:rtc-compile-load** that is like **:compile-load**, except that it is built on a transformation called something like **:rtc-compile**, which uses the read table compiler rather than the Lisp compiler. In the above system, then, if the **:rtc-compile** transformation is to be performed, the **:fasload** transformation must be done on **read-table-compiler** first; that is, the read table compiler must be loaded if the read table is to be recompiled. If you say **(make-system 'reader ':compile)**, then the **:compile** transformation will still happen on the **read-table-compiler** module, compiling the read table compiler if necessary. But if you issue **(make-system 'reader)**, the reader and the read table will be loaded, but the **:skip** keeps this from happening to the read table compiler.

So far nothing has been said about what can be given as a *condition* for a transformation, except for the default functions that check for a source file being newer than the binary, and so on. In general, any function that takes the same arguments as the transformation function (for example, **compile-file**) and returns **t** if the transformation needs to be performed, can be in this place as a symbol, including, for example, a closure.

To take an example, suppose a file contains **compile-flavor-methods** for a system and should therefore be recompiled if any of the flavor method definitions change. In this case, the condition function for compiling that file should return **t** if either the source of that file itself or any of the files that define the flavors have changed. This is the purpose of the **:compile-load-init** complex transformation. It is defined in the **si** package like this:

```
(defmacro (:compile-load-init defsystem-macro)
               (input add-dep &optional com-dep load-dep
                &aux function)
  (setq function (let-closed ((*additional-dependent-modules*
                              (parse-module-components add-dep *system-being-defined*)))
                  'compile-load-init-condition))
  '(:fasload (:compile ,input ,com-dep ,function) ,load-dep))

(defun compile-load-init-condition (source-file binary-file)
  (or (file-newer-than-file-p source-file binary-file)
      (local-declare ((special *additional-dependent-modules*))
        (other-files-newer-than-file-p
                    *additional-dependent-modules*
                    binary-file))))
```

The condition function generated when this macro is used returns **t** either if **file-newer-than-file-p** would do so with those arguments, or if any of the other files in **add-dep** (which presumably is a *module specification*) are newer than the compiled code file. Thus the file (or module) to which the **:compile-load-init** transformation applies will be compiled if it or any of the source files on which it depends has been changed, and will be loaded under the normal conditions. In most (but not all cases), **com-dep** would be a **:fasload** transformation of the same files as **add-dep** specifies, so that all the files on which this one depends would be loaded before compiling it.

9. Patch Facility

The patch facility allows a system maintainer to manage new releases of a large system and issue patches to correct bugs. It is designed to be used to maintain the Lisp Machine system itself as well as applications systems that are large enough to be loaded into a Lisp world and saved into a FEP file (disk partition on an LM-2).

When a system of programs is very large, it needs to be maintained; for example, often problems are found and need to be fixed, or other little changes need to be made. However, it takes a long time to load up all of the files that make up such a system, and so rather than having users load up all the files every time they want to use the system, usually the files just get loaded once into a Lisp world, and then the Lisp world is saved away in a FEP file (disk partition on the LM-2). Users then use this file (disk partition), and copies of it are distributed. The problem is that since the users do not load up the system every time they want to use it, they do not get all the latest changes.

The purpose of the patch system is to solve this problem. A *patch* file is a little file that, when loaded, updates the old version of the system into the new version of the system. Most often, patch files just contain new function definitions; old functions are redefined to perform their new contracts. When you want to use a system, you first use the Lisp environment saved on the disk, and then you load all the latest patches. Patch files are very small, so loading them does not take much time. You can even load the saved environment, load up the latest patches, and then save it away, to save future users the trouble of even loading the patches. (Of course, new patches can be made later, and then these will have to be loaded if you want to get the very latest version.)

Every system has a series of patches that have been made to that system. To get the latest version of the system, you load each patch file in the series, in order. Sooner or later, the system maintainer will want to stop building more and more patches, and recompile everything, starting afresh. A complete recompilation is also necessary when a system is changed in a far-reaching way, in a way that cannot be done with a small patch. For example, if you completely reorganize a program or change a lot of names or conventions, you might need to completely recompile it to make it work again. After a complete recompilation, the old patch files are no longer suitable to use; loading them might even break things.

To keep track of all these changes the patch facility labels each version of a system with a two-part number. The two parts are called the *major version number* and the *minor version number*. The minor version number is increased every time a new patch is made; the patch is identified by the major and minor version number together. The major version number is increased when the program is completely recompiled, and at that time the minor version number is reset to zero. A complete system version is identified by the major version number, followed by a dot, followed by the minor version number.

The following typical scenario should clarify this.

1. A new system is created; its initial version number is 1.0.

2. Then a patch file is created; the version of the program that results from loading the first patch file into version 1.0 is called 1.1.

3. Then another patch file might be created, and loading that patch file into system 1.1 creates version 1.2.

4. Then the entire system is recompiled, creating version 2.0 from scratch.

5. Now the two patch files are irrelevant, because they fix old software; the changes that they reflect are integrated into system 2.0.

Note that the second patch file should only be loaded into system 1.1 in order to create system 1.2; you should not load it into 1.0 or any other system besides 1.1. It is important that all the patch files be loaded in the proper order, for two reasons.

- First, it is very useful that any system numbered 1.1 be exactly the same software as any other system numbered 1.1, so that if somebody reports a bug in version 1.1, it is clear just which software is being cited.

- Secondly, one patch might patch another patch; loading them in some other order might have the wrong effect.

The patch facility keeps track, in the file system, of all the patch files that exist, remembering which version each one creates. A separate numbered sequence of patch files exists for each major version of each system, for example, lmfs-37-15.lisp, lmfs-37-16.lisp, and so forth. All of them are stored in the file system, and the patch facility keeps track of where they all reside.

In addition to the patch files themselves, the *patch-directory file* contains the patch facility's database by which the patch facility keeps track of what minor versions exist for a major version, and what the last major version of a system is. For example, lmfs-37.patch-dir contains a listing of the patches made for major version 37 and a comment on why each patch was made. These files and how to make them are described in this section.

In order to use the patch facility, you must define your system with **defsystem** and declare it as patchable with the **:patchable** option. (See the section "Defining a System".) When you load your system with **make-system**, it is added to the list of all systems present in the world. (See the function **make-system**.) Whenever you use **make-system** to compile your patchable system, its major version in the file system is incremented; thus a major version is associated with a set of compiled code files.

The patch facility keeps track of which version of each patchable system is present, and where the data about that system reside in the file system. This information can be used to update the Lisp world automatically to the latest versions of all the systems it contains. Once a system is present, you can ask for the latest patches to be loaded, ask which patches are already loaded, and add new patches. You can also load patches or whole new systems and then save the entire Lisp environment away in a FEP file (disk partition). See the function **disk-save**.

9.1 Finding Out About Patchable Systems

When a Lisp Machine is booted, it displays a line of information telling you what systems are present, and which version of each system is loaded. This information is returned by the function **si:system-version-info**. It is followed by a text string containing any additional information that was specified by whoever created the current world load (disk partition on the LM-2). See the function **disk-save**.

print-system-modifications &rest *system-names* *Function*

With no arguments, **print-system-modifications** lists all the systems present in this world and, for each system, all the patches that have been loaded into this world. For each patch it shows the major version number (which will always be the same since a world can only contain one major version), the minor version number, and an explanation of what the patch does, as entered by the person who made the patch.

If **print-system-modifications** is called with arguments, only the modifications to *systems-named* are listed.

si:get-system-version &optional (*system* **"System"**) *Function*

Returns three values. The first two are the major and minor version numbers of the version of *system* currently loaded into the machine. The third is the status of the system, as a keyword symbol: **:experimental**, **:released**, **:obsolete**, or **:broken**. *system* defaults to **System**. This returns **nil** if that system is not present at all.

si:system-version-info &optional (*brief-p* **nil**) *Function*

Returns a string giving information about which systems and what versions of the systems are loaded into the machine (for systems that differ from the released versions) and what microcode version is running. A typical string for it to produce is:

nil
"Release 5.2,
FEP 24"
T
"Rel 5.2"

```
"System 242.264, Zmail 83.42, LMFS 37.31, Vision 10.23, Tape 21.9,
microcode TMC5-MIC 264, FEP 17"
```

If *brief-p* is **t**, it uses short names, suppresses the microcode version, any systems that should not appear in the disk label comment, the name **System**, and the commas:

```
"242.264 Vis 10.23"
```

si:patch-loaded-p *major-version minor-version* &optional *(system* **"System"***)* *Function*

A predicate that tells whether the loaded version of *system* is past (or at) the specified patch level. Returns **t** if:

- the major version loaded is *major-version* and the minor version loaded is greater than or equal to *minor-version*
- the major version loaded is greater than *major-version*

Otherwise, the function returns **nil**.

Releases have numbers and status associated with them, just as systems do. Symbolics staff assign the release number.

si:get-release-version *Function*

si:get-release-version returns three values, the release numbers and the status of the current world load:

5 Major version number
2 Patch version number or string describing minor patch level
Status of the world load as a keyword symbol:
:experimental
✓ **:released**
:obsolete
:broken
nil (when status cannot be determined)

9.2 Types of Patch Files

The patch facility maintains several different types of files in the directory associated with your system:

- System version-directory file
- Patch directory file
- Individual patch file

This directory is specified to **defsystem** via either the **:patchable** option or the **:pathname-default** option. These files are maintained automatically, but so that you will know what they are and when they are obsolete (because they are associated with an obsolete version of your system), they are described in this section.

System version information is recorded in a database called the *system version-directory file* for each patchable system. Whenever you run **make-system** it creates or updates this file, recording the name, type, and file version number of all constituent files of each version of a patchable system. In addition, it contains keywords describing the status of the system (for example, **:released** and **:latest**), associating particular system versions with these keywords. (**make-system** automatically updates the file when you specify the **:update-directory** keyword: See the section "**make-system** keywords".) System version information is maintained in parallel for both LM-2 and 3600 systems.

The physical file type of the system version-directory file is shown for some host systems:

Host	*File type*
TOPS-20	PATCH-DIR
UNIX	pd
VMS	VPD
ITS	(PDIR)
LMFS	patch-dir or directory
Multics	patch-dir

Example: The system version-directory file for the **lmfs** system is:

```
q:>sys>lmfs>patch>lmfs.patch-dir.44
```

The host, device, and directory in this example come from the system definition.

The major benefit of this detailed record keeping is that your site can support multiple versions of the same system. General users and system developers can load specific versions of systems and specific versions of system files, even when newer and possibly incompatible versions have been made. Some examples:

- System developers can work on the *latest* versions of systems, editing and recompiling some files, without forcing the average user to contend with new and experimental changes to the system.
- General users, on the other hand, can load the stable, *released* versions.
- Symbolics can more easily distribute versions of the system other than the newest version.
- You can use pre-Release-5.0 versions of systems after recompiled versions have been made for Release 5.0.

In addition, you can load a system in several different ways:

- by version number
- by version name
- by designation as released, latest, or newest

To load a specific system, use the **:version** keyword: See the section "**make-system** keywords".

The released version is the fully debugged version intended for general use. You must explicitly update the system version-directory file to indicate that a system is released. See the **:update-directory** keyword to **make-system**.

The latest version is the most recently compiled version of the system. The system version-directory file is automatically updated whenever you compile or recompile the system.

The newest version is the version consisting of the most recently compiled version of each *file* of a system. The newest version differs from the latest version when individual files have been compiled by hand. The newest version of a system has no version number. Note that you cannot define patches for the newest system.

Each major version of the system has a ***patch directory file***, which describes the individual patches for a particular major version.

Example: The patch directory file for major version #37 of the **lmfs** system:

```
q:>sys>lmfs>patch>lmfs-37.patch-dir.69
```

make-system creates a new patch directory file automatically when you recompile a system or use the **:increment-patch** option. See the section "**make-system** keywords".

Each minor version of the system has a patch source file, whose name is the system name, the major version number, the minor version number, .lisp file type, and the source file version number.

Example: The first patch of major version 37 of the **lmfs** system has the following pathname:

```
q:>sys>lmfs>patch>lmfs-37-1.lisp.1
```

Patch files get compiled, so you will find patch files like the following:

```
q:>sys>lmfs>patch>lmfs-37-1.bin.1
```

A slightly different set of file name conventions are used, if the **:patchable** option to **defsystem** is given an argument, telling it to put the patch files in a different directory than the one which holds the other files of the system.

On TOPS-20, the file names take these forms:

System version-directory file	EE:PS:<PATDIR>*system*.PATCH-DIRECTORY
Patch directory file	EE:PS:<PATDIR>*system-nnn*.PATCH-DIRECTORY
Individual patch file	EE:PS:<PATDIR>*system-nnn-mmm*.LISP (or .BIN)

These file name conventions allow the patches for multiple systems to coexist in the same directory.

9.3 Loading Patches

load-patches &rest *options* *Function*

Used to bring the current world up to the latest minor version of whichever major version it is, for all systems present, or for certain specified systems. If there are any patches available, **load-patches** offers to read them in. With no arguments, **load-patches** updates all the systems present in this world.

Note: When you do a **make-system** of a patchable system, **make-system** calls **load-patches** after loading the system. If **make-system** is silent, then **load-patches** is silent; if **make-system** asks for confirmation, then **load-patches** asks for confirmation.

load-patches returns **t** if any patches were made, and **nil** otherwise.

options, if supplied, is one or more keywords or system names. The following options are accepted:

:systems *list* — *list* is a list of names of systems (symbols or strings) to be brought up to date. If this option is not specified, all systems are processed.

:verbose — Prints an explanation of what is being done. This is the default.

:selective — For each patch, says what it is and then asks you whether or not to load it. This is the default. Answering P turns off selective mode for any remaining patches to the current system.

:noselective — Turns off **:selective**.

:silent — Turns off both **:selective** and **:verbose**. In **:silent** mode all necessary patches are loaded without printing anything and without querying the user.

:nowarn — Suppresses questions requiring operator response.

system-name — The name of a system (symbol or string) to be brought up to date.

load-patches returns **t** if any patches were loaded, otherwise **nil**.

load-and-save-patches &rest *keyword-args* *Function*

load-and-save-patches disables network services and MORE processing. If no one is logged in, it logs in anonymously. It loads any patches that need to be loaded and any new versions of the site files, calling **load-patches** with arguments of **:noselective** and any other keywords provided as *keyword-args*. If any patches have been loaded, it then calls **disk-save** to save the resulting world load. If no patches have been loaded, it restores network services to their state before **load-and-save-patches** was called, and if it has logged in anonymously it logs out.

Before disk-saving on the 3600, **load-and-save-patches** prompts for the name of a FEP file in which to save the world load. Before disk-saving on the LM-2, it calls **print-disk-label** and prints an estimate of the size of the world load before prompting for a band in which to save the world load.

Call **load-and-save-patches** *before* you log in in order to avoid putting the contents of your init file into the saved world load.

9.4 Making Patches

During a typical maintenance session you might make several edits to a system's source files. The patch facility allows you to copy these edits into a patch file so that they can be automatically incorporated into the system to create a new minor version. Edits in a patch file can be of varying levels of complexity — modified function definitions, new functions, modified **defvars** and **defconsts**, or arbitrary forms to be evaluated, even including **loads** of new files.

Start Patch (m-X) and Start Private Patch (m-X) are two commands for initiating a patch.

Start Patch (m-X)

Starts a new patch but does not move any Lisp forms into the patch file. Prompts you for the system you want to patch; it must be a system currently loaded. It allocates a new minor version number for that particular system and starts constructing the patch file in an editor buffer.

While you are making your patch file, the minor version number that has been allocated for you is reserved so that nobody else can use it. Thus, if two people are patching a system at the same time, they cannot both get the same minor version number. Also note that you can put together patches for only one system at a time.

If you do a subsequent patch after finishing the current patch (see Finish Patch (m-X)), Start Patch (m-X) asks you which system you wish to patch and start a new minor version.

Start Private Patch (m-X)

Similar to Start Patch (m-X), but it does not have any relationship to systems, major and minor version numbers, and official patch directories. Instead of prompting for a system, it prompts for a file name. You can use other patching commands, like Add Patch (m-X), Finish Patch (m-X), and Abort Patch (m-X). When you finish the patch it is written out to the specified file.

This command allows you to make a private patch file that you can load, test, and share with other users before you install a numbered patch that all users automatically get.

If you change a function, you should recompile it and test it; then, once it works, use Add Patch (m-X), Add Patch Changed Definitions (m-X), or Add Patch Changed Definitions of Buffer (m-X) to put the code in the patch file.

Add Patch (m-X)

Adds the region (if there is one) or else the current definition to the patch file currently being constructed. If you mistakenly use the command on code that does not work, select the buffer containing the patch file and delete it. Then later you can use Add Patch (m-X) on the corrected version.

Add Patch Changed Definitions of Buffer (m-X)

Selects each definition that was changed in the buffer and asks you whether or not you want the definition patched.

For each definition, you can respond as follows:

Response	*Action*
Y	Patches the definition.
N	Skips the definition.
P	Patches the definition and any additional definitions in the same buffer without asking any more questions.

A definition needs to be patched if it has been changed since it was last patched or if it has not been patched since the file was read into the buffer.

Note that patching any region of text lying entirely within a definition (with Add Patch (m-X)) counts as patching that definition.

Add Patch Changed Definitions (m-X)

Selects a buffer in which definitions were changed and asks whether or not you want to patch the changed definitions. Answering N skips the buffer and proceeds to the next buffer, if any. Answering Y selects each definition that has changed in that buffer and asks you whether or not you want the definition patched. For each definition, you can respond as follows:

Response	*Action*
Y	Patches the definition.

N	Skips the definition.
P	Patches the definition and any additional definitions in the same buffer without asking any more questions; when done, it proceeds to the next buffer.

If there are more buffers containing definitions to be patched, it asks questions again when it gets to the next buffer.

A definition needs to be patched if it has been changed since it was last patched or if it has not been patched since the file was read into the buffer.

Note that patching any region of text lying entirely within a definition (with Add Patch (m-X)) counts as patching that definition.

After making and testing all of your patches, use Finish Patch (m-X).

Finish Patch (m-X) Installs the patch file so that other users can load it. This compiles the patch file if you have not done so yourself (patches are always compiled). It prompts you for a comment describing the reason for the patch; **load-patches** and **print-system-modifications** print these comments.

Sometimes you start making a patch file and for a variety of reasons do not install it — for example, you decide to abort the patch, you need to end your work session at this machine, or your machine crashes.

Abort Patch (m-X) Deallocates the minor version number that was assigned by Start Patch (m-X). It tells Zmacs that you are no longer currently making a patch; the next time you do Start Patch (m-X), Zmacs starts a new patch instead of appending to the one in progress.

Resume Patch (m-X) Allows you to go back to a patch that you were not able to finish in the same session in which you started it. This command works only if you have previously saved all modified buffers.

If the system crashes, use Resume Patch (m-X) and then Abort Patch (m-X). Begin the patch again.

9.5 Patchable System Status

The patch system has the concept of the *status* of a major version of a system. The status is displayed with the system version, in places such as the system print herald and the **comment** properties in FEP files (disk partition comments on the LM-2 disk label). This status announces the state, or condition, of system software — for example, whether a system is released or still experimental.

Use **set-system-status** to change the status of a system.

The status is one of the following keywords:

:experimental
The system has been built but has not yet been fully debugged and released to users. This is the default status when a new major version is created, unless it is overridden with the **:initial-status** option to **defsystem**.

:released
The system is released for general use. This status produces no extra text in the print herald and the **comment** properties in FEP files.

:obsolete
The system is no longer supported.

:broken
Similar to **:experimental** but is used when the system was thought incorrectly to have been debugged and hence was assigned **:released** status.

set-system-status *system new-status* &optional *major-version only-update-on-disk-p* *Function*

Changes the status of a system.

system The name of the system.

major-version The number of the major version to be changed; if unsupplied it defaults to the version currently loaded into the Lisp world.

new-status A defined keyword — **:experimental, :released, :obsolete, :broken.**

only-update-on-disk-p
If its value of is **t**, the patch directory file is updated to show *new-status*, but the running Lisp environment is not modified.

Call **set-system-status** manually; you should *not* place it in patch files.

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symbolics™

COMP The Compiler

Cambridge, Massachusetts

The Compiler
# 995009

February 1984

This document corresponds to Release 5.0.

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Printing year and number: 87 86 85 84 9 8 7 6 5 4 3 2 1

Table of Contents

1. The Basic Operations of the Compiler

The purpose of the Lisp compiler is to convert Lisp functions into programs in the Lisp Machine's instruction set. Compiled functions run more quickly and take up less storage than interpreted code. They are executed directly by the microcode.

Compiled functions are represented in Lisp by compiled code objects, which contain machine code as well as various other information. On the 3600 the printed representation of the object is as follows:

`#<DTP-COMPILED-FUNCTION` *name address*`>`

On the LM-2 compiled code objects are represented by FEFs (Function Entry Frames), whose printed representation is as follows:

`#<DTP-FEF-POINTER` *address name*`>`

The assembly language for the 3600 is very similar to that of the LM-2. If you want to understand the output of the LM-2 compiler: See the section "How to Read Assembly Language". For information on 3600 assembly language: See the section "Assembly Language on the 3600".

The compiler checks for errors and issues warnings regarding faulty syntax, typographical errors, unbound symbols, and the like. See the section "Controlling Compiler Warnings".

1.1 File Types

The results of the compiler are written to a file of canonical type **:bin** (**:qbin** on the LM-2). The actual file types for compiled-code files are host-dependent, of course.

The following table gives the file types of **:bin** and **:qbin** files respectively.

Host type	*File type for compiled code files on the 3600*	*File type for compiled code files on the LM-2*
ITS	BIN	QBIN
Lisp Machine	bin	qbin
Multics	BIN	qbin
TENEX	BIN	QBIN
TOPS-20	BIN	QBIN
UNIX	bn	qb
VAX/VMS	BIN	QBN

2. How to Invoke the Compiler

You can invoke the compiler from the Lisp Machine in several ways.

- Use the function **compile** to compile an interpreted function in the Lisp environment.
- Use Zmacs editor commands to read Lisp code in an editor buffer and compile it.
- Use **compiler:compile-file** and related functions to translate source files into compiled code files.

Note 1: Loading the compiled code file is almost the same as reading in the source file, except that the functions defined in the file are defined as compiled functions instead of interpreted functions.

Note 2: Compiling code in a Zmacs buffer causes some side effects on the Lisp environment, whereas compiling a source file does not. For more information:

- See the section "Compiling Code in a Zmacs Buffer".
- See the section "Compiling and Loading a File".

For general information on compiling, evaluating, and loading code:

- See the document *Zmacs Manual.*
- See the section "Compiling and Evaluating Lisp".
- See the document *Program Development Help Facilities*.

On the 3600 you can compile as many processes as you want at one time.

On the LM-2 only one process at a time can use the compiler. Attempts to invoke the compiler while it is running produce a message like the following:

```
[10:29 Compiler in process ZMACS-WINDOWS: waiting for resources.]
```

This means that you tried to run the compiler in the zmacs-windows process, but some other process is running in the compiler and is holding the global compiler lock. If you want to do your compilation, select the process that is using the compiler and either abort it or wait for it to finish. Your process that produced the error then wakes up and proceeds. Otherwise, you can give up on the attempt that produced the error by using c-ABORT on that process.

compile *name* &optional *lambda-exp* *Function*

name is a function spec. See the section "Functions". The compiler converts *lambda-exp*, if supplied, into a compiled code object, saves the lambda-expression as the **:previous-expr-definition** and **:previous-definition** properties of *name* if it is a symbol, and changes *name*'s definition to be the compiled code object. See the function **fdefine.**

uncompile *function-spec* *Function*

If *function-spec* is not defined as an interpreted function and it has a **:previous-expr-definition** property, then **uncompile** restores the function cell from the value of the property. (Otherwise, **uncompile** does nothing and returns "**Not compiled**".) This "undoes" the effect of **compile**. See the function **undefun.**

compiler:compile-file *infile* &optional *outfile in-package dont-set-default-p* *Function*

The file *infile* is given to the compiler, and the output of the compiler is written to a file whose name is *infile* with a file type on the Lisp Machine of .bin for a 3600 (.qbin for an LM-2). For a description of the input format for files to the compiler: See the section "Input to the Compiler". *outfile* lets you change where the output is written. *dont-set-default-p* suppresses the changing of the default file name to *infile*, which normally occurs.

compiler:compile-file-load &rest *compile-file-args* *Function*

compiler:compile-file-load compiles a file and then loads in the resulting compiled code file. Its arguments are the same as those of **compiler:compile-file**. See the function **compiler:compile-file**.

To examine a compiled function in symbolic form: See the function **disassemble.**

3. Input to the Compiler

The purpose of **compiler:compile-file** is to take a file and produce a translated version that does the same thing as the original except that the functions are compiled. **compiler:compile-file** reads through the input file, processing the forms in it one by one. For each form, suitable binary output is sent to the compiled code file, which when loaded reproduces the effect of that source form. The differences between source files and compiled code files are that:

1. The latter are in a compressed binary form that reads and executes much faster but cannot be edited.
2. Function definitions in compiled code files have been translated from Lisp forms to compiled code objects.

Thus, if the source contains a **(defun ...)** form at top level, then when the compiled code file is loaded, the function is defined as a compiled function. If, on the other hand, the source file contains a form that is not of a type known specially to the compiler, then that form (encoded in binary format) is output "directly" into the compiled code file, so that when that file is loaded that form is evaluated. For example, if the source file contains **(setq x 3)**, then the compiler places in the compiled code file instructions to set **x** to **3** at load time (that is, when the compiled code file is loaded into the Lisp environment). (It happens that compiled code files have a specific way to **setq** a symbol. For a more general form, the compiled code file would contain instructions to recreate the list structure of a form and then call **eval** on it.)

Sometimes you might want to put things in the compiled code file that are not meant merely to be translated into binary form. Top-level macro definitions fall into this category; the macros must actually get defined within the compiler in order for the compiler to be able to expand them at compile time. So when a macro form is seen, it should (sometimes) be evaluated at compile time, and should (sometimes) be put into the compiled code file.

Compiler declarations also fall into this category. Compiler declarations are forms that should be evaluated at compile time in order to tell the compiler something. They should not be put into the compiled code file, unless they are useful for working incrementally on the functions in the file, compiling them one by one from the editor.

3.1 declare and eval-when

You might want the compiler to handle forms in a variety of ways. (See the section "Input to the Compiler".) You might want a form to be:

- Put into the compiled code file (compiled, of course), or not.
- Evaluated within the compiler, or not.
- Evaluated if the file is read directly into Lisp, or not.

The compiler recognizes two forms that allow you to tell it exactly what to do with a form: the completely general **eval-when** and the less general **declare**.

An **eval-when** form looks like this:

```
(eval-when times-list
           form1
           form2
           ...)
```

The *times-list* can contain one or more of the symbols **load, compile**, or **eval**.

If this symbol is present *Then* forms *are*

load Written into the compiled code file to be evaluated when the compiled code file is loaded, with the exception that **defun** forms put the compiled definition into the compiled code file.

compile Evaluated in the compiler.

eval Evaluated when read into Lisp; this is because **eval-when** is defined as a special form in Lisp. (The compiler ignores **eval** in the *times-list*.)

Example: The following form would define **foo** as a macro in the compiler and when the file is read in interpreted, but not when the compiled code file is loaded.

```
(eval-when (compile eval) (macro foo (x) (cadr x)))
```

Note: For the rest of this section, we use lists such as are given to **eval-when** (for example, **(load eval), (load compile)**) to describe when forms are evaluated.

A **declare** form looks like:

```
(declare form1 form2 ...)
```

declare is defined in Lisp as a special form that does nothing, so the forms within a **declare** are not evaluated at **eval** time. The compiler does the following upon finding *form* within a **declare**: If *form* is a call to either **special** or **unspecial,** *form* is treated as **(load compile)**; otherwise it is treated as **(compile)**.

In addition to recognizing **declare** as the first forms in the body of a function, the compiler recognizes **declare** as the first forms in the bodies of the following:

let	**let***
do	**do***
do-named	**do*-named**
prog	**prog***
lambda	

This means that you can have **special** declarations that are local to any of these blocks.

If a form is not enclosed in either an **eval-when** or a **declare**, then the times at which it will be evaluated depend on the form. The following table summarizes at what times evaluation will take place for any given form seen at top level by the compiler.

(eval-when *times-list form1* ...)
times-list

(declare (special ...)) or (declare (unspecial ...))
(load compile)

(declare *anything-else*)
(compile)

(special ...) or (unspecial ...)
(load compile eval)

(macro ...) or (defmacro ...) or (defsubst ...)
(load compile eval)

(comment ...)
Ignored at all times.

(compiler-let ((*var val*) ...) *body*...)
Processes the *body* in its normal fashion, but at **(compile eval)** time, the indicated variable bindings are in effect. These variables typically affect the operation of the compiler or of macros. See the section "Nesting Macros".

(local-declare (*decl decl* ...) *body*...)
Processes the *body* in its normal fashion, with the indicated declarations added to the front of the list that is the value of **local-declarations**.

(defflavor ...) or (defstruct ...)
(load compile eval)

(defun ...) or (defmethod ...) or (defselect ...)
(load eval), but at load time what is processed is not this form itself, but the result of compiling it.

anything-else
(load eval)

Sometimes a macro wants to return more than one form for the compiler top level to see (and to be evaluated). The following facility is provided for such macros. If the following form is seen at the compiler top level, all of the *forms* are processed as if they had been at compiler top level.

`(progn (quote compile)` *form1 form2* `...)`

(Of course, in the interpreter they will all be evaluated, and the **(quote compile)** will harmlessly evaluate to the symbol **compile** and be ignored.) For additional discussion: See the section "Macros Expanding Into Many Forms".

eval-when &quote *times* &rest *body* *Special Form*

When seen by the interpreter, if one of the *times* is the symbol **eval**, then the *body* forms are evaluated. Otherwise **eval-when** does nothing; but when seen by the compiler, this special form does special things. See the section "Input to the Compiler".

declare &quote &rest *ignore* *Special Form*

declare does nothing, and returns the symbol **declare**.

But when seen by the compiler, this special form does special things. See the section "Input to the Compiler". There is also a different use of **declare**, used in conjunction with the **arglist** function. See the function **arglist**. See the section "Compiler Declarations".

4. Compiler Declarations

This section describes functions meant to be called during compilation, and variables meant to be set or bound during compilation, by using **declare** or **local-declare**.

local-declare *declarations* &body *body* *Special Form*

A **local-declare** form looks like

```
(local-declare (decl1 decl2 ...)
   form1
   form2
   ...)
```

Example:

```
(local-declare ((special foo1 foo2))
(defun larry ()
     )
(defun george ()
     )
  ); end of local-declare
```

Each *decl* is consed onto the list **local-declarations** while the *forms* are being evaluated (in the interpreter) or compiled (in the compiler). There are two uses for this. First, it can be used to pass information from outer macros to inner macros. Secondly, the compiler will specially interpret certain *decls* as local declarations, which only apply to the compilations of the *forms*. It understands the following forms:

(special *sym1 sym2 ...***)**

The variables *sym1*, *sym2*, and so on are treated as special variables during the compilation of the *forms*.

(unspecial *sym1 sym2 ...***)**

The variables *sym1*, *sym2*, and so on are treated as local variables during the compilation of the *forms*.

(arglist . *arglist***)**

Putting this local declaration around a **defun** saves *arglist* as the argument list of the function, to be used instead of its lambda-list if anyone asks what its arguments are. This is purely documentation.

(values . *values***)**

Putting this local declaration around a **defun** saves *values* as the return values list of the function, to be used if anyone asks what values it returns. This is purely documentation.

(def *function* **.** *defining-forms***)**

function is defined for the compiler during the compilation of the *forms*. The compiler uses this to keep track of macros and open-codeable functions (**defsubsts**) defined in the file being compiled. Note that the **cddr** of this item is a function.

special &quote &rest *symbols* *Special Form*

Declares each of the *symbols* to be "special" for the compiler.

unspecial &quote &rest *symbols* *Special Form*

Removes any "special" declarations of the *symbols* for the compiler.

The next three declarations are primarily for Maclisp compatibility.

***expr** &quote &rest *functions* *Special Form*

Declares each function spec in the list of *functions* to be the name of a function. In addition it prevents these functions from appearing in the list of functions referenced but not defined, which appears at the end of the compilation.

***lexpr** &quote &rest *functions* *Special Form*

Declares each function spec in the list of *functions* to be the name of a function. In addition it prevents these functions from appearing in the list of functions referenced but not defined printed at the end of the compilation.

***fexpr** &quote &rest *functions* *Special Form*

Declares each function spec in the list of *functions* to be the name of a special form. In addition it prevents these names from appearing in the list of functions referenced but not defined printed at the end of the compilation.

The compile-time values of the following variables affect the operation of the compiler. You can set these variables by including in his file forms such as

```
(declare (setq open-code-map-switch t))
```

run-in-maclisp-switch *Variable*

This variable works only on the LM-2. If this variable is non-**nil**, the compiler tries to warn you about any constructs that do not work in Maclisp. By no means are all Lisp Machine system functions not built-in to Maclisp cause for warnings — only those which could not be written by the user in Maclisp (for example, **make-array**, **value-cell-location**, and so on). Also, lambda-list keywords such as **&optional** and initialized **prog** variables are mentioned. This switch also inhibits the warnings for obsolete Maclisp functions. The default value of this variable is **nil**.

obsolete-function-warning-switch *Variable*

If this variable is non-**nil**, the compiler tries to warn you whenever an "obsolete" Maclisp-compatibility function, such as **maknam** or **samepnamep**, is used. The default value is **t**.

allow-variables-in-function-position-switch *Variable*

This variable works only on the LM-2. If this variable is non-**nil**, the compiler allows the use of the name of a variable in function position to mean that the variable's value should be **funcall**'d. This is for compatibility with old Maclisp programs. The default value of this variable is **nil**.

open-code-map-switch *Variable*

If this variable is non-**nil**, the compiler attempts to produce inline code for the mapping functions (**mapc**, **mapcar**, and so on, but not **mapatoms**) if the function being mapped is an anonymous some lambda-expression. This allows that function to reference the local variables of the enclosing function without the need for special declarations. The generated code is also more efficient. The default value is **t**.

all-special-switch *Variable*

If this variable is non-**nil**, the compiler regards all variables as special, regardless of how they were declared. This provides compatibility with the interpreter at the cost of efficiency. The default is **nil**.

inhibit-style-warnings-switch *Variable*

If this variable is non-**nil**, all compiler style-checking is turned off. Style checking is used to issue obsolete function warnings and won't-run-in-Maclisp warnings, and other sorts of warnings. The default value is **nil**.

See the macro **inhibit-style-warnings**. The **inhibit-style-warnings** macro acts on only one level of an expression.

compiler-let &quote *bindlist* &rest *body* *Macro*

Syntactically identical to **let**, **compiler-let** allows compiler switches to be bound locally at compile time, during the processing of the *body* forms. Value forms are evaluated at compile time.

```
Example:
(compiler-let ((open-code-map-switch nil))
          (map (function (lambda (x) ...)) foo))
```

This prevents the compiler from open-coding the **map**. When interpreted, **compiler-let** is equivalent to **let**. This is so that global switches that affect the behavior of macro expanders can be bound locally.

compiler:compiler-verbose *Variable*

The compiler displays a message (using **standard-output**) each time it starts compiling a function when the value is **t**. The default value is **nil**.

5. Compiler Warnings Database

Compiler warnings are kept in an internal database, and several functions and editor commands are provided that allow you to inspect and manipulate this database in various ways.

The database of compiler warnings is organized by pathname; warnings that were generated during the compilation of a particular file are kept together, and this body of warnings is identified by the generic pathname of the file being compiled. Any warnings that were generated while compiling some function not in any file (for example, by using the **compile** function on some interpreted code) are stored under the pathname **nil**. For each pathname, the database has entries, each of which associates the name of a function (or a flavor) with the warnings generated during its compilation.

The database starts out empty when you cold boot. Whenever you compile a file, buffer, or function, the warnings generated during its compilation are entered into the database. If you recompile a function, the old warnings are removed, and any new warnings are inserted. If you get some warnings, fix the mistakes, and recompile everything, the database becomes empty again.

Warnings are printed out as well as stored in the database. If the value of the special variable **suppress-compiler-warnings** is not **nil**, warnings are not printed, although they are still stored in the database.

The database has a printed representation. **print-compiler-warnings** produces this printed representation from the database, and **compiler:load-compile-warnings** updates the database from a saved printed representation. Following are the details:

print-compiler-warnings &optional *files* *(stream* **standard-output***)* *Function*

Prints out the compiler warnings database. If *files* is **nil** (the default), it prints the entire database. Otherwise, *files* should be a list of generic pathnames, and only the warnings for the specified files are printed. (**nil** can be a member of the list, too, in which case warnings for functions not associated with any file are also printed.) The output is sent to *stream*; you could use this to send the results to a file.

compiler:load-compiler-warnings *file* &optional *(flush-old-warnings* **t***)* *Function*

Updates the compiler warnings database. *file* should be the pathname of a file containing the printed representation of the compiler warnings related to the compilation of one or more files. If *flush-old-warnings* is **t** (the default), any existing warnings in the database for the files in question are completely replaced by the warnings in *file*. If *flush-old-warnings* is **nil**, the warnings in *file* are added to those already in the database.

The printed representation of a set of compiler warnings is sometimes stored in a file. You can create such a file using **print-compiler-warnings**, but it is usually created with **make-system** given the **:batch** option. The default type for such files is CWARNS.

Several Zmacs commands deal with the database.

Compiler Warnings (m-X)

> Prints the compiler warnings database into a buffer called Compiler Warnings, creates the buffer if it does not exist already, and switches to that buffer. You can peruse the compiler warnings by scrolling around and doing text searches through them.

Edit Compiler Warnings (m-X)

> Prompts you with the name of each file mentioned in the database, allowing you to edit the warnings for that file. It then splits the Zmacs frame into two windows: the upper window displays a warning message, and the lower one displays the source code whose compilation caused the warning. After you have finished editing each function, c-. gets you to the next warning: the top window scrolls to show the next warning, and the bottom window displays the function associated with this warning. Successive c-. s take you through all of the warning messages for all of the files you specified. When you are done, the last c-. puts the frame back into its one-window configuration.

Edit File Warnings (m-X)

> Asks you for the name of the file whose warnings you want to edit. You can give either the source file or the compiled file. Only warnings for this file are edited. If the database does not have any entries for the file you specify, the command prompts you for the name of a file that contains the warnings, in case you know that the warnings are stored in another file.

Load Compiler Warnings (m-X)

> Prompts you for the name of a file containing the printed representation of some compiler warnings and loads them into the database. (This is like the **compiler:load-compiler-warnings** function.) This command always passes **t** as the *flush-old-warnings* argument; that is, it replaces the old warnings rather than merging with them. The default file type is CWARNS and the default version is **:newest** (the latest version).

6. Controlling Compiler Warnings

The compiler performs style checking on all forms. Style checking is implemented by the **compiler:style-checker** property on a symbol; the value of the property is called on all forms whose **car** is that symbol, except those immediately enclosed in **inhibit-style-warnings**.

By controlling the compile-time values of the variables **run-in-maclisp-switch**, **obsolete-function-warning-switch**, and **inhibit-style-warning-switch** you can enable or disable some of the warning messages of the compiler. (See the section "Compiler Declarations".)

The following special form is also useful:

inhibit-style-warnings *body* *Macro*

Prevents the compiler from performing style-checking on the top level of *body*. Style-checking will still be done on the arguments of *body*. Both obsolete function warnings and won't-run-in-Maclisp warnings are done by means of the style-checking mechanism, so, for example,

```
(setq bar (inhibit-style-warnings (value-cell-location foo)))
```

does not warn that **value-cell-location** will not work in Maclisp, but

```
(inhibit-style-warnings (setq bar (value-cell-location foo)))
```

will warn, since **inhibit-style-warnings** applies only to the top level of the form inside it (in this case, to the **setq**).

Sometimes functions take arguments that they deliberately do not use. Normally the compiler warns you if your program binds a variable that it never references. In order to disable this warning for variables that you know you are not going to use, you can do one of two things.

- You can name the variables **ignore** or **ignored**. The compiler will not complain if a variable by one of these names is not used. Furthermore, by special dispensation, it is all right to have more than one variable in a lambda-list that has one of these names.

- You can simply use the variable for effect (ignoring its value) at the front of the function. Example:

```
(defun the-function (list fraz-name fraz-size)
  fraz-size       ; This argument is not used.
  ...)
```

This has the advantage that **arglist** will return a more meaningful argument list for the function, rather than returning something with **ignores** in it. See the function **arglist**.

The compiler uses a set of variables and functions to keep track of which functions have been defined and which have been referenced. These are the basis for the messages "FOO was defined but never referenced" that occur during compiling.

The following variables, used for this purpose, are implemented as hash tables:

> **sys:file-local-declarations**
> **compiler:functions-defined**
> **compiler:functions-referenced**

compiler:function-defined *fspec* *Function*

> **function-defined** tells the compiler that the function *fspec* has been defined (by putting it into the hash table in **compiler:functions-defined**).

compiler:file-declare *thing declaration value* *Function*

> **file-declare** enters a declaration in the table **sys:file-local-declarations** for the remaining extent of the compilation environment.

```
(compiler:file-declare 'foo 'special t)
```

compiler:file-declaration *thing declaration* *Function*

> **file-declaration** looks up a declaration in the table **sys:file-local-declarations**. It returns the declaration when *thing* is a declaration of type *declaration* and **nil** otherwise.

In addition to the above functions, **compiler:function-referenced** is useful for requesting compiler warnings in certain esoteric cases. Normally, the compiler notices whenever any function *x* uses (calls) any other function *y*; it takes note of all these uses, and then warns you at the end of the compilation if the function *y* got called but was neither defined nor declared (by ***expr**). See the special form ***expr**.

This usually does what you want, but sometimes the compiler has no way of telling that a certain function is being used. Suppose that instead of *x*'s containing any forms that call *y*, *x* simply stores *y* away in a data structure somewhere, and someplace else in the program that data structure is accessed and **funcall** is done on it. In this case the compiler cannot see that this is going to happen; the result is that it cannot note the function usage and hence cannot create a warning message. In order to make such warnings happen, you can explicitly call the function **compiler:function-referenced** at compile-time.

compiler:function-referenced *what* &optional *by* *Function*
compiler:default-warning-function

> *what* is a symbol that is being used as a function. *by* can be any function spec. **compiler:function-referenced** must be called at compile-time while a compilation is in progress. It tells the compiler that the function *what* is referenced by *by*. When the compilation is finished, if the function *what* has not been defined, the compiler issues a warning to the effect that *by* referred to the function *what*, which was never defined.

compiler:make-obsolete *function reason* *Special Form*

This special form declares a function to be obsolete; code that calls it gets a compiler warning, under the control of **obsolete-function-warning-switch**. See the function **obsolete-function-warning-switch**. This is used by the compiler to mark as obsolete some Maclisp functions that exist in Zetalisp but should not be used in new programs. It can also be useful when maintaining a large system, as a reminder that a function has become obsolete and that its use should be phased out. An example of an obsolete-function declaration is:

```
(compiler:make-obsolete create-mumblefrotz
        "use MUMBLIFY with the :FROTZ option instead")
```

7. Compiler Source-level Optimizers

The optimizer feature of the 3600 compiler works differently in the LM-2 compiler. The most important difference on the 3600 is that when an optimizer for a function (*not* for a special form) is run, the argument forms it sees have already been optimized.

An optimizer can be used to transform code into an equivalent but more efficient form, which can be compiled better. For example, **(eq** *obj* **nil)** is transformed into **(null** *obj***)**, which can be compiled better.

An optimizer can also be used to tell the compiler how to compile a special form. For example, in the interpreter **do** is a special form, implemented by a function that takes quoted arguments and calls **eval**. In the compiler, **do** is expanded in a macro-like way by an optimizer, into equivalent Lisp code using **prog**, **cond**, and **go**, which the compiler understands.

The compiler stores optimizers for source code on property lists in order to make it easy for you to add them. The compiler finds the optimizers to apply to a form by looking for the **compiler:optimizers** property of the symbol that is the **car** of the form. The value of this property should be a list of optimizers, each of which must be a function of one argument. The compiler tries each optimizer in turn, passing the form to be optimized as the argument. An optimizer that returns the original form unchanged (**eq** to the argument) has "done nothing", and the next optimizer is tried. If the optimizer returns anything else, it has "done something", and the whole process starts over again. Only after all the optimizers have been tried and have done nothing is an ordinary macro definition processed. This is so that the macro definitions, which will be seen by the interpreter, can be overridden for the compiler by optimizers.

Do not use optimizers to define new language features, because they take effect only in the compiler; the interpreter (that is, the evaluator) does not know about optimizers. So an optimizer should not change the effect of a form; it should produce another form that does the same thing, possibly faster or with less memory. If you want to actually change the form to do something else, you should use macros.

compiler:add-optimizer &quote *target-function optimizer-name* &rest *optimized-into...* *Special Form*

Puts *optimizer-name* on *target-function*'s optimizers list if it is not there already. *optimizer-name* is the name of an optimization function, and *target-function* is the name of the function calls that are to be processed. Neither is evaluated.

(compiler:add-optimizer *target-function optimizer-name optimize-into-1 optimize-into-2...* also remembers *optimize-into-1*, and so on, as names of functions that can be called in place of ***target-function*** as a result of the optimization.

8. Files That Must Be Compiled on the 3600 and the LM-2

In some cases it will be necessary to conditionalize pieces of programs so that one version runs on the LM-2 and another runs on the 3600.

To facilitate this, the list returned by **(status features)** on the 3600 contains the Lisp object **3600** (as a fixnum, 3600 decimal), whereas on the LM-2 it does not. To conditionalize a piece of a program so that it runs on both the LM-2 and the 3600, use the #+ conditional expressions.

Example: Suppose a function **solarize-screen** that on the LM-2 expects coordinate pairs of the form *(x,y)* was changed to expect them in *(y, x)* order on the 3600. One way to write machine-dependent code is to conditionalize it, as follows:

```
#+cadr (solarize-screen arg1 arg2) ;the LM-2 version
#+3600 (solarize-screen arg2 arg1) ;the 3600 version
```

For information on sharp-sign (#) abbreviations: See the section "Sharp-sign Abbreviations".

9. Files That Maclisp Must Compile

Certain programs are intended to be run both in Maclisp and in Zetalisp. Their source files need some special conventions. For example, all **special** declarations must be enclosed in **declares**, so that the Maclisp compiler sees them. The main issue is that many functions and special forms of Zetalisp do not exist in Maclisp. It is suggested that you turn on **run-in-maclisp-switch** in such files, which warns you about a great many problems that your program might have if you try to run it in Maclisp.

The macro-character combination "#Q" causes the object that follows it to be visible only when compiling for Zetalisp. The combination "#M" causes the following object to be visible only when compiling for Maclisp. These work both on subexpressions of the objects in the file, and at top level in the file. To conditionalize top-level objects, however, it is better to put the macros **if-for-lispm** and **if-for-maclisp** around them. (You can only put these around a single object.) The **if-for-lispm** macro turns off **run-in-maclisp-switch** within its object, preventing spurious warnings from the compiler. The **#Q** macro-character cannot do this, since it can be used to conditionalize any Lisp object, not just a top-level form.

To allow a file to detect what environment it is being compiled in, the following macros are provided:

if-for-lispm &rest *forms* *Macro*

Seen at the top level of the compiler, *forms* is passed to the compiler top level if the output of the compiler is a compiled code file intended for Zetalisp. If the Zetalisp interpreter sees this it evaluates *forms* (the macro expands into *forms*).

if-for-maclisp &rest *forms* *Macro*

Seen at the top level of the compiler, *forms* is passed to the compiler top level if the output of the compiler is a compiled code file intended for Maclisp (for example, if the compiler is COMPLR). If the Zetalisp interpreter sees this it ignores it (the macro expands into **nil**).

if-for-maclisp-else-lispm *maclisp-form lispm-form* *Macro*

When **(if-for-maclisp-else-lispm** *form1 form2***)** is seen at the top level of the compiler, *form1* is passed to the compiler top level if the output of the compiler is a compiled code file intended for Maclisp; otherwise *form2* is passed to the compiler top level.

if-in-lispm &rest *forms* *Macro*

In Zetalisp, **(if-in-lispm** *forms***)** causes *forms* to be evaluated; in Maclisp, *forms* is ignored.

if-in-maclisp &rest *forms* *Macro*

In Maclisp, **(if-in-maclisp** *forms***)** causes *forms* to be evaluated; in Zetalisp, *forms* is ignored.

When you have two definitions of one function, one conditionalized for one machine and one for the other, put them next to each other in the source file with the second "**(defun)**" indented by one space, and the editor will put both function definitions on the screen when you ask to edit that function.

In order to make sure that those macros are defined when reading the file into the Maclisp compiler, you must make the file start with a prelude, which should look like:

```
(declare (cond ((not (status feature lispm))
                (load '|AI: LISPM2; CONDIT|))))
```

This will do nothing when you compile the program on the Lisp Machine. If you compile it with the Maclisp compiler, it will load in definitions of the above macros, so that they will be available to your program. The form **(status feature lispm)** is generally useful in other ways; it evaluates to **t** when evaluated on the Lisp Machine and to **nil** when evaluated in Maclisp.

10. Putting Data in Compiled Code Files

It is possible to make a compiled code file containing data, rather than a compiled program. This can be useful to speed up loading of a data structure into the machine, as compared with reading in printed representations. Also, certain data structures, such as arrays, do not have a convenient printed representation as text, but can be saved in compiled code files.

In compiled programs, the constants are saved in the compiled code file in this way. The compiler optimizes by making constants which are **equal** become **eq** when the file is loaded. This does not happen when you make a data file yourself; identity of objects is preserved. Note that when a compiled code file is loaded, objects that were **eq** when the file was written are still **eq**; this does not normally happen with text files.

The following types of objects can be represented in compiled code files:

Symbols
Numbers of all kinds
Lists
Strings
Arrays of all kinds
Instances (for example, hash tables)
Compiled code objects

When an instance is put (dumped) into a compiled code file, it is sent a **:fasd-form** message, which must return a Lisp form which, when evaluated, will recreate the equivalent of that instance. This is because instances are often part of a large data structure, and simply dumping all of the instance variables and making a new instance with those same values is unlikely to work. Instances remain **eq**; the **:fasd-form** message is sent only the first time a particular instance is encountered during writing of a compiled code file. If the instance does not accept the **:fasd-form** message, it cannot be dumped.

sys:dump-forms-to-file *file forms-list* &optional *attribute-list* *Function*

sys:dump-forms-to-file writes data to a file in binary form. *forms-list* is a list of Lisp forms, each of which is dumped in sequence. It dumps the forms, not their results. The forms are evaluated when you load the file.

For example, suppose **a** is a variable bound to any Lisp object, such as a list or array. The following example creates a compiled code file that recreates the variable **a** with the same value:

```
(sys:dump-forms-to-file "f:>foo>aval"
        (list '(setq a ',a)))
```

For the purposes of understanding what this function does, you can consider that it is the same as the following:

```
(defun sys:dump-forms-to-file (file forms)
   (with-open-file (s file ':direction ':output)
      (dolist (f forms)
        (print f s))))
```

The real definition writes a binary file so it will load faster. It can also dump arrays, which you cannot write to a Lisp source file.

attribute-list supplies an optional attribute list for the resulting compiled code file. It has basically the same result when loading the binary file as the file attribute list does for **compiler:compile-file**. Its most important application is for controlling the package that the file is loaded into.

```
(sys:dump-forms-to-file "foo" forms-list '(:package "user"))
```

sys:dump-forms-to-file always puts a package attribute into the binary file it writes. If you do not specify the *attribute-list* argument, or if *attribute-list* does not contain a **:package** attribute, the function uses the **user** package. This is to ensure that package prefixes on symbols are always interpreted when they are loaded as they were intended when the file was dumped.

To examine a compiled code file, use **si:unbin-file** (**si:unfasl** on the LM-2). The output format from **unbin-file** is similar to that of **unfasl** but is improved to include disassembled code for any compiled functions in the compiled code file.

si:unbin-file *file* &optional *outfile* *Function*

Converts the compiled code file *file* on the 3600 to human-readable file, which you can optionally specify. It includes disassembled code for any compiled functions in the compiled code file.

si:unfasl *input-file* &optional *output-file* *Function*

Converts the compiled code file *input-file* on the LM-2 to a human-readable file, which you can optionally specify.

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symbolics™

MISCT Other Tools

Cambridge, Massachusetts

Other Tools

# 995014

February 1984

This document corresponds to Release 5.0.

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Printing year and number: 87 86 85 84 9 8 7 6 5 4 3 2 1

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1. The Inspector

1.1 Introduction to the Inspector

The Inspector is a window-oriented program for inspecting data structures. When you ask to inspect a particular object, its components are displayed. The particular components depend on the type of object; for example, the components of a list are its elements, and those of a symbol are its value binding, function definition, and property list.

The objects displayed on the screen by the Inspector are mouse-sensitive, allowing you to do something to that object, such as inspect it, modify it, or give it as the argument to a function.

The Inspector can be part of another program or it can be used standalone; for example, the Display Debugger can utilize some of the panes of the Inspector. Note, however, that although the display looks the same as that of the standalone Inspector, the handling of the mouse buttons depends upon the particular program being run.

You can enter the standalone Inspector via [Inspect] in the System menu or by the **inspect** function, which inspects its argument, if any.

See the document *Program Development Tools and Techniques*.

Figure 1 shows the standalone Inspector window. The display consists of the following panes, from top to bottom:

- A small interaction pane
- A history pane and menu pane
- Some number of inspection panes (three by default)

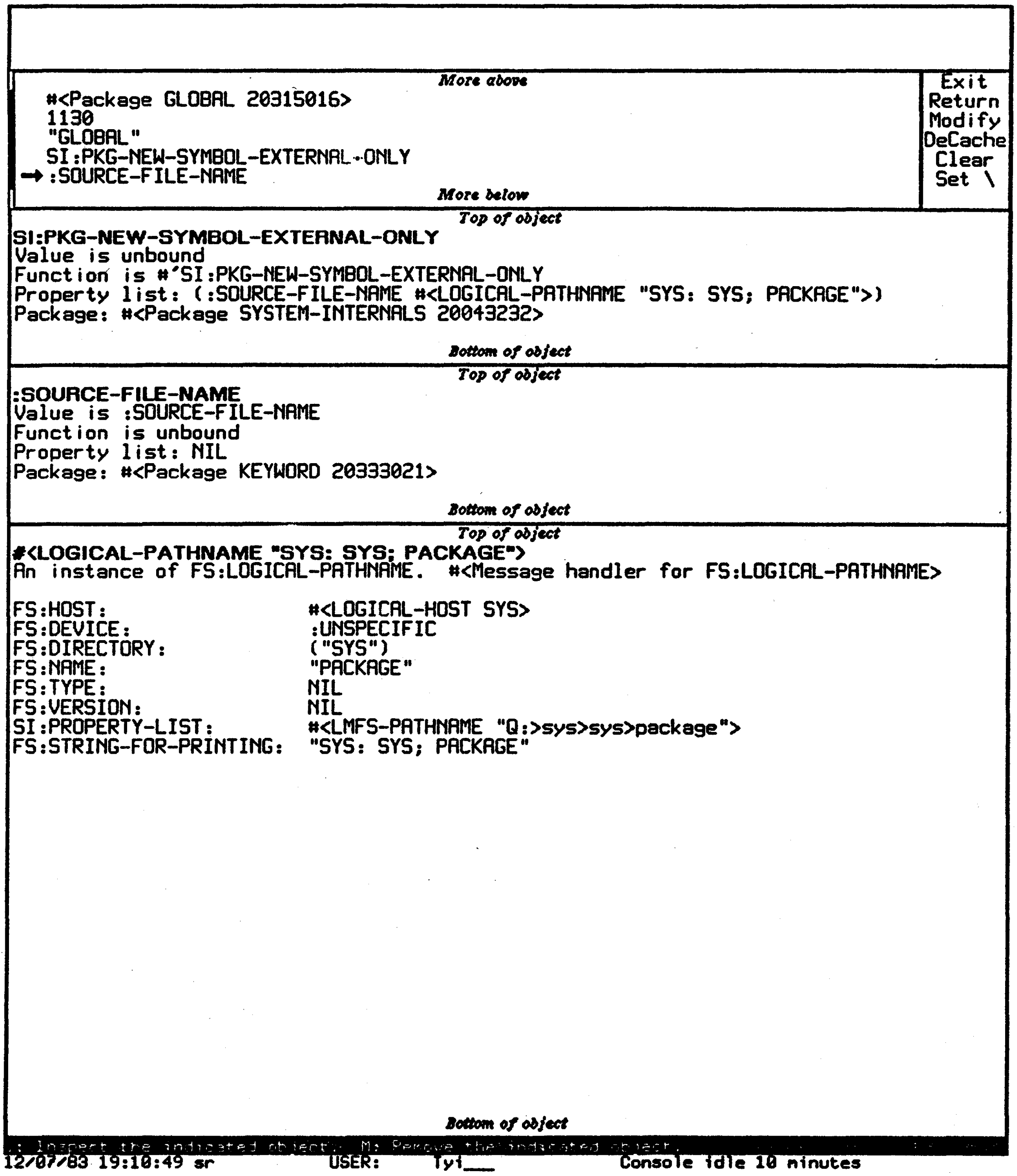
1.2 The Inspector History Pane

The history pane maintains a list of all objects that have been inspected. The last recently displayed object is at the top of the list, and the most recently displayed object is at the bottom.

You can inspect any mouse-sensitive object in the history pane by clicking on it. In addition, you can perform other operations by placing the mouse cursor in the *line region*, which is the left-hand side of the history pane, the area bounded by the margin on one side and the list of objects on the other. In the line region the shape of the mouse cursor changes to a rightward-pointing arrow.

- Clicking left in the line region inspects the object. This is sometimes useful

Figure 1. The Inspector.



```
                              More above
  #<Package GLOBAL 20315016>
  1130
  "GLOBAL"
  SI:PKG-NEW-SYMBOL-EXTERNAL-ONLY
→ :SOURCE-FILE-NAME
                              More below
                              Top of object
SI:PKG-NEW-SYMBOL-EXTERNAL-ONLY
Value is unbound
Function is #'SI:PKG-NEW-SYMBOL-EXTERNAL-ONLY
Property list: (:SOURCE-FILE-NAME #<LOGICAL-PATHNAME "SYS: SYS; PACKAGE">)
Package: #<Package SYSTEM-INTERNALS 20043232>

                              Bottom of object
                              Top of object
:SOURCE-FILE-NAME
Value is :SOURCE-FILE-NAME
Function is unbound
Property list: NIL
Package: #<Package KEYWORD 20333021>

                              Bottom of object
                              Top of object
#<LOGICAL-PATHNAME "SYS: SYS; PACKAGE">
An instance of FS:LOGICAL-PATHNAME.  #<Message handler for FS:LOGICAL-PATHNAME>

FS:HOST:                  #<LOGICAL-HOST SYS>
FS:DEVICE:                :UNSPECIFIC
FS:DIRECTORY:             ("SYS")
FS:NAME:                  "PACKAGE"
FS:TYPE:                  NIL
FS:VERSION:               NIL
SI:PROPERTY-LIST:         #<LMFS-PATHNAME "Q:>sys>sys>package">
FS:STRING-FOR-PRINTING:   "SYS: SYS; PACKAGE"

                              Bottom of object
: Inspect the indicated object.  M: Remove the indicated object.
12/07/83 19:10:49 sr         USER:     Tyi___          Console idle 10 minutes
```

when the object is a list and it is inconvenient to position the mouse at the open parenthesis.

- Clicking middle deletes the object from the history.

The history pane also maintains a cache allowing quick redisplay of previously displayed objects. This means that merely reinspecting an object does not reflect any changes in its state. Clicking middle in the line region deletes the object from the cache as well as deleting it from the history pane. Use [DeCache] in the menu pane to clear everything from the cache.

The history pane has a scroll bar at the far left, as well as scrolling zones in the middle of its top and bottom edges. The last three lines of the history are always the objects being inspected in the inspection panes.

1.3 The Inspector Inspection Pane

Each inspection pane can inspect a different object. When you inspect an object it appears in the large inspection pane at the bottom, and the previously inspected objects shift upward.

At the top of an inspection pane is either a label, which is the printed representation of the object being inspected in that window, or the words "a list", which means a list is being inspected. The main body of an inspection pane is a display of the components of the object, labelled with their names, if any. You can scroll this display using the scroll bar on the left or the "more above" and "more below" scrolling zones at the top and bottom.

Clicking on any mouse-sensitive object in an inspection pane inspects that object. The three mouse buttons have distinct meanings, however.

- Clicking left inspects the object in the bottom pane, pushing the previous objects up.
- Clicking middle inspects the object but leaves the source (namely, the object being inspected in the window in which the mouse was clicked) in the second pane from the bottom.
- Clicking right tries to find and inspect the function associated with the selected object (for example, the function binding if a symbol was selected).

1.3.1 Inspection Pane Display

The inspection display that is chosen depends upon the type of the object:

Symbol The name, value, function, property list, and package of the symbol are displayed. All but the name and the package are modifiable.

List — The list is displayed ground by the system grinder. Any piece of substructure is selectable, and any **car** or atom in the list can be modified.

Instance — The flavor of the instance, the method table, and the names and values of the instance-variable slots are displayed. The instance-variables are modifiable.

Closure, Entity — The function, and the names and values of the closed variables are displayed. For an entity the type or class is displayed as well. The values of the closed variables are modifiable.

Named structure — The names and values of the slots are displayed. The values are modifiable.

Array — The leader of the array is displayed if present. For one-dimensional arrays, the elements of the array are also displayed. The elements are modifiable.

Compiled code object — The disassembled code is displayed.

Select Method — The keyword/function pairs are shown, in alphabetical order by keyword. The function associated with a keyword is settable via the keyword.

Stack Frame — This is a special internal type used by the Display Debugger. It is displayed as either interpreted code (a list) or as a compiled code object with an arrow pointing to the next instruction to be executed.

1.4 The Inspector Interaction Pane

The interaction pane has two functions: to prompt you and to receive input. If you are not being asked a question, then a read-eval-inspect loop is active. Any forms you type are echoed in the interaction pane and evaluated. The result is not printed, but rather inspected. When you are prompted for input, usually due to having invoked a menu operation, any input you type at the read-eval-inspect loop is saved away and erased from the interaction pane. When the interaction is finished, the input is re-echoed and you can continue to type the form.

1.5 Special Characters Recognized by the Inspector

Some special keyboard characters are recognized when not in the middle of typing in a form.

c-z Exits and deactivates the Inspector.

BREAK Runs a break loop in the typeout window of the bottom-most inspection pane.

ESCAPE Reads a form, evaluates it, and prints the result instead of inspecting it. On the LM-2 use the ALTMODE key.

1.6 The Inspector Menu Pane

The menu pane (to the right of the history pane) displays these infrequently used but useful commands:

[Exit] Equivalent to c-z. Exits the Inspector and deactivates the frame.

[Return] Similar to [Exit], but allows selection of an object to be returned as the value of the call to **inspect**.

[Modify] Allows simple editing of objects. Selecting [Modify] changes the mouse sensitivity of items on the screen to only include fields that are modifiable. In the typical case of named slots, the names are the mouse-sensitive parts. When the field to modify has been selected, a new value can be specified either by typing a form to be evaluated or by using the mouse to select any normally mouse-sensitive object. The object being modified is redisplayed. Clicking right at any time aborts the modification.

[DeCache] Flushes all knowledge about the insides of previously displayed objects and redisplays the currently displayed objects.

[Clear] Clears out the history, the cache, and all the inspection panes.

[Set] \ Sets the value of the symbol \ by choosing an object.

2. Flavor Examiner

The Flavor Examiner is available via SELECT X or the system menu. This is strictly an interim program; it is supported fully in Release 5 but will eventually be incorporated into the Inspector.

Use the HELP command to learn how to use this new feature.

The Flavor Examiner utility lets you examine the structure of flavors defined in the Lisp environment. The Flavor Examiner window is divided into six panes.

```
---------------------------------------------------------
|                         |                             |
| flavor history pane     |    method history pane      |
|-------------------------|-----------------------------|
|                                              | Edit   |
|        examiner pane                         | Lock   |
|                                              |        |
|                                              |        |
|----------------------------------------------|--------|
|                                              | Edit   |
|        examiner pane                         | Lock   |
|                                              |        |
|                                              |        |
|----------------------------------------------|--------|
|                                              | Edit   |
|        examiner pane                         | Lock   |
|                                              |        |
|                                              |        |
|----------------------------------------------|--------|
|                                              | Clear  |
|        interaction pane                      | Help   |
|----------------------------------------------|--------|
```

The examiner panes (the three middle panes) list the answer to a query. The edit item of each examiner pane places the contents of the pane into a Zmacs possibilities buffer. The lock item for a examiner pane prevents the pane from being updated.

You enter a flavor name or method-spec into the interaction pane (the bottom pane).

To get started, type the name of a flavor in the interaction pane.

Methods are listed in the following format:

```
MESSAGE-NAME method-type method-combination-type FLAVOR
```

If the method-combination-type is **:case**, this format is used:

```
MESSAGE-NAME SUBMESSAGE-NAME method-type method-combination-type FLAVOR
```

Clicking on a flavor results in these actions:

- A left click on a flavor presents a menu of flavors and methods related to the flavor. (Note that automatically generated methods to get and set instance variables and methods associated with **si:vanilla-flavor** are not listed.)

- A middle click on a flavor presents a menu of related instance variables.
- A right click on a flavor presents a menu of operations on the flavor, including edit and inspect.
- Any click on a flavor places it in the flavor history pane if it is not already there.

Clicking on a method results in these actions:

- A left click on a method lists the instance variables to which the method refers.
- A middle click on a combined method lists the methods used to build the combined method.
- A middle click on a noncombined method lists all methods for that message from any flavor.
- A right click on a method presents a menu of operations on the method, including [arglist], [documentation], [edit], [inspect], [method spec], [trace], and [disassemble], unless the method is pseudocombined.
- Any click on a method places it in the method history if it is not already there.

Clicking on an instance variable results in these actions:

- A left click on an instance variable lists the methods that refer to the instance variable.
- A middle click on an instance variable shows the default value of the instance variable.

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