13. MEDLEY EXECUTIVES

In most Common Lisp implementations, there is a "top-level read-eval-print loop," which reads an expression, evaluates it, and prints the results. In Medley, the Exec acts as the top-level loop, but does much more.

The Exec traps all THROWS, and recovers gracefully. It prints all values resulting from evaluation, on separate lines. (When zero values are returned, nothing is printed).

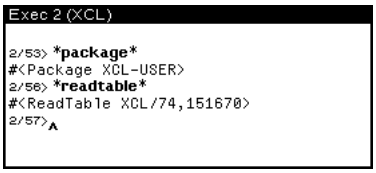
The Exec keeps track of your previous inputs, in the history list. Each entry you type creates a history event, which sotres the input and its values.

It's easy to use the results of earlier events, redo and event, or recall an earlier input, edit it, and run it. This makes it much easier to get your work done.

Multiple Execs and the Exec's Type

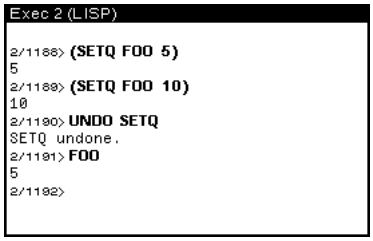
Sometimes you need more than one Exec open at a time. It's easy to open as many as you need by using the right button background menu and selecting the kind of Exec you need. The Execs are differentiated from one another by their "names" in their title bars and by their prompts. For example, the second Exec you open may have a prompt like 2/50> if it's the second Common Lisp Exec you've opened. Events in each Exec are placed on the global history list with their Exec number so the system can tell them apart.

Several variables are very important to an Exec since they control the format of reading and printing. Together these variables describe a type of exec, or its mode. Some standard bindings for the variables have been named to make mode setting easy. The names provide you with an Exec of the Common Lisp (LISP), Interlisp or Old Interlisp (IL), or Medley (XCL) type. An Exec's type is displayed in the title bar of its window:

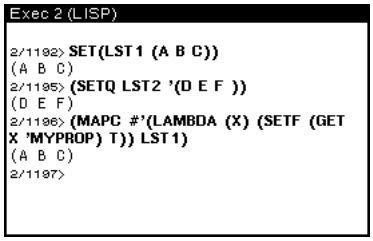


A Brief Example of Exec Interactions

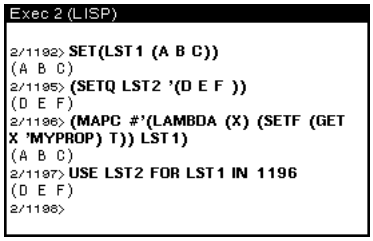
The following dialogue contains examples and gives the flavor of the use of an Exec. The commands are described in greater detail in the following sections. For now, be sure to type these examples to an Exec whose *PACKAGE* is set to the XCL-USER package. The Exec that Medley starts up with is set to the XCL-USER package. Each prompt consists of an Exec number, an event number and a prompt character (">" for Common Lisp and "←" for Interlisp).



You have instructed the Exec to UNDO the previous event.

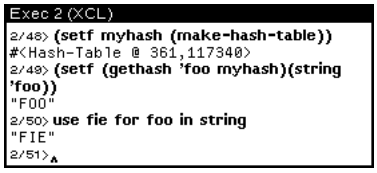


The Exec accepts input both in APPLY format (the SET) and EVAL format (the SETQ). In event 1196, you added a property MYPROP to the symbols A, B, and C.

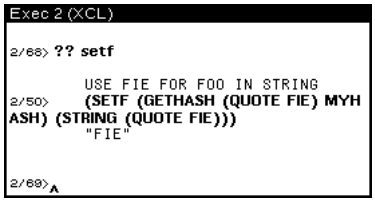


You told the Exec to go back to event 1196, substitute LST2 for LST1, and then re-execute the expression.

If STRING were computationally expensive (it isn't), you might be caching its value for later use.



You now decide you would like to redo the SETF with a different value. You can specify the event using any symbol in the expression.



Here you ask the Exec (using the ?? command) what it has on its history list for the last input. Since the event corresponds to a command, the Exec displays both the original command and the generated input.

You'll usually deal with the Exec at top level or in the debugger, where you type in expressions for evaluation, and see the values printed out. An Exec acts much like a standard Lisp top-level loop, but before it evaluates an input, it first adds it to the history list. If the operation is aborted or causes an error, the input is still available for you to modify or re-execute.

After updating the history list, the Exec executes the computation (i.e., evaluates the form or applies the function to its arguments), saves the value in the history-list entry for that input, and prints the result. Finally the Exec displays a prompt to show it's again ready for input.

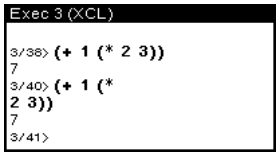
Input Formats

The Exec accepts three forms of input: an expression to be evaluated (EVAL-format), a function-name and arguments to apply it to (APPLY-format), and Exec commands, as follows:

EVAL-format input

If you type a single expression, either followed by a carriage-return, or, in the case of a list, terminated with balanced parenthesis, the expression is evaluated and the value is returned. For example, if the value of FOO is the list (A B C):

Similarly, if you type a Lisp expression, beginning with a left parenthesis and terminated by a matching right parenthesis, the form is simply passed to EVAL for evaluation. Notice that it is not necessary to type a carriage return at the end of such a form; the reader will supply one automatically. If a carriage-return is typed before the final matching right parenthesis or bracket, it is treated the same as a space, and input continues. The following examples are interpreted identically:



APPLY-format input

Often, you call functions with constant argument values, which would have to be quoted if you typed them in EVAL-format. For convenience, if you type a symbol immediately followed by a list, the symbol is APPLYed to the elements within the list, unevaluated. The input is terminated by the matching right parenthesis. For example, typing LOAD(FOO) is equivalent to typing (LOAD 'FOO), and GET(X

COLOR) is equivalent to (GET 'X 'COLOR). As a simple special case, a single right parenthesis is treated as a balanced set of parentheses, e.g. UNBREAK) is equivalent to UNBREAK()

The reader will only supply the "carriage return" automatically if no space appears between the initial symbol and the list that follows; if there is a space after the initial symbol on the line and the list that follows, the input is not terminated until you type a carriage return.

The Exec will not consider unparenthesized input with more than one argument to be in apply format, e.g.:

LIST(1) is apply format (executes after closing parenthesis is typed)

LIST (1) is apply format (second argument is a list, no trailing arguments given)

LIST '(1) 2 3 is NOT apply format, arguments are evaluated

LIST 1 2 3 is NOT apply format, arguments are evaluated

LIST 1 not legal input: second argument is not a list

Note that APPLY-format input cannot be used for macros or special forms.

Exec commands

The Exec recognizes a number of commands, which usually refer to past events on the history list. These commands are treated specially; for example, they may not be put on the history list. The format of a command is always a line beginning with the command name. (The Exec looks up the command name independent of package.) The remainder of the line, if any, is treated as "arguments" to the command. For example,

```
128> UNDO
mapc undone
129> UNDO (FOO --)
foo undone
```

are both valid command inputs.

Event Specification

Exec commands, like UNDO, frequently refer to previous events in the session's history. All Exec commands use the same conventions and syntax for indicating which event(s) the command refers to. This section shows you the syntax used to specify previous events.

An event address identifies one event on the history list. For example, the event address 42 refers to the event with event number 42, and -2 refers to two events back in the current Exec. Usually, an event address will contain only one or two commands.

Event addresses can be concatenated. For example, if FOO refers to event N, FOO FIE will refer to the first event before event N which contains FIE.

The symbols used in event addresses (such as AND, F, etc.) are compared with STRING-EQUAL, so that it does not matter what the current package is when you type an event address symbol to an Exec.

Specifications used below of the form *EventAddress* refer to event addresses, as described above. Since an event address may contain multiple words, the event address is parsed by searching for the words which delimit it. For example, in *EventAddress* AND *EventAddress*, the notation *EventAddress* corresponds to all words up to the AND in the event specification, and *EventAddress* to all words after the AND in the event specification.

Event addresses are interpreted as follows:

N (an integer) If N is positive, it refers to the event with event number N (no matter which Exec the event occurred in.) If N is negative, it always refers to the event -N events backwards, counting only events belonging to the current Exec.

F Specifies that the next object in the event address is to be searched for, regardless of what it is. For example, F -2 looks for an event containing -2.

FROM *EventAddress*

All events since *EventAddress*, inclusive. For example, if there is a single Exec and the current event is number 53, then FROM 49 specifies events 49, 50, 51, and 52. FROM includes events from *all* Execs.

ALL *EventAddress*

Specifies all events satisfying *EventAddress*. For example, ALL LOAD, ALL SUCHTHAT FOO-P.

empty If nothing is specified, it is the same as specifying -1, i.e., the last event in the current Exec.

EventSpec AND *EventSpec* AND . . . AND *EventSpec*

Each of the is an event specification. The lists of events are concatenated. For example, REDO ALL MAPC AND ALL STRING AND 32 redoes all events containing MAPC, all containing STRING, and also event 32. Duplicate events are removed.

Exec Commands

You enter an Exec commands by typing the name of the command at the prompt. The name of an Exec command is not a symbol and therefore is not sensitive to the setting of the current package (the value of *PACKAGE*).

EventSpec is used to denote an event specification which in most cases will be either a specific event address (e.g., 42) or a relative one (e.g., -3). Unless specified otherwise, omitting *EventSpec* is the same as specifying *EventSpec* = -1. For example, REDO and REDO -1 are the same.

REDO *EventSpec* [Exec command]

Redoes the event or events specified by *EventSpec*. For example, REDO 123 redoes the event numbered 123.

RETRY *EventSpec* [Exec command]

Like REDO but sets the debugger parameters so that any errors that occur while executing *EventSpec* will cause breaks.

USE *NEW* [**FOR** *OLD*] [**IN** *EventSpec*] [Exec command]

Substitutes *NEW* for *OLD* in the events specified by *EventSpec*, and redoes the result. *NEW* and *OLD* can include lists or symbols, etc.

For example, USE SIN (- X) FOR COS X IN -2 AND -1 will substitute SIN for every occurrence of COS in the previous two events, and substitute (- X) for every occurrence of X, and reexecute them. (The substitutions do not change the previous information saved about these events on the history list.)

If IN *EventSpec* is omitted, the first member of *OLD* is used to search for the appropriate event. For example, USE DEFAULTFONT FOR DEFLATFONT is equivalent to USE DEFAULTFONT FOR DEFLATFONT IN F DEFLATFONT. The F is inserted to handle the case where the first member of *OLD* could be interpreted as an event address command.

If *OLD* is omitted, substitution is for the "operator" in that command. For example FBOUNDP(FF) followed by USE CALLS is equivalent to USE CALLS FOR FBOUNDP IN -1.

If *OLD* is not found, USE will print a question mark, several spaces and the pattern that was not found. For example, if you specified USE Y FOR X IN 104 and X was not found, "X ?" is printed to the Exec.

You can also specify more than one substitution simultaneously as follows:

USE *NEW* **FOR** *OLD* **AND** ... **AND** *NEW* **FOR** *OLD* [**IN** *EventSpec*] [Exec command]

[The USE command is parsed by a small finite state parser to distinguish the expressions and arguments. For example, USE FOR FOR AND AND AND FOR FOR will be parsed correctly.]

Every USE command involves three pieces of information: the expressions to be substituted, the arguments to be substituted for, and an event specification that defines the input expression in which the substitution takes place. If the USE command has the same number of expressions as arguments, the substitution procedure is straightforward. For example, USE X Y FOR U V means substitute X for U and Y for V, and is equivalent to USE X FOR U AND Y FOR V.

However, the USE command also permits distributive substitutions for substituting several expressions for the same argument. For example, USE A B C FOR X means first substitute A for X then substitute B for X (in a new copy of the expression), then substitute C for X. The effect is the same as three separate USE commands.

Similarly, USE A B C FOR D AND X Y Z FOR W is equivalent to USE A FOR D AND X FOR W, followed by USE B FOR D AND Y FOR W, followed by USE C FOR D AND Z FOR W. USE A B C FOR D AND X FOR Y also corresponds to three substitutions, the first with A for D and X for Y, the second with B for D, and X for Y, and the third with C

for D, and again X for Y. However, USE A B C FOR D AND X Y FOR Z is ambiguous and will cause an error.

Essentially, the USE command operates by proceeding from left to right handling each AND separately. Whenever the number of expressions exceeds the available expressions, multiple USE expressions are generated. Thus USE A B C D FOR E F means substitute A for E at the same time substituting B for F, then in another copy of the indicated expression, substitute C for E and D for F. This is also equivalent to USE A C FOR E AND B D FOR F.

The USE command correctly handles the situation where one of the old expressions is the same as one of the new ones, USE X Y FOR Y X, or USE X FOR Y AND Y FOR X.

? *NAME* [Exec command]

If *NAME* is not provided describes all available Exec commands by printing the name, argument list, and description of each. With *NAME*, only that command is described.

?? *EventSpec* [Exec command]

Prints the most recent event matching the given *EventSpec*. Without *EventSpec*, lists all entries on the history list from all execs, not necessarily in the order in which they occured (since the list is in allocation order). If you haven't completed typing a command it will be listed as "<in progress>" .

Note: Event nubmers are allocated at the time the prompt is printed, except in the Old Interlisp exec where they are assigned at the end of type-in. This means that if activity occurs in another exec, the number printed next to the command is not necessarily the number associated with the event.

CONN *DIRECTORY* [Exec command]

Changes default pathname to *DIRECTORY*.

DA [Exec command]

Returns current date and time.

DIR *PATHNAME KEYWORDS* [Exec command]

Shows a directory listing for *PATHNAME* or the connected directory. If provided, *KEYWORDS* indicate information to be displayed for each file. Some keywords are: *AUTHOR*, *AU*, *CREATIONDATE*, *DA*, etc.

DO-EVENTS *INPUTS ENV* [Exec command]

DO-EVENTS is intended as a way of putting together several different events, which can include commands. It executes the multiple *INPUTS* as a single event. The values returned by the *DO-EVENTS* event are the concatenation of the values of the inputs. An input is not an EventSpec, but a call to a function or command. If *ENV* is provided it is a lexical environment in which all evaluations (functions and commands) will take place. Event specification in the *INPUTS* should be explicit, not relative, since referring to the last event will reinvoke the executing *DO-EVENTS* command.

FIX *EventSpec* [Exec command]

Edits the specified event prior to re-executing it. If the number of characters in the fixed line is less than the variable TTYINFIXLIMIT then it will be edited using TTYIN, otherwise the Lisp editor is called via EDITE.

FORGET *EventSpec* [Exec command]

Erases UNDO information for the specified events.

NAME *COMMAND-NAME ARGUMENTS EVENT-SPEC* [Exec command]

Defines a new command, *COMMAND-NAME*, and its *ARGUMENTS*, containing the events in *EVENT-SPEC*.

NDIR *PATHNAME KEYWORDS* [Exec command]

Shows a directory listing for *PATHNAME* or the connected directory in abbreviated format. If provided, *KEYWORDS* indicate information to be displayed for each file. Some keywords are: AUTHOR, AU, CREATIONDATE, DA, etc.

PL *SYMBOL* [Exec command]

Prints the property list of *SYMBOL* in an easy to read format.

REMEMBER *&REST EVENT-SPEC* [Exec command]

Tells File Manager to remember type-in from specified event(s), *EVENT-SPEC*, as expressions to save.

SHH *LINE* [Exec command]

Executes *LINE* without history list processing.

UNDO *EventSpec* [Exec command]

Undoes the side effects of the specified event (see below under “Undoing”).

PP *NAME TYPES* [Exec command]

Shows (prettyprinted) the definitions for *NAME* specified by *TYPES*.

SEE *FILES* [Exec command]

Prints the contents of *FILES* in the Exec window, hiding comments.

SEE* *FILES* [Exec command]

Prints the contents of *FILES* in the Exec window, showing comments.

TIME *FORM &KEY REPEAT &ENVIRONMENT ENV* [Exec command]

Times the evaluation of *FORM* in the lexical environment *ENV*, repeating *REPEAT* number of times. Information is displayed in the Exec window.

TY *FILES* [Exec command]

Exactly like the *TYPE* Exec command.

TYPE *FILES* [Exec command]

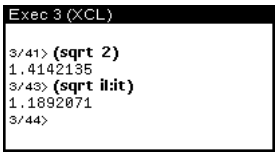
Prints the contents of *FILES* in the Exec window, hiding comments.

Variables

A number of variables are provided for convenience in the Exec.

IL:IT [Variable]

Whenever an event is completed, the global value of the variable IT is reset to the event's value. For example,



Following a ?? command, IL:IT is set to the value of the last event printed. The inspector has an option for setting the variable IL:IT to the current selection or inspected object, as well. The variable IL:IT is global, and is shared among all Execs. IL:IT is a convenient mechanism for passing values from one process to another.

Note: IT is in the Interlisp package and these examples are intended for an Exec whose *PACKAGE* is set to XCL-USER. Thus, IT must be package qualified (the IL:).

The following variables are maintained independently by each Exec. (When a new Exec is started, the initial values are NIL, or, for a nested Exec, the value for the "parent" Exec. However, events executed under a nested Exec will not affect the parent values.)

CL:- [Variable]
CL:+ [Variable]
CL:++ [Variable]
CL:+++ [Variable]

While a form is being evaluated by the Exec, the variable CL:- is bound to the form, CL:+ is bound to the previous form, CL:++ the one before, etc. If the input is in apply-format rather than eval-format, the value of the respective variable is just the function name.

CL:* [Variable]
CL:** [Variable]
CL:*** [Variable]

While a form is being evaluated by the Exec, the variable CL:* is bound to the (first) value returned by the last event, CL:** to the event before that, etc. The variable CL:* differs from IT in that IT is global while each separate Exec maintains its own copy of CL:*, CL:** and CL:***. In addition, the history commands change IT, but only inputs that are retained on the history list can change CL:*.

CL:/ [Variable]
CL:// [Variable]
CL:/// [Variable]

While a form is being evaluated by an Exec, the variable CL:/ is bound to a list of the results of the last event in that Exec, CL:// to the values of the event before that, etc.

Fonts in the Exec

The Exec can use different fonts for displaying the prompt, user's input, intermediate printout, and the values returned by evaluation. The following variables control the Exec's font use:

PROMPTFONT [Variable]

Font used for printing the event prompt.

INPUTFONT [Variable]

Font used for echoing your type-in.

PRINTOUTFONT [Variable]

Font used for any intermediate printing caused by execution of a command or evaluation of a form. Initially the same as DEFAULTFONT.

VALUEFONT [Variable]

Font used to print the values returned by evaluation of a form. Initially the same as DEFAULTFONT.

Modifying an Exec

(**CHANGESLICE** *N HISTORY* —) [Function]

Changes the maximum number of events saved on the history list *HISTORY* to *N*. If NIL, *HISTORY* defaults to the top level history LISPXHISTORY.

The effect of *increasing* the time-slice is gradual: the history list is simply allowed to grow to the corresponding length before any events are forgotten. *Decreasing* the time-slice will immediately remove a sufficient number of the older events to bring the history list down to the proper size. However, CHANGESLICE is undoable, so that these events are (temporarily) recoverable. Therefore, if you want to recover the storage associated with these events without waiting *N* more events until the CHANGESLICE event drops off the history list, you must perform a FORGET command.

Defining New Commands

You can define new Exec commands using the XCL:DEFCOMMAND macro.

(**XCL:DEFCOMMAND** *NAME ARGUMENT-LIST &REST BODY*) [Macro]

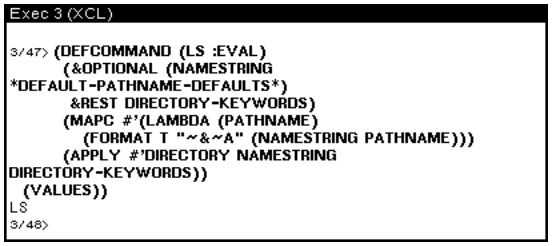
XCL:DEFCOMMAND is like XCL:DEFMACRO, but defines new Exec commands. The *ARGUMENT-LIST* can have keywords, and use all of the features of macro argument lists. When *NAME* is subsequently typed to the Exec, the rest of the line is processed like the arguments to a macro, and the *BODY* is executed. XCL:DEFCOMMAND is a definer; the

File Manager will remember typed-in definitions and allow them to be saved, edited with EDITDEF, etc.

There are three kinds of commands that can be defined, :EVAL, :QUIET, and :INPUT. Commands can also be marked as only for the debugger, in which case they are labelled as :DEBUGGER. The command type is noted by supplying a list for the *NAME* argument to XCL:DEFCOMMAND, where the first element of the list is the command name, and the other elements are keyword(s) for the command type and, optionally :DEBUGGER.

The documentation string in user defined Exec commands is automatically added to the documentation descriptions by the CL:DOCUMENTATION function under the COMMANDS type and can be shown using the ? Exec command.

:EVAL This is the default. The body of the command just gets executed, and its value is the value of the event. For example (in an XCL Exec),



would define the LS command to print out all file names that match the input NAMESTRING. The (VALUES) means that no value will be printed by the event, only the intermediate output from the FORMAT.

:QUIET These commands are evaluated, but neither your input nor the results of the command are stored on the history list. For example, the ?? and SHH commands are quiet.

:INPUT These commands work more like macros, in that the result of evaluating the command is treated as a new line of input. The FIX command is an input command. The result is treated as a line; a single expression in EVAL-format should be returned as a list of the expression to EVAL.

Undoing

Note: This discussion only applies to undoing under the Exec or Debugger, and within the UNDOABLY macro; text and structure editors handle undoing differently.

The UNDO facility allows recording of destructive changes such that they can be played back to restore a previous state. There are two kinds of UNDOing: one is done by the Exec, the other is available for use in your code. Both methods share information about what kind of operations can be undone and where the changes are recorded.

Undoing in the Exec

UNDO *EventSpec* [Exec command]

The Exec's UNDO command is implemented by watching the evaluation of forms and requiring undoable operations in that evaluation to save enough information on the history list to reverse their side effects. The Exec simply executes operations, and any undoable changes that occur are automatically saved on the history list by the responsible functions. The UNDO command works on itself the same way: it recovers the saved information and performs the corresponding inverses. Thus, UNDO is effective on itself, so that you can UNDO an UNDO, and UNDO that, etc.

Only when you attempt to undo an operation does the Exec check to see whether any information has been saved. If none has been saved, and you have specifically named the event you want undone, the Exec types `nothing saved`. (When you just type UNDO, the Exec only tries to undo the last operation.)

UNDO watches evaluation using CL:EVALHOOK (thus, calling CL:EVALHOOK cannot be undone). Each form given to EVAL is examined against the list LISPXFNS to see if it has a corresponding undoable version. If an undoable version of a call is found, it is called with the same arguments instead of the original. Therefore, before evaluating all subforms of your input, the Exec substitutes the corresponding undoable call for any destructive operation. For example, if you type (DEFUN FOO ...), undoable versions of the forms that set the definition into the symbol function cell are evaluated. FOO's function definition itself is not made undoable.

Undoing in Programs

There are two ways to make a program undoable. The simplest method is to wrap the program's form in the UNDOABLY macro. The other is to call undoable versions of destructive operations directly.

(**XCL:UNDOABLY** *&REST FORMS*) [Macro]

Executes the forms in *FORMS* using undoable versions of all destructive operations. This is done by "walking" (see WALKFORM) all of the *FORMS* and rewriting them to use the undoable versions of destructive operations (LISPXFNS makes the association).

(**STOP-UNDOABLY** *&REST FORMS*) [Macro]

Normally executes as PROGN; however, within an UNDOABLY form, explicitly causes *FORMS* not to be done undoably. Turns off rewriting of the *FORMS* to be undoable inside an UNDOABLY macro.

Undoable Versions of Common Functions

When efficiencyis a serious concern, you may need more control over the saving of undo information than that provided by the UNDOABLY macro.

To make a function undoable, you can simply substitute the corresponding undoable function in your program. When the undoable function is called, it will save the undo information in the current event on the history list.

Various operations, most notably SETF, have undoable versions. The following undoable macros are initially available:

UNDOABLY-POP	UNDOABLY-SET-SYMBOL
UNDOABLY-PUSH	UNDOABLY-MAKUNBOUND
UNDOABLY-PUSHNEW	UNDOABLY-FMAKUNBOUND
UNDOABLY-REMF	UNDOABLY-SETQ
UNDOABLY-ROTATEF	XCL:UNDOABLY-SETF
UNDOABLY-SHIFTF	UNDOABLY-PSETF
UNDOABLY-DECF	UNDOABLY-SETF-SYMBOL-FUNCTION
UNDOABLY-INCF	UNDOABLY-SETF-MACRO-FUNCTION

Note: Many destructive Common Lisp functions do not have undoable versions, e.g., CL:NREVERSE, CL:SORT, etc. You can see the current list of undoable functions on the association list LISPXFNS.

Modifying the UNDO Facility

You may want to extend the UNDO facility after creating a form whose side effects might be undoable, for instance a file renaming function.

You need to write an undoable version of the function. You can do this by explicitly saving previous state information, or by renaming calls in the function to their undoable equivalent. Undo information should be saved on the history list using IL:UNDOSAVE.

You must then hook the undoable version of the function into the undo facility. You do this by either using the IL:LISPXFNS association list, or in the case of a SETF modifier, on the IL:UNDOABLE-SETF-INVERSE property of the SETF function.

LISPXFNS [Variable]

Contains an association list that maps from destructive operations to their undoable form. Initially this list contains:

```
((CL:POP . UNDOABLY-POP)
 (CL:PSETF . NDOABLY-PSETF)
 (CL:PUSH . UNDOABLY-PUSH)
 (CL:PUSHNEW . UNDOABLY-PUSHNEW)
 ((CL:REMF) . UNDOABLY-REMF)
 (CL:ROTATEF . UNDOABLY-ROTATEF)
 (CL:SHIFTF . UNDOABLY-SHIFTF)
 (CL:DECF . UNDOABLY-DECF)
 (CL:INCF . UNDOABLY-INCF)
 (CL:SET . UNDOABLY-SET-SYMBOL)
 (CL:MAKUNBOUND . UNDOABLY-MAKUNBOUND)
 (CL:FMAKUNBOUND . UNDOABLY-FMAKUNBOUND)
 . . . plus the original Interlisp undo associations)
```

(**XCL:UNDOABLY-SETF** *PLACE VALUE* . . .) [Macro]

Like CL:SETF but saves information so it may be undone. UNDOABLY-SETF uses undoable versions of the SETF function located on the UNDOABLE-SETF-INVERSE property of the function being SETFed. Initially these SETF names have such a property:

```
CL:SYMBOL-FUNCTION - UNDOABLY-SETF-SYMBOL-FUNCTION
CL:MACRO-FUNCTION - UNDOABLY-SETF-MACRO-FUNCTION
```

(**UNDOABLY-SETQ** *&REST FORMS*) [Function]

Typed-in SETQs (and SETFs on symbols) are made undoable by substituting a call to UNDOABLY-SETQ. UNDOABLY-SETQ operates like SETQ on lexical variables or those with dynamic bindings; it only saves information on the history list for changes to global, "top-level" values.

(**UNDOSAVE** *UNDOFORM HISTENTRY*) [Function]

Adds the undo information *UNDOFORM* to the SIDE property of the history event *HISTENTRY*. If there is no SIDE property, one is created. If the value of the SIDE property is NOSAVE, the information is not saved. *HISTENTRY* specifies an event. If *HISTENTRY*=NIL, the value of LISPXHIST is used. If both *HISTENTRY* and LISPXHIST are NIL, UNDOSAVE is a no-op.

The form of UNDOFORM is (FN . ARGS). Undoing is done by performing (APPLY (CAR UNDOFORM) (CDR UNDOFORM)).

\#UNDOSAVES [Variable]

The maximum number of UNDOFORMs to be saved for a single event. When the count of UNDOFORMs reaches this number, UNDOSAVE prints the message CONTINUE SAVING?, asking if you want to continue saving. If you answer NO or default, UNDOSAVE discards the previously saved information for this event, and makes NOSAVE be the value of the property SIDE, which disables any further saving for this event. If you answer YES, UNDOSAVE changes the count to -1, which is then never incremented, and continues saving. The purpose of this feature is to avoid tying up large quantities of storage for operations that will never need to be undone.

If \#UNDOSAVES is negative, then when the count reaches (ABS \#UNDOSAVES), UNDOSAVE simply stops saving without printing any messages or other interactions. \#UNDOSAVES = NIL is equivalent to \#UNDOSAVES = infinity. \#UNDOSAVES is initially NIL.

The configuration described here is very satisfactory. You pay a very small price for the ability to undo what you type in, since the interpreted evaluation is simply watched for destructive operations, or if you wish to protect yourself from malfunctioning in your own programs, you can explicitly call, or rewrite your program to explicitly call, undoable functions.

Undoing Out of Order

UNDOABLY-SETF operates undoably by saving (on the history list) the cell that is to be changed and its original contents. Undoing an UNDOABLY-SETF restores the saved contents.

This implementation can produce unexpected results when multiple modifications are made to the same piece of storage and then undone out of order. For example, if you type (SETF (CAR FOO) 1), followed by (SETF (CAR FOO) 2), then undo both events by undoing the most recent event first, then undoing the older event, FOO will be restored to its state before either event operated. However if you undo the first event, then the second event, (CAR FOO) will be 1, since this is what was in CAR of FOO before (UNDOABLY-SETF (CAR FOO) 2) was executed. Similarly, if you type

(NCONC FOO '(1)), followed by (NCONC FOO '(2)), undoing just (NCONC FOO '(1)) will remove both 1 and 2 from FOO. The problem in both cases is that the two operations are not independent.

In general, operations are always independent if they affect different lists or different sublists of the same list. Undoing in reverse order of execution, or undoing independent operations, is always guaranteed to do the right thing. However, undoing dependent operations out of order may not always have the predicted effect.

Format and Use of the History List

LISPXHISTORY [Variable]

The Exec currently uses one primary history list, LISPXHISTORY for the storing events.

The history list is in the form (*EVENTS EVENT# SIZE MOD*), where *EVENTS* is a list of events with the most recent event first, *EVENT#* is the event number for the most recent event on *EVENTS*, *SIZE* is the the maximum length *EVENTS* is allowed to grow. *MOD* is is the maximum event number to use, after which event numbers roll over. *LISPXHISTORY* is initialized to (NIL 0 100 1000).

The history list has a maximum length, called its time-slice. As new events occur, existing events are aged, and the oldest events are forgotten. The time-slice can be changed with the function CHANGESLICE. Larger time-slices enable longer memory spans, but tie up correspondingly greater amounts of storage. Since you seldom need really ancient history, a relatively small time-slice such as 30 events is usually adequate, although some users prefer to set the time-slice as large as 200 events.

Each individual event on *EVENTS* is a list of the form (*INPUT ID VALUE . PROPS*). For Exec events, *ID* is a list (*EVENT-NUMBER EXEC-ID*). The *EVENT-NUMBER* is the number of the event, while the *EXEC-ID* is a string that uniquely identifies the Exec. (The *EXEC-ID* is used to identify which events belong to the "same" Exec.) *VALUE* is the (first) value of the event. *PROPS* is a property list used to associate other information with the event (described below).

INPUT is the input sequence for the event. Normally, this is just the input that you type in. For an APPLY-format input this is a list consisting of two expressions; for an EVAL-format input, this is a list of just one expression; for an input entered as list of atoms, *INPUT* is simply that list. For example,

User Input	*INPUT* is:
LIST(1 2)	(LIST (1 2))
(LIST 1 1)	((LIST 1 1))
DIR "{DSK}<LISPFILES>"*cr*	(DIR "{DSK}<LISPFILES>")

If you type in an Exec command that executes other events (REDO, USE, etc.), several events might result. When there is more than one input, they are wrapped together into one invocation of the DO-EVENTS command.

The same convention is used for representing multiple inputs when a USE command involves sequential substitutions. For example, if you type FBOUNDP(FOO) and then USE

FIE FUM FOR FOO, the input sequence that will be constructed is DO-EVENTS (EVENT FBOUNDP (FIE)) (EVENT FBOUNDP (FUM)), which is the result of substituting FIE for FOO in (FBOUNDP (FOO)) concatenated with the result of substituting FUM for FOO in (FBOUNDP (FOO)).

PROPS is a property list of the form (PROPERTY VALUE PROPERTY VALUE ...), that can be used to associate arbitrary information with a particular event. Currently, the following properties are used by the Exec:

SIDE

A list of the side effects of the event. See UNDOSAVE.

LISPXPRINT

Used to record calls to EXEC-FORMAT, and printed by the ?? command.

Making or Changing an Exec

(**XCL:ADD-EXEC** *&KEY PROFILE REGION TTY ID*) [Function]

Creates a new process and window with an Exec running in it. *PROFILE* is the type of the Exec to be created (see below under XCL:SET-EXEC-TYPE). *REGION* optionally gives the shape and location of the window to be used. If not provided you will be prompted. *TTY* is a flag, which, if true, causes the tty to be given to the new Exec process. *ID* is a string identifier to use for events generated in this exec. *ID* defaults to the number given to the Exec process created.

(**XCL:EXEC** *&KEY WINDOW PROMPT COMMAND-TABLES ENVIRONMENT PROFILE TOP-LEVEL-P TITLE FUNCTION ID*) [Function]

This is the main entry to the Exec. The arguments are:

WINDOW defaults to the current TTY display stream, or can be provided a window in which the Exec will run.

PROMPT is the prompt to print.

COMMAND-TABLES is a list of hash-tables for looking up commands (e.g., *EXEC-COMMAND-TABLE* or *DEBUGGER-COMMAND-TABLE*).

ENVIRONMENT is a lexical environment used to evaluate things in.

READTABLE is the default readtable to use (defaults to the "Common Lisp" readtable).

PROFILE is a way to set the Exec's type (see above, "Multiple Execs and the Exec's Type").

TOP-LEVEL-P is a boolean, which should be true if this Exec is at the top level (it's NIL for debugger windows, etc).

TITLE is an identifying title for the window title of the Exec.

FUNCTION is a function used to actually evaluate events, default is EVAL-INPUT.

ID is a string identifier to use for events generated in this Exec. *ID* defaults to the number given to the Exec process.

XCL:*PER-EXEC-VARIABLES* [Variable]

A list of pairs of the form (*VAR INIT*). Each time an Exec is entered, the variables in *PER-EXEC-VARIABLES* are rebound to the value returned by evaluating *INIT*. The initial value of *PER-EXEC-VARIABLES* is:

```
((*PACKAGE* *PACKAGE*)
 (* *)
 (** **)
 (*** ***)
 (+ +)
 (++ ++)
 (+++ +++)
 (- -)
 (/ /)
 (// //)
 (/// ///)
 (HELPFLAG T)
 (*EVALHOOK* NIL)
 (*APPLYHOOK* nil)
 (*ERROR-OUPUT* *TERMINAL-IO*)
 (*READTABLE* *READTABLE*)
 (*package* *package*)
 (*eval-function* *eval-function*)
 (*exec-prompt* *exec-prompt*)
 (*debugger-prompt* *debugger-prompt*))
```

Most of these cause the values to be (re)bound to their current value in any inferior Exec, or to NIL, their value at the "top level".

XCL:*EVAL-FUNCTION* [Variable]

Bound to the function used by the Exec to evaluate input. Typically in an Interlisp Exec this is IL:EVAL, and in a Common Lisp Exec, CL:EVAL.

XCL:*EXEC-PROMPT* [Variable]

Bound to the string printed by the Exec as a prompt for input. Typically in an Interlisp Exec this is " ← ", and in a Common Lisp Exec, "> ".

XCL:*DEBUGGER-PROMPT* [Variable]

Bound to the string printed by the debugger Exec as a prompt for input. Typically in an Interlisp Exec this is " ←: ", and in a Common Lisp Exec, ": ".

(**XCL:EXEC-EVAL** *FORM &OPTIONAL ENVIRONMENT*) [Function]

Evaluates *FORM* (using EVAL) in the lexical environment *ENVIRONMENT* the same as though it were typed in to EXEC, i.e., the event is recorded, and the evaluation is made undoable by substituting the UNDOABLE-functions for the corresponding destructive functions. XCL:EXEC-EVAL returns the value(s) of the form, but does not print it, and does not reset the variables *, **, ***, etc.

(**XCL:EXEC-FORMAT** *CONTROL-STRING &REST ARGUMENTS*) [Function]

In addition to saving inputs and values, the Exec saves many system messages on the history list. For example, FILE CREATED ..., FN redefined, VAR reset, output of TIME, BREAKDOWN, ROOM, save their output on the history list, so that when ?? prints the event, the output is also printed. The function XCL:EXEC-FORMAT can be used in your code similarly. XCL:EXEC-FORMAT performs (APPLY #'CL:FORMAT *TERMINAL-IO* *CONTROL-STRING ARGUMENTS*) and also saves the format string and arguments on the history list associated with the current event.

(**XCL:SET-EXEC-TYPE** *NAME*) [Function]

Sets the type of the current Exec to that indicated by *NAME*. This can be used to set up the Exec to your liking. *NAME* may be an atom or string. Possible names are:

INTERLISP, IL	*READTABLE* INTERLISP *PACKAGE* INTERLISP XCL:*DEBUGGER-PROMPT* "←: " XCL:*EXEC-PROMPT* "←" XCL:*EVAL-FUNCTION* IL:EVAL
XEROX-COMMON-LISP, XCL	*READTABLE* XCL *PACKAGE* XCL-USER XCL:*DEBUGGER-PROMPT* ": " XCL:*EXEC-PROMPT* "> " XCL:*EVAL-FUNCTION* CL:EVAL
COMMON-LISP, CL	*READTABLE* LISP *PACKAGE* USER XCL:*DEBUGGER-PROMPT* ": " XCL:*EXEC-PROMPT* "> " XCL:*EVAL-FUNCTION* CL:EVAL
OLD-INTERLISP-T	*READTABLE* OLD-INTERLISP-T *PACKAGE* INTERLISP XCL:*DEBUGGER-PROMPT* "←: " XCL:*EXEC-PROMPT* ": " XCL:*EVAL-FUNCTION* IL:EVAL

(**XCL:SET-DEFAULT-EXEC-TYPE** *NAME*) [Function]

Like XCL:SET-EXEC-TYPE, but sets the type of Execs created by default, as from the background menu. Initially XCL. This can be used in your greet file to set default Execs to your liking.

Editing Exec Input

The Exec features an input editorwhich provides completion, spelling correction, help facility, and character-level editing. The implementation is borrowed from the Interlisp module TTYIN. This section describes the use of the TTYIN editor from the perspective of the Exec.

Editing Your Input

Some editing operations can be performed using any of several characters; characters that are interrupts will, of course, not be read, so several alternatives are given. The following characters may be used to edit your input:

CONTROL-A

BACKSPACE Deletes a character. At the start of the second or subsequent lines of your input, deletes the last character of the previous line.

CONTROL-W Deletes a "word". Generally this means back to the last space or parenthesis.

CONTROL-Q Deletes the current line, or if the current line is blank, deletes the previous line.

CONTROL-R Refreshes the current line. Two in a row refreshes the whole buffer (when doing multiline input).

ESCAPE Tries to complete the current word from the spelling list USERWORDS. In the case of ambiguity, completes as far as is uniquely determined, or beeps.

UNDO key Retrieves characters from the previous non-empty buffer when it is able to; e.g., when typed at the beginning of the line this command restores the previous line you typed; when typed in the middle of a line fills in the remaining text from the old line; when typed following CONTROL-Q or CONTROL-W restores what those commands erased.

CONTROL-X Goes to the end of your input (or end of expression if there is an excess right parenthesis) and returns if parentheses are balanced.

If you are already at the end of the input and the expression is balanced except for lacking one or more right parentheses, CONTROL-X adds the required right parentheses to balance and returns.

During most kinds of input, lines are broken, if possible, so that no word straddles the end of the line. The pseudo-carriage return ending the line is still read as a space, however; i.e., the program keeps track of whether a line ends in a carriage return or is merely broken at some convenient point. You will not get carriage returns in your strings unless you explicitly type them.

Using the Mouse

Editing with the mouse during TTYIN input is slightly different than with other modules. The mouse buttons are interpreted as follows during TTYIN input:

LEFT Moves the caret to where the cursor is pointing. As you hold down LEFT, the caret moves around with the cursor; after you let up, any type-in will be inserted at the new position.

MIDDLE
LEFT+RIGHT Like LEFT, but moves only to word boundaries.

RIGHT Deletes text from the caret to the cursor, either forward or backward. While you hold down RIGHT, the text to be deleted is inverted; when you let up, the text goes away. If you let up outside the scope of the text, nothing is deleted (this is how to cancel this operation).

If you hold down MOVE, COPY, SHIFT or CTRL while pressing the mouse buttons, you instead get secondary selection, move selection or delete selection. The selection is made by holding the appropriate key down while pressing the mouse buttons LEFT (to select a character) or MIDDLE (to select a word), and optionally extend the selection either left or right using RIGHT. While you are doing this, the caret does not move, but the selected text is highlighted in a manner indicating what is about to happen. When the selection is complete, release the mouse buttons and then lift up on MOVE/COPY/CTRL/SHIFT and the appropriate action will occur:

COPY
SHIFT The selected text is inserted as if it were typed. The text is highlighted with a broken underline during selection.

CTRL The selected text is deleted. The text is complemented during selection.

MOVE
CTRL+**SHIFT** Combines copy and delete. The selected text is moved to the caret.

You can cancel a selection in progress by pressing LEFT or MIDDLE as if to select, and moving outside the range of the text.

The most recent text deleted by mouse command can be inserted at the caret by typing the UNDO key. This is the same key that retrieves the previous buffer when issued at the end of a line.

Editing Commands

A number of characters have special effects while typing to the Exec. Some of them merely move the caret inside the input stream. While caret positioning can often be done more conveniently with the mouse, some of the commands, such as the case changing commands, can be useful for modifying the input.

In the descriptions below, current word means the word the cursor is under, or if under a space, the previous word. Currently, parentheses are treated as spaces, which is usually what you want, but can occasionally cause confusion in the word deletion commands.

Most commands can be preceded by a numeric argument. A numeric argument can be a number or an escape. You enter the numeric argument by holding down the meta key and entering a number. You only need to hold down the meta key for the firs digit of the argument. Entering escape as a numeric argument means infinity.

Some commands also accept negative arguments, but some only look at the magnitude of the argument. Most of these commands are confined to work within one line of text unless otherwise noted.

Cursor Movement Commands

Meta-BACKSPACE Backs up one (or n) characters.

Meta-SPACE Moves forward one (or n) characters.

Meta-^ Moves up one (or n) lines.

Meta-LINEFEED Moves down one (or n) lines.

Meta-(Moves back one (or n) words.

Meta-) Moves ahead one (or n) words.

Meta-tab Moves to end of line; with an argument moves to nth end of line; **Meta-Control-tab** goes to end of buffer.

Meta-Control-L Moves to start of line (or nth previous, or start of buffer).

Meta-{ Goes to start of buffer.

Meta-} Goes to end of buffer.

Meta-[Moves to beginning of the current list, where cursor is currently under an element of that list or its closing paren. (See also the auto-parenthesis-matching feature below under "Assorted Flags".)

Meta-] Moves to end of current list.

Meta-Sx Skips ahead to next (or nth) occurrence of character x, or rings the bell.

Meta-Bx Backward search.

Buffer Modification Commands

Meta-Zx Zaps characters from cursor to next (or nth) occurrence of x. There is no unzap command.

Meta-A
Meta-R Repeats the last S, B, or Z command, regardless of any intervening input.

Meta-K Kills the character under the cursor, or n chars starting at the cursor.

Meta-CR When the buffer is empty is the same as undo i.e. restores buffer's previous contents. Otherwise is just like a <cr> (except that it also terminates an insert). Thus, **Meta-CR Meta-CR** will repeat the previous input (as will undo<cr> without the meta key).

Meta-O Does "Open line", inserting a crlf after the cursor, i.e., it breaks the line but leaves the cursor where it is.

Meta-T Transposes the characters before and after the cursor. When typed at the end of a line, transposes the previous two characters. Refuses to handle odd cases, such as tabs.

Meta-G Grabs the contents of the previous line from the cursor position onward. **Meta-**n **Meta-G** grabs the nth previous line.

Meta-L Puts the current word, or n words on line, in lower case. **Meta-**<escape> **Meta-L** puts the rest of the linein lower case; or if given at the end of line puts the entire line in lower case.

Meta-U Analogous to **Meta-L**, for putting word, line, or portion of line in upper case.

Meta-C Capitalizes. If you give it an argument, only the first word is capitalized; the rest are just lowercased.

Meta-Control-Q Deletes the current line. **Meta-**<escape> **Meta-Control-Q** deletes from the current cursor position to the end of the buffer. No other arguments are handled.

Meta-Control-W Deletes the current word, or the previous word if sitting on a space.

Miscellaneous Commands

Meta-P Prettyprints buffer. Clears the buffer and reprints it using prettyprint. If there are not enough right parentheses, it will supply more; if there are too many, any excess remains unprettyprinted at the end of the buffer. May refuse to do anything if there is an unclosed string or other error trying to read the buffer.

Meta-N Refreshes line. Same as **Control-R**. **Meta-**<escape> **Meta-N** refreshes the whole buffer; **Meta-**n **Meta-N** refreshes n lines. Cursor movement in TTYIN depends on TTYIN being the only source of output to the window; in some circumstances, you may need to refresh the line for best results.

Meta-Control-Y Gets an Interlisp Exec. **Meta-**<escape> **Meta-Control-Y** Gets an Interlisp Exec, but first unreads the contents of the buffer from the cursor onward. Thus if you typed at TTYIN something destined for Interlisp, you can do **Meta-Control-L** **Meta-**<escape> **Meta-Control-Y** and give it to Lisp.

Meta-_ Adds the current word to the spelling list USERWORDS. With zero argument, removes word. See TTYINCOMPLETEFLG.

Useful Macros

If the event is considered short enough, the Exec command FIX will load the buffer with the event's input, rather than calling the structure editor. If you really wanted the Lisp editor for your fix, you can say FIX EVENT - |TTY:|.

?= Handler

Typing the characters ?=<cr> displays the arguments to the function currently in progress. Since TTYIN wants you to be able to continue editing the buffer after a ?=, it prints the arguments below your type-in and then puts the cursor back where it was when ?= was typed.

Assorted Flags

These flags control aspects of TTYIN's behavior. Some have already been mentioned. All are initially set to T.

?ACTIVATEFLG [Variable]

If true, enables the feature whereby ? lists alternative completions from the current spelling list.

SHOWPARENFLG [Variable]

If true, then whenever you are typing Lisp input and type a right parenthesis, TTYIN will briefly move the cursor to the matching parenthesis, assuming it is still on the screen. The cursor stays there for about 1 second, or until you type another character (i.e., if you type fast you will never notice it).

USERWORDS [Variable]

USERWORDS contains words you mentioned recently: functions you have defined or edited, variables you have set or evaluated at the executive level, etc. This happens to be a very convenient list for context-free escape completion; if you have recently edited a function, chances are good you may want to edit it again (typing "ED(xx$)") or type a call to it. If there is no completion for the current word from USERWORDS, or there is more than one possible completion, TTYIN beeps. If typed when not inside a word, Escape completes to the value of LASTWORD, i.e., the last thing you typed that the Exec noticed,

except that Escape at the beginning of the line is left alone (it is an Old Interlisp Exec command).

If you really wanted to enter an escape, you can, of course, just quote it with a CONTROL-V, like you can other control characters.

You may explicitly add words to USERWORDS yourself that would not get there otherwise. To make this convenient online the edit command [←] means "add the current atom to USERWORDS" (you might think of the command as pointing out this atom). For example, you might be entering a function definition and want to point to one or more of its arguments or prog variables. Giving an argument of zero to this command will instead remove the indicated atom from USERWORDS.

Note that this feature loses some of its value if the spelling list is too long, if there are too many alternative completions for you to get by with typing a few characters followed by escape. Lisp's maintenance of the spelling list USERWORDS keeps the temporary section (which is where everything goes initially unless you say otherwise) limited to \#USERWORDS atoms, initially 100. Words fall off the end if they haven't been used (they are used if FIXSPELL corrects to one, or you use <escape> to complete one).

Old Interlisp T compatibility

The Old Interlisp exec contains a few extra Exec commands not listed above. They are explained here.

In addition to the normal Event addresses you can also specify the following Event addresses:

= Specifies that the next object is to be searched for in the values of events, instead of the inputs

SUCHTHAT *PRED* Specifies an event for which the function *PRED* returns true. *PRED* should be a function of two arguments, the input portion of the event, and the event itself.

PAT Any other event address command specifies an event whose input contains an expression that matches *PAT*. When multiple Execs are active, all events are searched, no matter which Exec they belong to. The pattern can be a simple symbol, or a more complex search pattern.

Significant Changes in MEDLEY Rele[redacted]ase

There are two major differences between the Medley release and older versions of the system:

- SETQ does not interact with the File Manager. In older releases (Koto, etc.), when you typed in (SETQ FOO *some-new-value*) the executive responded with (FOO reset) and the file manager was told that FOO's value had changed. Files containing FOO were marked for cleanup, if none existed you were prompted for one when you typed (FILES?).

  This is still the case in the Old Interlisp executive but not in any of the others. If you are setting a variable that is significant to a program and you want to save it on a file, you should use the Common Lisp macro CL:DEFPARAMETER instead of SETQ. This will give the symbol a definition of type VARIABLES (instead of VARS), and it will be noticed by the File Manager. Subseqent

changes to the variable must be done by another call to CL:DEFPARAMETER or by editing it using ED (not DV).

- The following functions and variables are only available in the Old Interlisp Exec: LISPX, USEREXEC, LISPXEVAL, READBUF, (READLINE), (LISPXREAD), (LISPXREADP), (LISPXUNREAD), (PROMPTCHAR), (HISTORYSAVE), (LISPXSTOREVALUE), (LISPXFIND), (HISTORYFIND), (HISROTYMATCH), (ENTRY), (UNDOSAVE), #UNDOSAVES, (NEW/FN), (LISPX/), (UNDOLISPX), (UNDOLISPX1), and (PRINTHISTORY).

  The function USEREXEC invokes an old-style executive, but uses the package and readtable of its caller. Callers of LISPXEVAL should use EXEC-EVAL instead.

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