Application Note: Starting IsoMax State Machines

When the IsoPod is reset, it disables all running state machines. You must explicitly start your state machines as part of your application -- usually, in your autostart code. There are two ways to do this: with `INSTALL`, or with `SCHEDULE-RUNS`.

Using INSTALL to start a State Machine

From IsoMax version 0.36 onward, the preferred method of starting state machines is with `INSTALL`. After you have defined a state machine, you can start it by typing

```
state-name SET-STATE
INSTALL machine-name
```

Note that you must use `SET-STATE` to specify the starting state of the machine **first.** This is because `INSTALL` will start the machine immediately. To start more machines, simply `INSTALL` them one at a time:

```
state-name-2 SET-STATE
INSTALL machine-name-2
state-name-3 SET-STATE
INSTALL machine-name-3
etc.
```

Normally,[1] the state machine will start running immediately at the default rate of 100 Hz. `SET-STATE` and `INSTALL` can be used even while other state machines are running, that is, `INSTALL` will *add* a state machine to an already-running list of state machines.

At present, up to 16 state machines can be `INSTALL`ed. Attempting to `INSTALL` more than 16 machines will result in the message "Too many machines." To install more machines, you can use `UNINSTALL` or define a `MACHINE-CHAIN` (both described below).

`SET-STATE` and `INSTALL` can be used interactively from the command interpreter, or as part of a word definition.

Removing a State Machine

`INSTALL` builds a list of state machines which are run by IsoMax. `UNINSTALL` will remove the last-added machine from this list. You can use `UNINSTALL` repeatedly to remove more machines from the list, in a last-in first-out order. For example:

```
INSTALL machine-name-1    ( SET-STATE commands have been omitted for clarity)
INSTALL machine-name-2
INSTALL machine-name-3
      . . .
UNINSTALL                       ...removes machine-name-3
UNINSTALL                       ...removes machine-name-2
UNINSTALL                       ...removes machine-name-1
UNINSTALL                       ...removes nothing
```

If there are no state machines running, `UNINSTALL` will simply print the message "No machines."

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[1] The commands `COLD`, `SCRUB`, and `STOP-TIMER` will halt IsoMax. The command `SCHEDULE-RUNS` will override the `INSTALL`ed state machines and dedicate IsoMax to running a particular machine chain.

To remove *all* the `INSTALL`ed state machines with a single command, use `NO-MACHINES`.

Changing the IsoMax Speed

When the IsoPod is reset, IsoMax returns to its default rate of 100 Hz -- that is, all the state machines are performed once every 10 milliseconds. You can change this rate with `PERIOD`. The command

        n PERIOD

will set the IsoMax period to "`n`" cycles of a 5 MHz clock. Thus,

        DECIMAL 5000 PERIOD   ...will execute state machines once per millisecond

        DECIMAL 1000 PERIOD   ...will execute state machines every 200 microseconds

...and so on. You can specify a period from 10 to 65535.[2] (Be sure to specify the `DECIMAL` base when entering large numbers, or you may get the wrong value.) The default period is 50000.

Stopping and Restarting IsoMax

Certain commands will halt IsoMax processing:

        the `COLD` command
        the `SCRUB` command

This is necessary because either `COLD` or `SCRUB` can remove state machines from the IsoPod memory.[3] You can also halt IsoMax manually with the command `STOP-TIMER`.

In all these cases, the timer that runs IsoMax is halted. So, even if you `INSTALL` new state machines, they won't run. To restart IsoMax you should use the command `ISOMAX-START`. This command will

        a) Remove all installed state machines, and
        b) Start IsoMax at the default rate of 100 Hz.

Since `ISOMAX-START` removes all installed state machines, you must use it *before* you use `INSTALL`. For example:

        STOP-TIMER
            . . .
        ISOMAX-START
        state-name-1 SET-STATE
        INSTALL machine-name-1
        state-name-2 SET-STATE
        INSTALL machine-name-2
        state-name-3 SET-STATE
        INSTALL machine-name-3

Resetting the IsoPod does the same as `ISOMAX-START`: it will remove all installed state machines, and reset the timer to the default rate of 100 Hz.

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[2] Note, however, that very few state machines will be able to run in 2 microseconds (corresponding to `10 PERIOD`). If you specify too small a `PERIOD`, no harm will be done, but IsoMax will "skip" periods as needed to process the state machines.

[3] The command `FORGET` can also remove state machines from memory. Be very careful when using `FORGET` that you don't remove an active state machine; or use `STOP-TIMER` to halt IsoMax first.

Running More Than 16 Machines

`INSTALL` can install both state machines and *machine chains*. A "machine chain" is a group of state machines that is executed together. Machine chains, like state machines, are compiled as part of the program:

```
MACHINE-CHAIN chain-name
      machine-name-1
      machine-name-2
      machine-name-3
END-MACHINE-CHAIN
```

This example defines a chain with the given name, and includes the three specified state machines (which must already have been defined). A machine chain can include any number of state machines.

You must still set the starting state for each of the state machines in a machine chain, before you install the chain. So, you could start this example chain with:

```
state-name-1 SET-STATE          ...a state in machine-name-1
state-name-2 SET-STATE          ...a state in machine-name-2
state-name-3 SET-STATE          ...a state in machine-name-3
INSTALL chain-name
```

You can of course `UNINSTALL` a machine chain, which will stop all of its state machines.

Using SCHEDULE-RUNS

Prior to IsoMax version 0.36, the preferred method of starting state machines was with `SCHEDULE-RUNS`.[4] `SCHEDULE-RUNS` worked only with machine chains, and required you to specify the IsoMax period when you started the machines:

```
EVERY n CYCLES SCHEDULE-RUNS chain-name
```

`SCHEDULE-RUNS` is still available in IsoMax, to allow older IsoMax programs to be compiled. **However,** you should be aware that using `SCHEDULE-RUNS` will *disable* any machines started with `INSTALL`. `SCHEDULE-RUNS` *replaces* any previously running state machines -- including any previous use of `SCHEDULE-RUNS` -- and there is no "uninstall" function for it. After using `SCHEDULE-RUNS`, the only ways to "reactivate" the `INSTALL` function are

    a) use the `ISOMAX-START` command, or
    b) reset the IsoPod

`ISOMAX-START` will disable any machine chain started by `SCHEDULE-RUNS`, and will re-initialize IsoMax. You can then `INSTALL` state machines as described above.

You can use the `PERIOD` command to change the speed of a machine chain started with `SCHEDULE-RUNS`.

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[4] Some versions of IsoMax prior to version 0.36 have a different implementation of `INSTALL`. That implementation does not work as described here, so for those versions of IsoMax we recommend you use `SCHEDULE-RUNS`.

Autostarting State Machines

When the IsoPod is reset, all state machines are halted. (Strictly speaking, the IsoMax timer is running, but the list of installed state machines is empty.) To automatically start your state machines after a reset, you must write an autostart routine, which uses `SET-STATE` and `INSTALL` to start your machines. For example:

```
: MAIN
      state-name-1 SET-STATE
      INSTALL machine-name-1
      state-name-2 SET-STATE
      INSTALL machine-name-2
      state-name-3 SET-STATE
      INSTALL machine-name-3

      . . . more startup code . . .
      . . . application code . . .

; EEWORD

SAVE-RAM
HEX 7C00 AUTOSTART MAIN
```

In this example, the word `MAIN` is executed when the IsoPod is reset. The first thing it does is to install three state machines. Note that these machines will begin running immediately. If you need to do some initialization before starting these machines, that code should appear before the first `INSTALL` command.

Refer to "Autostarting an IsoMax Application" for details about using `SAVE-RAM` and `AUTOSTART`.